Escola de Álgebra XXVII

Brazilian Algebra Meeting
27th edition

July 15-19, 2024 IME-USP

ABSTRACTS

FAPESP CAPES CNPq INCTMat Instituto Nacional de Ciência e Tecnologia de Matemática FAPERJ Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro IME USP Universidade de São Paulo PROEX PPG-MAT IME-USP

Version: July 22, 2024

July 22 - changes

- List of participants updated

July 21 - changes

- S8 talks (1 abstract removed), S8 timetable updated
- S9 posters (2 abstacts removed)
- List of participants updated

July 18 - changes

- S7 talks (1 abstract included), S7 timetable updated
- List of participants updated

July 17 - changes

- S4 talks (1 abstract updated)
- S5 posters (1 abstract removed)
- S6 talks (1 abstract removed), S6 timetable updated
- S7 posters (1 abstract removed)
- List of partcipants updated

July 16 - changes

- S1 posters (2 abstracts removed)
- S4 talks (1 abstract removed) timetable updated
- S8 posters (2 abstracts removed)
- List of participants updated

July 14 - changes

- Plenary talks timetable updated
- S3 talks (1 abstract removed, 1 abstract updated), S3 timetable updated
- S5 talks (2 abstracts removed) S5 timetable updated
- S9 posters (1 abstract included)
- List of participants updated

July 13 - changes

- S4 talks (1 abstract updated)

July 12 - changes:

- S2 talks (2 abstract updated)
- S8 timetable updated
- S9 posters (1 abstract included)
- List of participants updated

July 11 - changes:

- S7/S9 posters (1 abstract moved from S7 to S9)

July 9 - changes:

- plenary talks (1 abstract updated)
- S8 talks (1 abstract updated, 1 abstract removed)

Scientific Committee

- Ana Cristina Vieira, UFMG
- Carolina Araujo, IMPA
- Dessislava Kochloukova, IMECC-UNICAMP
- Eduardo do Nascimento Marcos, IME-USP
- Pavel Zalesski, UnB
- Plamen E. Kochloukov, IMECC-UNICAMP

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- Javier Sánchez Serdà
- Felipe Yukihide Yasumura
- Jose Luis Vilca Rodriguez
- Kostiantyn Iusenko (chair)
- Lucia Satie Ikemoto Murakami
- Vitor de Oliveira Ferreira

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- Antonio Paques, UFRGS
- Aron Simis, UFPE
- César Polcino, IME-USP
- Israel Vainsencher, UFMG
- Ivan Shestakov, IME-USP
- Said Sidki, UnB
- Noraí Rocco, UnB

Sessions organizers

S1 – Algebraic geometry and commutative algebra

- Aline Andrade (UFMG)
- Maral Mostafazadehfard (UFRJ)
- Renato Vidal da Silva Martins (UFMG)

S2 – Algebraic methods in various areas

- Cristian Ortiz (IME-USP)
- Matias del Hoyo (UFF)
- Mikhailo Dokuchaev (IME-USP)

S3 – Coalgebras, Hopf algebras, and related topics

- Bárbara Seelig Pogorelsky (UFRGS)
- Marcelo Muniz Silva Alves (UFPR)
- Vitor de Oliveira Ferreira (IME-USP)

S4 – Finite Fields and Applications

- Herivelto M. Borges Filho (ICMC-USP)
- César Polcino (IME-USP)
- Cícero Carvalho (UFU)

S5 – Group Theory

- Luis Augusto de Mendonça (UFMG)
- Martino Garonzi (UnB)
- Slobodan Tanushevski (UFF)

S6 – Lie Algebras

- Luis Enrique Ramirez (UFABC)
- Matheus Brito (UFPR)
- Germán Benitez Monsalve (UFAM)

S7 – Number Theory

- Diego Marques (UnB)
- Jean Carlos de Aguiar Lelis (UFPA)
- Sinai Robins (IME-USP)

S8 – Representation theory

- Flávio U. Coelho (USP)
- John William Macquarrie (UFMG)
- Viktor Bekkert (UFMG)

S9 – Rings

- María Eugenia Martin (UFPR)
- Érica Zancanella Fornaroli (UEM)
- Viviane Ribeiro Tomaz da Silva (UFMG)

Plenary speakers

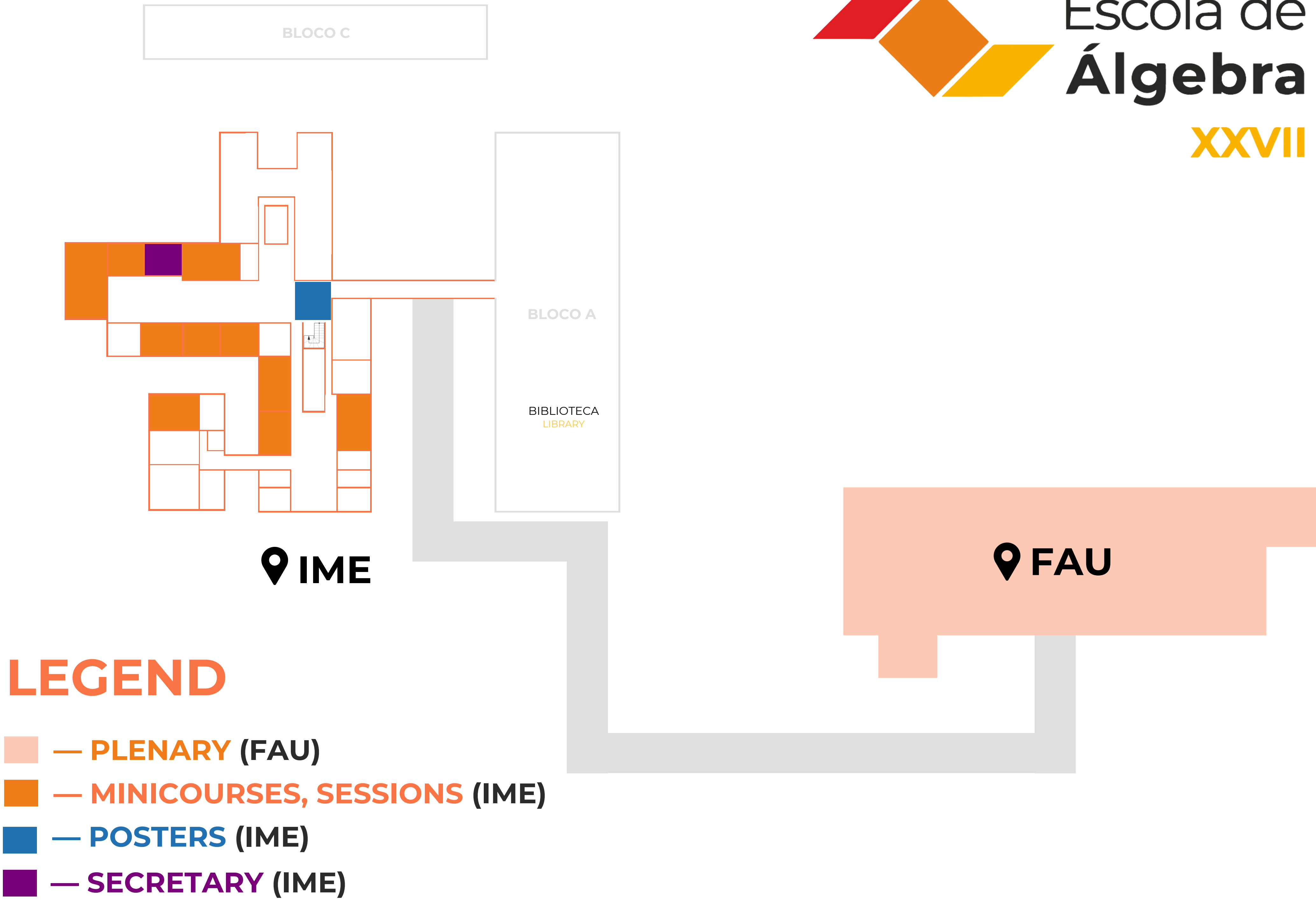
- Alberto Elduque (Universidad de Zaragoza, Spain)
- Andrea Solotar (Universidad de Buenos Aires, Argentina)
- Antonio Giambruno (Università degli Studi di Palermo, Italy)
- Cecília Salgado (University of Groningen, Netherlands)
- Conchita Martínez Perez (Universidad de Zaragoza, Spain)
- Dolors Herbera (Universitat Autònoma de Barcelona, Spain)
- Henrique Bursztyn (IMPA, Brazil)
- Jeremy Rickard (University of Bristol, UK)
- Volodymyr Nekrashevych (Texas A&M University, USA)
- Yuly Billig (Carleton University, Canada)

General index

Abstracts

Escola de **Álgebra**

XXVII



M1 Room CEC-06

M2 B02

M3 B01

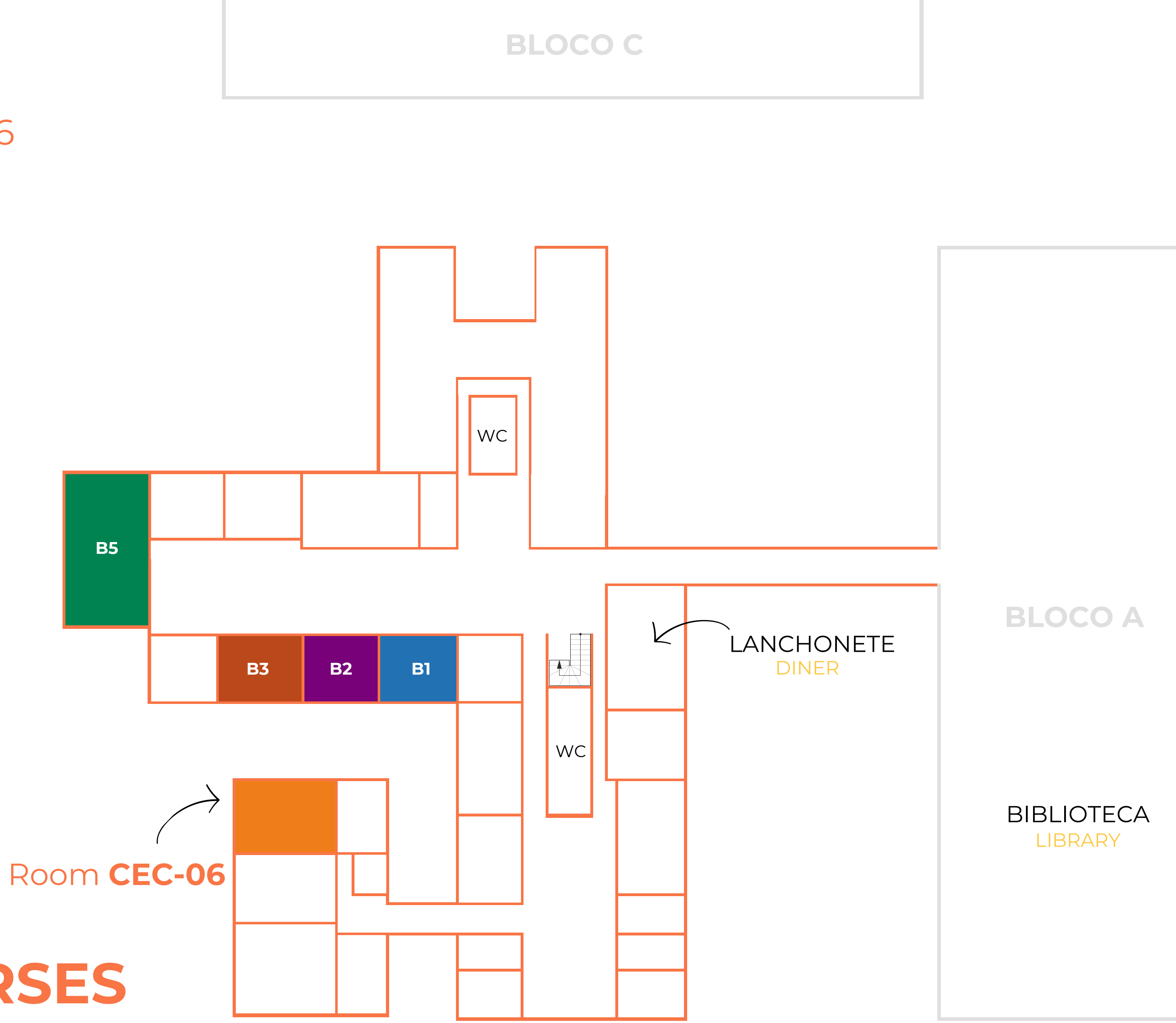
M4 B01

M5 B05

M6 B02

M7 B05

M8 B03



MINI COURSES

SESSION 1	B1
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SESSION 4	B16
SESSION 5	JACY MONTEIRO
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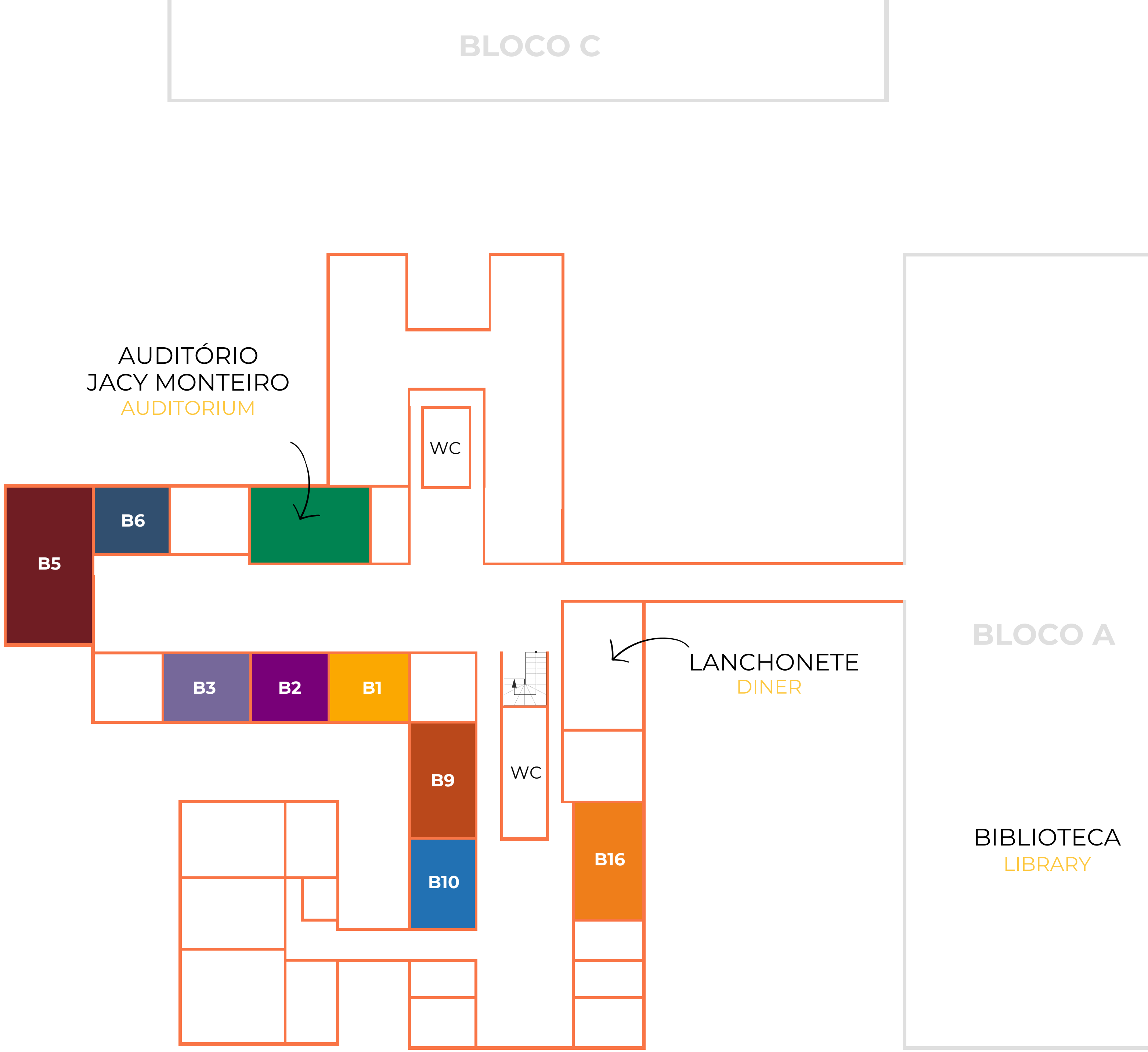

SESSIONS

MINICOURSES and PLENARY TALKS TIMETABLE

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-8:50	MC1, MC2, MC4, MC5				
9:00-9:50	MC3, MC6, MC7, MC8				
10:00-10:20	coffee break				
10:20-10:30	Opening	coffee break			
10:30-11:20	Antonio Giambruno (p. 47)	Volodymyr Nekrashevych (p. 50)	Cecília Salgado (p. 52)	Henrique Bursztyn (p. 45)	Yuly Billig (p. 44)
11:30-12:20	Dolors Herbera (p. 48)	Andrea Solotar (p. 53)	Jeremy Rickard (p. 51)	Conchita Martínez-Perez (p. 49)	Alberto Elduque (p. 46)
12:30-13:00			homage to Adilson Gonçalves		
13:00-13:30			homage to Jairo Gonçalves		

MC1: An Introduction to Computer Algebra with GAP (Csaba Schneider and Igor Lima): room CEC-6, IME (p. 56)
MC2: Exploring Rational Points on Curves over Finite Fields (Herivelto Borges): room B02, IME (p. 57)
MC3: Higher homological algebra in representation theory (Hipolito Treffinger): room B01, IME (p. 58)
MC4: Vertex Algebras (Jethro van Ekeren): room B01, IME (p. 60)
MC5: Selberg's Lemma and Applications (Samuel Quirino and Lucas Souza): room B05, IME (p. 61)
MC6: Congruences and cohomology (Masha Vlasenko): room B02, IME (p. 63)
MC7: Group gradings on algebras and modules (Mikhail Kotchetov): room B05, IME (p. 65)
MC8: New foundations for matroid theory and tropical geometry (Oliver Lorscheid): room B03, IME (p. 66)

Coffee-break: FAU
Plenary talks: FAU's auditorium

S1 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)	Friday (p. 24)
14:00 - 14:35	Ethan Cotterill (p. 72)	André Contiero (p. 71)		Cleto Miranda-Neto (p. 80)	Zaqueu Ramos (p. 82)
14:40 - 15:15	Victor Pretti (p. 81)	Myrla Barbosa (p. 70)	free	Amar Henni (p. 77)	Rafael Holanda (p. 78)
15:20 - 15:55	Aislan Leal Fontes (p. 74)	Rodrigo Gondim (p. 76)		Thiago Freitas (p. 75)	Andre Dosea (p. 73)
16:00 - 16:30	coffee break / posters			coffee break / posters	
16:30 - 17:05				Victor D. Rubio (p. 83)	Felipe Zingali Meira (p. 79)

S1 room: B01 - IME

S2 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)	Friday (p. 24)
14:00 - 14:35	Alcides Buss (p. 100)	Arkady Tsurkov (p. 115)	free	Jethro van Ekeren (p. 104)	Claudio Gorodski (p. 106)
14:40 - 15:15	Gilles G. Castro (p. 102)	Eugene Plotkin (p. 112)		Thais Dalbelo (p. 103)	Emilia Alves (p. 99)
15:20 - 15:55	Daniel Gonçalves (p. 105)	Amanda Silva (p. 113)		Ariel Molinuevo (p. 110)	Daniel Lopez-Garcia (p. 109)
16:00 - 16:30	coffee break / posters			coffee break / posters	
16:30 - 17:05	Emmanuel Jerez (p. 107)	Lucas R. Lima (p. 108)		Gisele T. Paula (p. 111)	Alejandro Cabrera (p. 101)
17:10 - 17:45	Francisco G.K.C. Vidal (p. 116)	Jose Victor G. Teixeira (p. 114)			

S2 room: B02 - IME

S3 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)
14:00 - 14:35	Dirceu Bagio (p. 123)	Samuel Quirino (p. 126)	free	Gilson R. Santos F. (p. 129)
14:40 - 15:15	Bárbara Pogorelsky (p. 125)	Monique M.L. Rocha (p. 127)		Willian Velasco (p. 130)
15:20 - 15:55	Marcelo M.S. Alves (p. 122)	Virgínia S. Rodrigues (p. 128)		
16:00 - 16:30	coffee break / posters			
16:30 - 17:25	Vladislav K. Kharchenko (p. 124)			

S3 room: B03 - IME

S4 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)
14:00 - 14:15	Andre Leroy (p. 151)	Sergio Lopez-Permouth (p. 152)	free	Elena Berardini (p. 145)
14:20 - 14:35				Jade Nardi (p. 153)
14:40 - 14:55	Melina Privitelli (p. 157)	Annamaria Iezzi (p. 150)		John H. Castillo (p. 148)
15:00 - 15:15	Mariana Pérez (p. 156)	Cícero Carvalho (p. 147)		Claudio Qureshi (p. 158)
15:20 - 15:35	Fabio Brochero (p. 146)	Nazar Arakelian (p. 141)		Lara Vicino (p. 165)
15:40 - 15:55	Lucas Reis (p. 159)	Daniela A. Oliveira (p. 155)		Samir Assuena (p. 143)
16:00 - 16:30	coffee break / posters			coffee break / posters
16:30 - 16:45	Roberto Alvarenga (p. 139)	Pietro Speziali (p. 164)		André Luís Silva (p. 160)
16:50 - 17:05	Victor G.L. Neumann (p. 154)	Sarah Arpin (p. 142)		Franciele C. Silva (p. 161)
17:10 - 17:25	Arthur Fernandes (p. 149)	João P.G. Sousa (p. 162)		Juliana G. F. Souza (p. 163)
17:30 - 17:45		Cintya W.O. Benedito (p. 144)		
17:50 - 18:05		Carina Alves (p. 140)		

S4 room: B16 - IME

S5 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)	Friday (p. 24)
14:00 - 14:25	Noraí Rocco (p. 196)	Claude Marion (p. 191)		Pavel Zalesski (p. 203)	Csaba Schneider (p. 199)
14:30 - 14:55	Nicola Sambonet (p. 197)	Rosemary Miguel (p. 192)		Marlon Stefano (p. 201)	Danilo Silveira (p. 200)
15:00 - 15:25	Raimundo Bastos Jr. (p. 181)	Esteban Hernandez (p. 185)		Altair Tosti (p. 202)	Alex Dantas (p. 184)
15:30 - 15:55	Dylene Barros (p. 180)	Gurmeet Bakshi (p. 179)	free	Irene Nakaoka (p. 194)	
16:00 - 16:30	coffee break / posters			coffee break / posters	
16:30 - 16:55	Tulio Santos (p. 198)	Yuri Santos Rego (p. 195)		Marco Boggi (p. 182)	Sheila Chagas (p. 183)
17:00 - 17:25	Ênio Leite (p. 186)	Melissa S. Luiz (p. 187)		Mayumi Makuta (p. 190)	Plinio Murillo (p. 193)
17:30 - 17:55		John MacQuarrie (p. 188)		Sugandha Maheshwary (p. 189)	

S5 room: Auditório Jacy Monteiro - IME

S6 TIMETABLE

<table>
<tr><th></th><th>Monday
(p. 21)</th><th>Tuesday
(p. 22)</th><th>Wednesday</th><th>Thursday
(p. 23)</th></tr>
<tr><td>14:00 - 14:35</td><td>Theo Zapata
(p. 229)</td><td>Luan Bezerra
(p. 220)</td><td rowspan="6">free</td><td>Juan C. Arias U.
(p. 219)</td></tr>
<tr><td>14:40 - 15:15</td><td>Oscar Márquez
(p. 225)</td><td>Matheus Brito
(p. 221)</td><td>Oscar Morales
(p. 226)</td></tr>
<tr><td>15:20 - 15:55</td><td>María A. Alvarez
(p. 218)</td><td></td><td>João Schwarz
(p. 227)</td></tr>
<tr><td>16:00 - 16:30</td><td colspan="2">coffee break / posters</td><td>coffee break / posters</td></tr>
<tr><td>16:30 - 16:55</td><td rowspan="2">Vladimir Dotsenko
(p. 222)</td><td rowspan="2">Ryo Fujita
(p. 223)</td><td>José L. Vilca-Rodríguez
(p. 228)</td></tr>
<tr><td>17:00 - 17:25</td><td>Alexandre Grichkov
(p. 224)</td></tr>
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S6 room: B06 - IME

S7 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)
14:00 - 14:35	Robson Araujo (p. 236)	Hemar Godinho (p. 241)		Lucas Colucci (p. 238)
14:40 - 15:15	Marco Aymone (p. 237)	Sávio Ribas (p. 246)		Luan A. Ferreira (p. 239)
15:20 - 15:55	Valdir J. Pereira Jr (p. 245)	Sajad Salami (p. 247)	free	Jean Lelis (p. 243)
16:00 - 16:30	coffee break / posters			coffee break / posters
16:30 - 17:25	Luís R.A. Finotti (p. 240)	Ramon Nunes (p. 244)		Marc Hindry (p. 242)

S7 room: B09 - IME

S8 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)	Friday (p. 24)
14:00 - 14:40	Jeremy Rickard (p. 272)	Sonia Trepode (p. 273)		Marcelo Lanzilotta (p. 263)	Eduardo Marcos (p. 264)
14:50 - 15:20	Viktor Chust (p. 258)	Vitor Gulisz (p. 262)		Júlio Marques (p. 266)	Tobias Pinto (p. 270)
15:30 - 16:00	Leo Margolis (p. 265)	Roger Primolan (p. 271)	free	Ricardo Franquiz (p. 259)	Fernando Naves (p. 267)
16:00 - 16:30	coffee break / posters			coffee break / posters	
16:30 - 17:00	Viktor Bekkert (p. 257)	Ana Clara G. Elsener (p. 261)		Sinem Odabaşı (p. 268)	Felipe Gallego-Olaya (p. 260)
17:10 - 17:40	Marco A. Pérez (p. 269)	Edson Álvares (p. 256)			

S8 room: B10 - IME

S9 TIMETABLE

	Monday (p. 21)	Tuesday (p. 22)	Wednesday	Thursday (p. 23)	Friday (p. 24)
14:00 - 14:35	Ivan Shestakov (p. 306)	Ma Isabel Hernández (p. 292)		Plamen Kochloukov (p. 295)	Iryna Kashuba (p. 294)
14:40 - 14:55	Diogo Diniz (p. 287)	Victor Petrogradsky (p. 302)		Artem Lopatin (p. 297)	Rodrigo L. Rodrigues (p. 304)
15:00 - 15:15	Alexander Holguín Villa (p. 293)	Victor H. López Solís (p. 298)		Claudemir Bezerra Jr (p. 284)	Paula Cadavid (p. 285)
15:20 - 15:35	Víctor Marín (p. 300)	Paula M. Veloso (p. 309)	free	Manuela S. Souza (p. 308)	Mikhailo Dokuchaev (p. 288)
15:40 - 15:55	Renato Fehlberg Jr (p. 290)	Elena Aladova (p. 283)		Pedro Fagundes (p. 289)	Juaci Picanço (p. 303)
16:00 - 16:30	coffee break / posters			coffee break / posters	
16:30 - 17:05	Onofrio M. Di Vincenzo (p. 286)	Leonid Makar-Limanov (p. 299)		Daniela La Mattina (p. 296)	
17:10 - 17:25	Viviane R.T. Silva (p. 307)	Érica Z. Fornaroli (p. 291)		Thiago C. Mello (p. 301)	
17:30 - 17:45	Liudmila Sabinina (p. 305)				

S9 room: B05 - IME

SCHEDULE OF POSTER PRESENTATIONS

Monday, July 15

- S1 – Algebraic geometry and commutative algebra (p. 84)
- S2 – Algebraic methods in various areas (p. 117)
- S3 – Coalgebras, Hopf algebras, and related topics (p. 131)
- S6 – Lie algebras and their representations (p. 230)
- S8 – Representations of algebras (p. 274)

Tuesday, July 16

- S4 – Finite fields and applications (p. 166)
- S5 – Group Theory (p. 204)
- S7 – Number Theory (p. 248)

Thursday, July 18

- S9 – Rings (p. 310)

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TIMETABLE - July 15, 2024 (Monday)

	S1 (p. 11) room B01	S2 (p. 12) room B02	S3 (p. 13) room B03	S4 (p. 14) room B16	S5 (p. 15) Jacy	S6 (p. 16) room B06	S7 (p. 17) room B09	S8 (p. 18) room B10	S9 (p. 19) room B05
14:00-14:15	Cotterill	Buss	Baggio	Leroy	Rocco	Zapata	Araujo	Rickard	Shestakov
14:20-14:35					Sambonet				
14:40-14:55	Pretti	Castro	Pogorelsky	Privitelli		Marquez	Aymone	Chust	D.Diniz
15:00-15:15				Perez	Bastos				Holguín V.
15:20-15:35	Fontes	Gonçalves	M.Alves	Brochero	Barros	Alvarez	Pereira	Margolis	Marín
15:40-15:55				Reis					Fehlberg
16:00-16:30	coffee break / Posters S1, S2, S3, S6, S8								
16:30-16:45		Jerez	Kharchenko	Alvarenga	T.Santos	Dotsenko	Finotti	Bekkert	Di Vincenzo
16:50-17:05				Neumann	Leite				
17:10-17:25		Vidal		Fernandes				Perez	V.Silva
17:30-17:45									Sabinina

TIMETABLE - July 16, 2024 (Tuesday)

	S1 (p. 11) room B01	S2 (p. 12) room B02	S3 (p. 13) room B03	S4 (p. 14) room B16	S5 (p. 15) Jacy	S6 (p. 16) room B06	S7 (p. 17) room B09	S8 (p. 18) room B10	S9 (p. 19) room B05
14:00-14:15	Contiero	Tsurkov	Quirino	Lopez-P.	Marion	Bezerra	Godinho	Trepode	Hernández
14:20-14:35					Miguel				
14:40-14:55	Barbosa	Plotkin	M. Rocha	Iezzi		Brito	Ribas	Gulisz	Petrogradsky
15:00-15:15				Carvalho	Hernandez				López S.
15:20-15:35	Gondim	A.Silva	Rodrigues	Arakelian	Bakshi		Salami	Primolan	Veloso
15:40-15:55				D.Oliveira					Aladova
16:00-16:30	coffee break / Posters S4, S5, S7								
16:30-16:45		L.Lima		Speziali	Rego	Fujita	Nunes	Elsener	Makar-Limanov
16:50-17:05				Arpin	M.Luiz				
17:10-17:25		Teixeira		J.Sousa				Alvares	Fornaroli
17:30-17:45				Benedito	MacQuarrie				
17:50-18:05				C.Alves					

TIMETABLE - July 18, 2024 (Thursday)

	S1 (p. 11) room B01	S2 (p. 12) room B02	S3 (p. 13) room B03	S4 (p. 14) room B16	S5 (p. 15) Jacy	S6 (p. 16) room B06	S7 (p. 17) room B09	S8 (p. 18) room B10	S9 (p. 19) room B05
14:00-14:15	Miranda	Ekeren	G.Santos	Berardini	P.Zalesski	Arias	Colucci	Lanzilotta	Kochloukov
14:20-14:35				Nardi	Stefano				
14:40-14:55	Henni	Dalbelo	Velasco	Castillo		Morales	Ferreira	Marques	Lopatin
15:00-15:15				Qureshi	Tosti				Bezerra
15:20-15:35	Freitas	Molinuevo		Vicino		Schwarz	Lelis		M.Souza
15:40-15:55				Assuena	Nakaoka			Franquiz	Fagundes
16:00-16:30	coffee break / Posters S9								
16:30-16:45	Rubio	Paula		A.Silva	Boggi	Vilca R.	Hindry	Odabaşı	La Mattina
16:50-17:05				F.Silva	Makuta	Grichkov			
17:10-17:25				J.Souza					Mello
17:30-17:55					Maheshwary				

TIMETABLE - July 19, 2024 (Friday)

	S1 (p. 11) room B01	S2 (p. 12) room B02	S3 (p. 13) room B03	S4 (p. 14) room B16	S5 (p. 15) Jacy	S6 (p. 16) room B06	S7 (p. 17) room B09	S8 (p. 18) room B10	S9 (p. 19) room B05
14:00-14:15	Ramos	Gorodski			Schneider			Marcos	Kashuba
14:20-14:35					Silveira				
14:40-14:55	Holanda	E.Alves						Pinto	Rodrigues
15:00-15:15					Dantas				Cadavid
15:20-15:35	Dosea	Lopez						Naves	Dokuchaev
15:40-15:55									Picanço
16:00-16:30	coffee break								
16:30-16:45	Meira	Cabrera			Chagas			Gallego	
16:50-17:05					Murillo				
17:10-17:25									

Index of all abstracts

Plenary talks

Contents - Plenary talks

AV-modules

Yuly Billig
Carleton University, Canada

We wish to understand the representation theory of the Lie algebra V of vector fields on a smooth algebraic variety X. We introduce the category of AV-modules, which admit compatible actions of the Lie algebra of vector fields V and the commutative algebra A of functions on X. Modules over the algebra D of differential operators, or D-modules, form an important subcategory of AV-modules. Still, there are many natural examples of AV-modules that are not D-modules, like vector fields themselves. AV-modules were instrumental in establishing recent classification theorems of weight modules over the torus and the affine (super) spaces, however, we can study them in a much more general setting. In this talk, we shall discuss the theory of AV-modules over affine and projective varieties.

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Back to morning timetable: 10
Back to general index: 6

Symplectic geometry on graded manifolds

Henrique Bursztyn
IMPA, Brazil

Graded manifolds can be thought of as manifolds equipped with a suitable sheaf of graded algebras or, more intuitively, manifolds with local coordinates carrying an additional grading. I will discuss how symplectic geometry on graded N-manifolds leads to effective methods for studying objects in (higher) Lie theory and differential geometry that have gained interest in recent years, especially in connection with mathematical physics. The basic principle is that complicated/unfamiliar objects in classical geometry can often be translated into standard/familiar geometric structures defined on symplectic graded manifolds. I will illustrate fruitful applications of this viewpoint.

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Gradings on simple Lie algebras: old and new

Alberto Elduque
Universidad de Zaragoza, Spain

After reviewing the basic definitions about gradings, it will be shown how gradings by abelian groups on a (not necessarily associative) algebra correspond to morphisms from diagonalizable group schemes to the automorphism group scheme of the algebra. This is the clue to classify gradings on simple Lie algebras. The known classification results of such gradings will be surveyed. Moreover, the notion of almost fine gradings will be introduced. The classification of gradings up to isomorphism will be shown to be equivalent to classifying almost fine gradings up to equivalence and to determining their Weyl groups.

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Polynomial identities and central polynomials of associative algebras

Antonio Giambruno
Università degli Studi di Palermo, Italy

In my talk I will start by giving an overview of some of the links that the theory of polynomial identities has with other branches of mathematics.

Then I will focus on the progress made in the last few years in the construction of invariants of the identities of an algebra involving central polynomials.

Let A be an associative algebra over a field F and $F\langle X\rangle$ the free associative algebra of countable rank.

A polyomial $f \in F\langle X\rangle$ is a central polynomial of A if for any $a_1, \ldots, a_n \in A$, $f(a_1, \ldots, a_n) \in Z(A)$, the center of A. In case A takes only the zero value, f is a polynomial identity of A whereas if takes a non-zero value in $Z(A)$, we say that f is a proper central polynomial of A.

For instance $[x_1, x_2]^2$ is a proper central polynomial of $M_2(F)$, the algebra of 2×2 matrices over F.

I will compare the growth of the spaces of central polynomials, proper central polynomials and polynomial identities of an algebra A in characterstic zero, in a sense that I will explain. I will be interested in the asymptotic behavior of certain corresponding numerical sequences, and I will construct some algebras with specific extreme properties.

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Torsion free modules over commutative domains of Krull dimension 1

Dolors Herbera
Universitat Autònoma de Barcelona, Spain

Let R be a commutative domain. Let $\mathcal{F}$ be the class of R-modules that are infinite direct sums of finitely generated torsion-free modules. In the talk we will discuss the question whether $\mathcal{F}$ is closed under direct summands.

If R is local of Krull dimension 1, we prove that $\mathcal{F}$ is closed under direct summands if and only if any indecomposable, finitely generated torsion-free module has local endomorphism ring. If, in addition, R is noetherian this is further equivalent to R having local integral closure.

Recall that R is domain of finite character, if any nonzero ideal of R is only contained in a finite number of maximal ideals. For domains of finite character and of Krull dimension 1, the property $\mathcal{F}$ being closed under direct summands is inhereted by localization at a maximal ideal and, moreover, any localization at a maximal ideal of R, exept may be one, satisfies that any finitely generated ideal is two-generated. We manage to prove that the converse is true when R is integrally closed and also when R is noetherian with module-finite normalization.

The proof of such results rely on two main technical tools:

- Příhoda's theory of fair-sized projective modules [4,3] and its extension to a non-noetherian setting [2], that gives us a way to construct infinitely generated non-trivial summands;
- The Package Deal Theorems by L. Levy and C. Odenthal [5] that we extend to the setting of h-local domains that allows to glue together in a module over R compatible families of torsion-free modules over the localizations at maximal ideals.

These results are contained in the preprint [1].

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From right angled Artin groups to Artin groups: cohomology and combinatorics

Conchita Martínez-Perez
Universidad de Zaragoza, Spain

Artin groups are a fascinating and rather mysterious class of groups. Although we have a reasonably good understanding of some subfamilies, such as spherical or right angled Artin groups, there are still many basic questions about arbitrary Artin groups, such as whether they are torsion free. In this talk we will review some recent results on Artin groups, with a focus on properties of cohomological nature.

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Groups and algebras of dynamical origin
Volodymyr Nekrashevych
Texas A&M University, USA

We will discuss algebraic objects (groups and algebras) naturally associated with topological dynamical systems. Properties of the dynamical systems can be effectively used to study algebraic properties of the associated groups and algebras such as growth, amenability, simplicity, torsion, etc. In particular, one can construct examples with exotic properties, such as groups of intermediate growth, non-elementarily amenable groups, or simple groups and algebras with additional special properties. We will also discuss how algebraic objects can be used to study properties of the associated dynamical systems.

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The finitistic dimension conjecture

Jeremy Rickard
University of Bristol, UK

The finitistic dimension conjecture, a conjecture about homological properties of representations of finite-dimensional algebras, has been open since around 1960. It has since been shown to be related to several other questions. In the last ten years or so, various new approaches to understanding the conjecture have appeared. This talk will be a survey, intended to be accessible to non-specialists, of the conjecture, its consequences, and recent developments.

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Mordell-Weil rank jumps on families of elliptic curves

Cecília Salgado
University of Groningen, The Netherlands

We will give an overview of the recent developments around the variation of the Mordell-Weil rank in 1-dimensional families of elliptic curves, by studying them in the guise of elliptic surfaces. In particular, we will discuss elliptic surfaces in the light of the Enriques-Kodaira classification of algebraic surfaces, different methods to study the variation of Mordell-Weil ranks and potential obstructions due to the geometry of the underlying surface, treating rational, K3s and surfaces of Kodaira dimension 1.

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Hochschild cohomology ring of triangular monomial algebras

Andrea Solotar
Universidad de Buenos Aires, Argentina

The cup product endows the Hochschild cohomology $\mathrm{HH}^*(A)$ of an associative algebra A over a field k with a structure of graded commutative algebra. The description of this ring can be studied once the graded vector space $\mathrm{HH}^*(A)$ is known. There are several examples of algebras for which this ring is completely characterized. Amongst them, for triangular string algebras, quadratic string algebras, Fibonacci algebras it is known to be trivial in positive degrees. We prove that the same result holds for triangular monomial algebras.

This is a result obtained in collaboration with Dalia Artenstein, Janina Letz and Amrei Oswald.

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Minicourses

Contents - minicourses

MC1: An Introduction to Computer Algebra with GAP

Csaba Schneider and Igor dos Santos Lima
UFMG and UnB, Brazil

The objective of this mini-course is to solve some Computational Algebra problems using the GAP system (https://gap-system.org). The problems will be solved through projects that participants can freely choose. The projects involve the programming language of the GAP system and algebraic structures such as groups, rings, fields, and algebras. There will be assistance from the instructors. No programming knowledge is required, but if participants have some experience with any programming language or basic knowledge of algebraic structures, it will facilitate participation.

Reference: https://www.gap-system.org/

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MC2: Exploring Rational Points on Curves over Finite Fields

Herivelto Martins Borges Filho
ICMC-USP, Brazil

In this mini-course, we delve into key aspects of curves over finite fields, drawing from a curated selection of topics. In particular, we discuss bounds for the number of rational points, their improvements, and applications. Throughout the five lectures, several open problems will be discussed. Overall, participants will gain insights into the following subjects:

Lecture 1

We will provide an overview of the historical aspects that have motivated the study of curves over finite fields. We will present and briefly discuss some of the main results and examples that will be explored in the next lectures.

Lecture 2

We will discuss the problem of constructing and classifying maximal curves, that is, the curves that attain the Hasse-Weil upper bound. The starting points will be a theorem by Kleiman, Serre, and Tate, applied to the Hermitian curve and its large automorphism group.

Lecture 3

In this lecture, we address the problem of improving the Hasse-Weil bound, with a focus on the alternative bounds provided by Serre, Ihara, and Stöhr-Voloch.

Lecture 4

In this lecture, we delve deeper into the theory of Stöhr-Voloch, proving a prototype version of their main results and discussing the notion of curves with many points in this context. Particular emphasis is given to Frobenius classical curves.

Lecture 5

We discuss the rudiments of the theory of error-correcting codes and the role of curves with many points in the construction of codes with good parameters.

References

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MC3: Higher homological algebra in representation theory

Hipolito Treffinger
Universidad de Buenos Aires, Argentina

A classical result by Auslander states that there is a correspondence between Artin algebras of finite representation type and algebras whose global dimension at most 2 and dominant dimension at least 2. At the end of the 2000's Iyama realized and proved that this result constitutes a special case of a more general theorem stating a correspondence of "d-representation finite" algebras and algebras whose global dimension at most $d+1$ and dominant dimension at least $d+1$. The main insight of Iyama was to realize that, instead of looking at the whole of the module category, a generalization of Auslander's result required considering a maximal orthogonal rigid subcategory, also known as a "d-cluster tilting" subcategory, which behaves much like an abelian category where the shortest non-split exact sequences have $d+2$ terms. In other words, in a d-cluster tilting subcategory the bifunctor $\mathrm{Ext}^i(-,-)$ is zero for every i between 1 and $d-1$.

In this course we will go over the basics on representation theory of Artin algebras, we will give the definition of d-cluster tilting subcategories and we will see how the classical notions adapt to the higher setting. The topics covered in this course include (higher) homological algebra, (higher) Auslander-Reiten theory and (higher) torsion classes.

Lecture 1

Module categories and homological algebra. In this first lecture we will give a short introduction to homological algebra and we will explain the main properties of module categories of Artin algebras, which is the prime example where higher homological algebra arises.

Lecure 2

Higher homological algebra. In this second lecture (or maybe at the end of the previous lecture) we will discuss the first notions of higher homological algebra (d-cluster tilting subcategories, d-exact sequences, etc.) and we will see in which way higher homological algebra generalizes classical homological algebra.

Lecture 3

Torsion classes in abelian categories. In this lecture we will speak about an important notion in homological algebra: torsion theories. We will give the definition of torsion theories and we will discuss some of its key properties. Later we will concentrate on torsion theories in module categories and its relationship with some distinguished objects known as τ-rigid objects.

Lecture 4

Torsion classes in d-abelian categories. Mirroring what we have done in the first part of the course, in this fourth lecture we will consider d-torsion classes in d-cluster tilting subcategories in arbitrary abelian categories and also in module categories, where we will see its relationship with τ_d-rigid objects.

Lecture 5

Combinatorial aspects of higher homological algebra. In this last talk we will introduce a family of algebras known as higher Auslander algebras of type A and we will explain how to understand its d-cluster tilting subcategory combinatorially. Then we will use this description to count explicitly different notions of interest in higher homological algebra.

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MC4: Vertex Algebras
Jethro van Ekeren
IMPA, Brazil

This minicourse is an introduction to vertex algebras. Other than a general background in algebra, no specific prerequisites are required. We adopt the following point of view: the study of infinite dimensional Lie algebras and their representations requires methods that have no analogues in the finite dimensional world. These techniques (which are secretly related to ideas from quantum field theory) turn out to lead naturally to the notion of vertex algebra.

Lecture 1

In this lecture we briefly review finite dimensional simple Lie algebras and their highest weight representations. Then we familiarise ourselves with some important infinite-dimensional analogues: Kac-Moody, Heisenberg, and Virasoro Lie algebras.

Lecture 2

In this lecture we investigate a way to construct representations of the Virasoro Lie algebra from representations of the Heisenberg Lie algebra (the latter being much easier to understand). Then we see how this construction leads to the notion of vertex algebra.

Lecture 3

In this lecture we study the notion of vertex algebra, get to know examples related to the infinite dimensional Lie algebras of the first lecture as well as examples coming from integral lattices, and learn how to do calculations in these algebras.

Lecture 4

In this lecture we use lattice vertex algebras to give a proof of an important result in representation theory of infinite dimensional Lie algebras: the Kac determinant formula.

Lecture 5

In this lecture we return to the historical origins of vertex algebras, and learn what they have to do with monstrous moonshine.

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MC5: Selberg's Lemma and Applications

Samuel Quirino and Lucas H. R. de Souza
UFMG, Brazil

Abstract

Selberg's Lemma states that given a finitely generated subgroup G of the linear group over $\mathbb{C}$, $GL(n, \mathbb{C})$, i.e., the group of invertible $n \times n$ matrices with entries in the complex numbers, there exists a normal subgroup of G that is torsion-free and of finite index. The beauty of this theorem is that, in its proof, it traverses through group theory, field extensions, and algebraic geometry (a course on commutative algebra), and its applications extend beyond the boundaries of algebra, touching, for example, on geometry and topology. One example is that discrete groups of isometries of hyperbolic space $\mathbb{H}^n$ immediately possess this property (having a subgroup of finite index and torsion-free), which makes the quotient of $\mathbb{H}^n$ by the group's action very well-behaved.

In this minicourse, we will present and prove Selberg's Lemma, covering the necessary prerequisites from ring theory, algebraic geometry, and field extensions, dedicating a good part of the presentation to applications in geometry.

Minicourse Plan

Day 1: Historical notes and preliminaries: - Hilbert's Nullstellensatz.

Day 2: More preliminaries: - Field extensions.

Day 3: Selberg's Lemma. - Proof of Selberg's Lemma. - Corollary: Burnside's Theorem (finitely generated and torsion subgroups of the linear group are finite). - What happens with fields of finite characteristic? - The example of $SL(n, \mathbb{Z})$. We will promote Bass-Serre Theory and how we can extract more information from these finite index subgroups of $SL(n, \mathbb{Z})$. - Examples of infinite, finitely generated, and torsion groups (the Gupta-Sidki group).

Day 4: Why do we like torsion-free groups? - Fundamental group and covering spaces. Torsion-free groups tend to have good actions, whose quotients are covering applications.

Day 5: Application - Hyperbolic geometry, models, group of isometries, Poincaré's polygon theorem, geometric interpretation of finite index subgroups. - What happens with negatively curved manifolds that are not constant (Kapovich's example)? - (If time permits) Euclidean geometry and Bieberbach's theorem. It is a theorem of the same nature as Selberg's lemma. It states that given a compact n-manifold of zero sectional curvature, there exists a finite isometric covering to an n-dimensional torus. Algebraically, the fundamental group of the manifold has a finite index subgroup isomorphic to $\mathbb{Z}^n$.

References

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MC6: Congruences and cohomology

Masha Vlasenko
Polish Academy of Sciences, Poland

The course will give an elementary account of p-adic methods in de Rham cohomology of algebraic hypersurfaces with explicit examples and applications in number theory and combinatorics. Lectures are based on a series of our joint papers with Frits Beukers entitled *Dwork crystals* ([1,2,3]). These methods also have applications in mathematical physics and arithmetic geometry ([4,5]).

For an algebraic variety X over a finite field $\mathbb{F}_p$ there exist non-negative integers m, k and algebraic numbers $\alpha_1, \ldots, \alpha_m, \beta_1, \ldots, \beta_k \in \overline{\mathbb{Q}}$ such that numbers of points on X over all field extensions are given by

$$\#X(\mathbb{F}_{p^s}) = \sum_{i=1}^{m} \alpha_i^s - \sum_{j=1}^{k} \beta_j^s \quad \text{for all} \quad s \geq 1.$$

These α_i's and β_j's are called the *Frobenius roots* of X. Their existence in a general setting was proved by Bernard Dwork in early 1960s using p-adic methods. The natural building blocks in Dwork's approach were hypersurfaces. We are going to elaborate explicit p-adic formulas for their Frobenius roots and explore related algebraic constructions.

Weil conjectures and p-adic numbers

We start with explaining why Frobenius roots are interesting and state their properties, which were conjectured in 1940s by André Weil. Weil's conjectures were proved in 1960s and 1970s leading to the creation of p-adic and étale cohomology theories, with contributions by Bernard Dwork, Alexander Grothendieck, Pierre Deligne and many other mathematicians.

In the second part of the lecture we will discuss basic facts about p-adic numbers in preparation for the rest of the course.

Some elementary congruences

Our main player is a multivariable Laurent polynomial $f(\mathbf{x}) \in R[x_1^{\pm 1}, \ldots, x_n^{\pm 1}]$ with coefficients in a characteristic zero ring R. For ordinary primes p we will attach to $f(\mathbf{x})$ a natural $h \times h$ matrix Λ_p with coefficients in a p-adic completion of R. Here h is the number of integral internal points in the Newton polytope of $f(\mathbf{x})$. The entries of Λ_p are defined as p-adic limits of certain expressions in the coefficients of powers of $f(\mathbf{x})$. Later (in Lecture 4) we will see that when $R = \mathbb{Z}$ the eigenvalues of Λ_p are the Frobenius roots of the hypersurface $X = \{\mathbf{x} : f(\mathbf{x}) = 0\}$ restricted modulo p. This lecture is based on [6].

p-adic Cartier operation on differential forms

In the third lecture we will consider differential n-forms on the complement of the hypersurface $f(\mathbf{x}) = 0$ and introduce a p-adic operation on them, the Cartier operation. We will prove that under the *Hasse-Witt condition* the quotients modules of differential n-forms by *formally exact forms* are free modules called *unit-root crystals*.

Proof of Dwork's congruences

In this lecture we will prove that the matrix Λ_p, which was constructed in an elementary way in Lecture 2, is a matrix of the Cartier operation on the unit-root crystal corresponding to the interior of the Newton polytope. We will see that expansion coefficients of differential forms yield period maps modulo prime powers p^s, which will be our main tool in proving various congruences. As another application, we will prove *Gauss' congruences* for expansion coefficients of rational functions.

Beyond the unit root part

So far we developed a method which gives those Frobenius roots which are p-adic units. In the last lecture we will introduce *higher Hasse-Witt conditions* and explain a far going generalization of the previous results. These methods will allow to construct Cartier matrices on the whole de Rham cohomology modules. We will discuss applications and related phenomena of *supercongruences*.

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MC7: Group gradings on algebras and modules

Mikhail V. Kotchetov
Memorial University, Canada

Gradings (also known as gradations) have played an important role in algebra for a long time: for example, the grading of the algebra of polynomials by total degree or by multidegree, the grading of a complex semisimple Lie algebra by its root lattice, the natural grading of a crossed product.

Since the 1990's, there has been an increasing interest in classifying gradings by arbitrary groups on various algebras and studying the properties of the resulting graded algebras (for example, their "contractions", graded polynomial identities, graded representations).

This mini-course will start with the general theory of gradings on algebras: we will define the universal group of a grading, refinement and coarsening, isomorphism and equivalence. We will also see some important examples of gradings on associative and Lie algebras.

In the second lecture, we will establish the graded version of Wedderburn Theorem: a G-graded associative ring R is graded-simple and satisfies the descending chain condition on graded left (or right) ideals if and only if R is isomorphic to $\mathrm{End}_D(V)$ where D is a graded-division ring and V is a graded D-module of finite rank. Isomorphisms between such graded rings can be explicitly described, which allows us to reduce their classification to that of graded-division rings with support a subgroup of G. These latter are crossed products of the support with division rings, but classifying them up to isomorphism is difficult in general.

The third lecture will be dedicated to the duality between gradings and actions. In particular, if A is a finite-dimensional algebra (not necessarily associative) over an algebraically closed field of characteristic 0, then a grading on A by a (finitely generated) abelian group G is equivalent to a homomorphism of algebraic groups $\widehat{G} \to \mathrm{Aut}(A)$ where $\widehat{G}$ is the character group of G (a quasitorus). Thus the basic problems of classification of gradings by abelian groups on A can be expressed in terms of the algebraic group $\mathrm{Aut}(A)$ and can be transferred to another algebra B if $\mathrm{Aut}(A) \cong \mathrm{Aut}(B)$.

In the fourth lecture, we will classify gradings (up to isomorphism) on finite-dimensional simple associative algebras with involution over an algebraically closed field and use the transfer method mentioned above to classify gradings on classical simple Lie and Jordan algebras.

In the fifth and final lecture, we will survey some classification results for fine gradings (up to equivalence) on simple finite-dimensional Lie and Jordan algebras.

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MC8: New foundations for matroid theory and tropical geometry
Oliver Lorscheid
University of Groningen, The Netherlands

Prerequisites: Basic knowledge of algebraic geometry.

In a joint program with Matthew Baker (and other, in parts), we develop a new type of algebraic objects and algebraic geometry that captures matroids as vector spaces over the so-called Krasner hyperfield and tropical varieties as schemes over the so-called tropical hyperfield. This theory allows for a reformulation of many concepts and results in a precise analogy to classical linear algebra and algebraic geometry, which simplifies and streamlines previous approaches.

More importantly, this theory leads to new insights in both classical theory and about matroids and tropical geometry. For example: (a) Structural insights into the tropical hyperfield and the sign hyperfield lead to a new proof of Descartes rule of signs and the Newton polygon rule. (b) Structural insights into a new invariant for matroids, which we call its "foundation", have streamlined many known results and produced new results about the representation theory of matroids. (c) The combination of the methods from 1 and 2 has led to a better understanding of realization spaces (i.e. intersections of Grassmannian varieties with linear subspaces). (d) A surprising connection between Lorentzian polynomials (after Branden-Huh) with realization spaces over triangular hyperfields leads to new insights into the topological structure of these spaces. (e) The geometric interpretation of matroid theory in terms of F_1-geometry provides a natural answer to ideas of Jacques Tits who initially proposed the idea of a field with one element.

In this course, we give an introduction into this theory, which encompasses:

Lecture 1. Motivation and matroids with coefficients (aka Baker-Bowler theory)

After a motivation for these lectures, we turn to an introduction to matroids, bands, and eventually to matroids with coefficients in bands, enriched with lots of examples.

Lecture 2. Band schemes, moduli of matroids, tropicalizations as base change

After providing some more in depth discussion of bands, we introduce band schemes as a geometrization of bands. In particular, we explain what the Grassmannian over F1 (the field with one element) is, and why it is the moduli space of matroids. We explain how tropicalization can be viewed as a base change from a non-archimedean field to the tropical hyperfield.

Lecture 3. Realization spaces, foundations and applications

The realization space of a matroid is the locus of the Grassmannian whose non-vanishing coordinates form the bases of the matroid. They are related to Mnev's universality theorem, singularities in moduli spaces (after Vakil), Lafforgue's surgery on Grassmannians, Dressians in tropical geometry and Lorentzian polynomials. The geometry of a realization space is in general highly complicated, but completely controlled by an algebraic invariant of the matroid, which is a particular type of band and which we call the "foundation" of the matroid. In this lecture, we will introduce realization spaces and foundations. As applications, we discuss a short proof of a folklore theorem attributed to Lafforgue. We also show how Descartes' rule of signs and the Newton polygon rule can be derived from structural insights into polynomials over the sign hyperfield and the tropical hyperfield.

Lecture 4. Lorentzian polynomials as matroids over triangular hyperfields

Lorentzian polynomials were introduced by Branden and Huh as a mean to simplify and generalize proof techniques for unimodularity of various combinatorial functions that previously relied on deep techniques from algebraic geometry. In this lecture, we introduce Lorentzain polynomials and explain how they relate to matroid representations over triangular hyperfields. In particular, this leads to new structural insights into the space of Lorentzian polynomials. This lecture is based on joint work with Baker, Huh and Kummer.

Lecture 5. Tits's dream

Algebraic geometry over the so-called "field with one element" was an idea first conceived by Jacquet Tits in the 1950s. In this final lecture, we explain how our approach to F1-geometry, paired with matroid theory, provides a natural framework for the geometric objects that were proposed by Tits, and how they are embedded in the far more mysterious combinatorial flag varieties in the sense of Borovic, Gelfand and White. This lecture is based on joint works with Jarra and with Thas.

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SESSION 1

Algebraic geometry and commutative algebra

ORGANIZERS

Aline Andrade (UFMG)
Maral Mostafazadehfard (UFRJ)
Renato Vidal Martins (UFMG)

S1-Algebraic geometry and commutative algebra

Talks index

Clifford representatives via the uniform algebraic rank

Myrla Barbosa
UFSC, Brazil

During this talk we introduce the uniform algebraic rank of a divisor class on a finite graph. This rank lies between Caporaso's algebraic rank and the combinatorial rank of Baker and Norine, and It satisfies interesting results such as the Riemann-Roch theorem. Both the algebraic and the uniform algebraic rank are realized on effective divisors. As an application, we use the uniform algebraic rank to show that Clifford representatives always exist. We conclude with an explicit description of such Clifford representatives for a large class of graphs. This is a join work with Karl Christ and Margarida Melo.

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Complete Intersections Curves in Biprojective Spaces

André Luís Contiero
UFMG, Brazil

In this talk, we establish a lower bound on the gonality of well-behaved complete intersection curves in biprojective spaces, providing a biprojective analogue of Lazarsfeld's bound in the classical projective setting. As an application, we classify complete intersection curves in biprojective spaces whose canonical sheaves are hyperplane sections. This is a joint work with E. Ballico and Maxwell Santos.

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Tropical semirings and curve singularities

Ethan Cotterill
UNICAMP, Brazil

Curve singularities are classical objects of study in algebraic geometry. The key player in their combinatorial structure is the value semigroup, or its compactification, the value semiring. One natural problem is to explicitly determine the value semirings of distinguished infinite classes of singularities, with a view to understanding their asymptotic properties. In this paper, we establish a matroidal framework for systematically resolving this problem. More precisely, we show how to associate to any curve singularity a support semiring that maps homomorphically to the value semiring. This is a tropical semiring with a finitary matroid structure, and we show how its basic features explain well-known features of value semirings of singularities, including a natural characterization of minimal generating sets. In the case of either line arrangements (i.e., multiple points) or cusps, we can be more quantitatively precise; and our results have important consequences for the topology of Severi varieties of singular rational curves in projective space.

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The finiteness of associated primes of generalized cohomology modules: A dimensional approach

André Dosea
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The search for some conditions under which the local cohomology modules behave a great deal like a finitely generated module has became an important problem in commutative algebra. The so-called finiteness properties of local cohomology modules covers mainly the study of finiteness of associated primes, minimal primes, Bass numbers, Betti numbers and Lyubeznik numbers. This talk is addressed to discuss the finiteness of the set of associated primes of both ordinary and generalized local cohomology modules. The cornerstone of this problem rests in a conjecture made by C. Huneke in [1] at Sundance conference in 1990:

Let R be a local Noetherian ring, let I be an ideal of R and M be a finite R- module. Then, for all $i \geq 0$, the set of associated primes of $H^i_I(M)$ is finite.

This conjecture has revealed to be false, thanks to the counterexamples provided by A. Singh [3] (in the non-local case) and Katzman [2] (in the local case), although it is true in some cases, tipically in lower dimension. In this talk, we discuss several new results in dimension three, four, five and six. We highlight that, to the best of our knowledge, the six-dimensional case has not been considered in the literature so far. This is a joint work with professor Dr. Cleto B. Miranda-Neto.

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On moduli space of stable rank 2 vector bundles with odd determinant on P^3

Aislan Leal Fontes
Universidade Federal de Sergipe (UFS), Brazil

The classification of rank 2 bundles on the projective space $\mathbb{P}^3$ is already a classical problem in algebraic geometry. Horrocks showed that every bundle on $\mathbb{P}^3$ is the cohomology of a monad consisting only of line bundles, so we can classify this vector bundles by classifying all possible monads. Let $\mathcal{B}(e, m)$ denote the moduli space of stable rank 2 bundles on $\mathbb{P}^3$ with $c_1 = e$ and $c_2 = m$. In this talk let's review some results in the literature and describe new irreducible components of $\mathcal{B}(-1, m)$ for $m = 6, 8$ and $m = 10$.

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Fiber product rings, homological aspects and their geometric implications

Thiago Henrique de Freitas
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The main objective of this talk is to show the main properties of a interesting class of rings, called fiber product rings. In addition, we give some answers of two famous conjectures: the Buchsbaum-Eisenbud-Horrocks conjecture and the Total rank conjecture. The geometric aspects of the notion of fiber product rings are also given. This is a joint work with Victor Hugo Jorge Pérez (ICMC-USP-Brazil) and Aldício Miranda (UFU-MG-Brazil).

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On higher Jacobians, Laplace equations and Lefschetz properties

Rodrigo Gondim
UFRPE, Brazil

Let A be a standard graded $\mathbb{K}$-algebra of finite type over an algebraically closed field of characteristic zero. We use apolarity to construct, for each degree k, a projective variety whose osculating defect in degree s is equivalent to the non maximality of the rank of the multiplication map for a power of a general linear form $\times L^{k-s} : A_s \to A_k$. In the Artinian case, this notion corresponds to the failure of the Strong Lefschetz property for A, which allows to reobtain some of the foundational theorems in the field. It also implies the SLP for codimension two Artinian algebras, a known result. The results presented in this work provide new insights on the geometry of monomial Togliatti systems, and offer a geometric interpretation of the vanishing of higher order Hessians.

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Framed instanton pairs on the blow-up of the projective 3-space at a point

Abdelmoubine Amar Henni
UFSC, Brazil

We study some Huybrechts and Lehn framed sheaves on the Fano 3- fold given by blowing-up the 3-projective space at a point. In contrast with the cases of curves and surfaces, there are very few examples in higher dimensions. In this talk we give a new example of such pairs in dimension 3 and prove that the moduli space under study is fine, quasi-projective and unobstructed.

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Maximal Cohen-Macaulay tensor products and local cohomology

Rafael Holanda
UFPB, Brazil

The Cohen-Macaulay property of tensor products of modules over local rings is a classical topic in commutative algebra. We investigate some consequences of the maximal Cohen-Macaulay property of tensor products providing a duality result and freeness criteria. Also, we apply (generalized) local cohomology in the study of freeness criteria for modules over one-dimensional local rings. This is a joint work with Cleto Miranda-Neto.

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Jacobian Elliptic Fibrations on K3 surfaces with non-symplectic automorphisms of order 3

Felipe Zingali Meira
UFRJ, University of Groningen

An automorphism of a K3 surface X is defined as non-symplectic if it does not act trivially on the form $\omega_X \in H^0(X, K_X)$. The existence of a non-symplectic automorphism of order 3 gives information on the geometric structure of a K3 surface (see [1]). In this work, we consider elliptic fibrations on a K3 with a fixed non-symplectic automorphism σ of order 3, and classify them according to the action of σ on their fibres, building on work by Garbagnati and Salgado for non-symplectic involutions (see [2]).

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On the impact of cohomology vanishing in commutative algebra

Cleto Brasileiro Miranda-Neto
UFPB, Brazil

We will present recent results on the interplay between the vanishing of cohomology modules and the finiteness of (co)homological dimensions of finitely generated modules over Noetherian local rings (particularly, the investigation of freeness criteria), with a view to several applications mainly related to open problems such as the celebrated Huneke-Wiegand conjecture, among others.

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Relative homology of smooth algebras

Victor Pretti
IME-USP, Brazil

Introduced by Hochschild in [1], relative homology has long been a forgotten tool for describing homology concerning an extension of rings. Recently, it has gained attention in the context of the Han and Finitistic conjectures. Taking the Auslander–Buchsbaum–Serre theorem as a starting point, where a k-algebra is smooth if and only if it has finite global dimension for a perfect field k, we provide a complete characterization of smooth algebras in terms of the relative homological global dimension. This is joint work with K. Iusenko and E. N. Marcos.

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On the Rees Algebra of certain ideals of plane fat points

Zaqueu Alves Ramos
UFS, Brazil

An ideal of plane fat points is an ideal of the form $I = \bigcap_{i=1}^{n} I(p_i)^{m_i} \subset R = k[x, y, z]$ for a finite set of distincts points $p_1, \dots, p_n \in \mathbb{P}^2$ and positive integers m_i. The purpose of this talk is to discuss some results on the Rees algebra of ideals of plane fat points that are linearly presented. We interpret how each multiplicity m_i affects the syzygy matrix of I. Through this interpretation we can deduce equations for the defining ideal of Rees algebra of I.

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Auslander-Reiten conjecture, finite C-injective dimension of Hom, and vanishing of Ext

Victor Daniel Mendoza Rubio
ICMC-USP, Brazil

Let R be a Noetherian local ring, and let C be a semidualizing R-module. In this work, we present some results concerning the vanishing of Ext and finite injective dimension of Hom. Later on, we present the extensions of them in terms of finite C-injective dimension of Hom. As applications of these extensions, we investigate them in the case that C is a dualizing module, and prove that the Auslander-Reiten conjecture holds true for all finitely generated R-modules M such that $\mathcal{I}_C\text{-id}_R(\mathrm{Hom}_R(M,R)) < \infty$ or $M \in \mathcal{A}_C(R)$ with $\mathcal{I}_C\text{-id}_R(\mathrm{Hom}_R(M,M)) < \infty$, where $\mathcal{I}_C\text{-id}$ and $\mathcal{A}_C(R)$ denote the C-injective dimension and the Auslander Class with respect to C respectively. Additionally, we derive a number of criteria for the semidualizing R-module C to be a dualizing module.

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S1 – Algebraic geometry and commutative algebra

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Sheaves in real algebraic geometry

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The real spectrum arises from work by Coste and Coste-Roy in the beginning of the eighties, when investigating the topos étale $(\widetilde{\text{spec}A})_{ret}$ for a commutative ring with unit A. The motivating question was: Is this topos spatial? The answer is yes, and this topological space is what we call the real spectrum of A (see [1]). We can define real spectrum X_r of scheme $(X, \mathcal{O}_X)$ as glued space of $sper(\mathcal{O}_X(U_\lambda))$ for a covering $\{U_\lambda\}$ of X by open affine subschemes. The Grothendieck topology comes from the necessity of replace the usual, topological notion of an open covering with one that would use étale coverings instead for define étale cohomology theory. Furthermore Grothendieck topologies provide a framework for defining the sheaf on a category. There are some interesting relationships between the category of sheaves on X_r, the category of sheaves on real étale topology of X and the category of sheaves on étale topology. For example, category of sheaves on X_r and the category of sheaves on real étale topology of X are naturally equivalent (see [2]).

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The weak Lefschetz property for artinian algebras

Janaíne Geralda Mesquita Martins
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The investigation of Lefschetz properties in local Artinian rings was first suggested at a joint Japan-US seminar on combinatorics and commutative algebra held in Kyoto, Japan, in 1985, where R. Stanley and J. Watanabe presented their studies on the subject. However, in the early years, few results were achieved in this direction due to the complexity of the problems involved.

A significant breakthrough in this field of study was made by J. Migliore, J. Watanabe, T. Harima, and U. Nagel, and presented in the article "The weak and strong Lefschetz properties for Artinian K-algebras". After this article, many results were obtained and many connections with other areas of mathematics began to emerge. One of these connections involves algebraic geometry, differential, commutative algebra, and algebraic combinatorics and aims to classify smooth varieties that satisfy at least one Laplace equation. We are interested, in this poster, in discussing the main results addressing the current status of this classification, as well as presenting recent and original results.

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Hilbert-Kunz multiplicity of fiber product rings

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In this work, we introduce an important tool in positive characteristic commutative algebra which is the Hilbert-Kunz multiplicity and its properties. We will present some key results of this theory and recent generalizations. In this sense, we study some new formulas for the Hilbert-Kunz multiplicity of fiber product rings. In the end, we gave some applications of this formulas.
We would like to thanks FAPESP by financial support, grant 2022/12114-0.

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Hecke modifications of vector bundles over the projective line

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Let X be a smooth projective and geometrically irreducible curve defined over any field $\mathbb{F}$. For a closed point x on X, let $\mathcal{K}_x$ be the skyscraper sheaf with support on x and stalk isomorphic to the residual field of x. Given a vector bundle $\mathcal{E}$ over X, a Hecke modifications of $\mathcal{E}$ at point x of weight r is a pair $(\mathcal{E}', \psi)$, where $\mathcal{E}'$ is a vector bundle over X such that $\mathcal{E}' \subset \mathcal{E}$ and $\psi : \mathcal{E}/\mathcal{E}' \to \mathcal{K}_x^{\oplus r}$ is an isomorphism of coherent sheaves.

When $\mathbb{F}$ is a finite field, by a theorem due to Weil, one can see automorphic forms as functions on the set of classes of isomorphism of vector bundles over X. In this setting, to know the Hecke modifications means to know the action of Hecke operators in the space of unramified automorphic forms (see [1] and [2]).

Our goal in this work is to obtain explicitly Hecke modifications when X is the projective line. Using the theory of Hall algebras when $\mathbb{F}$ is a finite field (see [3]), we can describe all the Heck modifications for $\mathcal{E}$ being a vector bundle of any rank and x a degree one closed point.

Acknowledgments: We would like to thanks CAPES by financial support.

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Moduli Space of semistable sheaves

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Understanding the classification of sheaves and vector bundles in projective spaces became crucial. From the perspective of algebraic geometry, classifying sheaves and vector bundles involves studying their moduli spaces. The initial challenge in this approach is to ensure the existence of such objects. Following Maruyama's proof in [2] of the existence of projective moduli schemes parameterized by S-equivalence classes of semi-stable sheaves on projective varieties, the study of such moduli space became a very active research topic.

For curves and surfaces, there exists a rich literature on the subject, for example on $\mathbb{P}^2$ and fixed Chern classes the moduli space of semistable sheaves is always irreducible. However, when it comes to three-dimensional manifolds, the moduli space becomes complicated, as observed in [3], where the space may have multiple irreducible components of different dimensions, as we can see in [1] and [4].

The aim of this work is to understand the geometry of the moduli space of rank 2 sheaves on $\mathbb{CP}^3$ with Chern classes $(-1, 1, -1)$, denoted by $\mathcal{M}(-1, 1, -1)$. However, the focus initially lies on the case of $\mathcal{M}(-1, 1, 1)$. As demonstrated in [5], every point in $\mathbb{P}^3$, we can construct a corresponding stable sheaf, and conversely, every stable sheaf of rank 2 and Chern classes $(-1, 1, 1)$ corresponds to a point in $\mathbb{P}^3$. Consequently, the moduli space of stable sheaves with these characteristics is isomorphic to $\mathbb{P}^3$.

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Elementos Integrais
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A compreensão dos números é algo que chama atenção dos matemáticos é milenar, os pitagóricos já buscavam compreender os números naturais e suas propriedades, até mesmo Diofanto escreveu sobre as equações polinômiais em que as soluções eram números fracionários. Entretanto, o estudo da Teoria dos Números naturais volta a ser palco de desenvolvimento com os estudos de Fermat, principalmente com o tão conhecido Último Teorema de Fermat. A busca pela demonstração deste teorema avançou para os estudo da Teoria Algébrica dos Números. Já no século XIX, já tinhamos os estudos da Teoria da Álgebra [1]. Neste poster, trataremos sobre conceitos iniciais de elementos integrais, com finalidade de ser uma introdução a esses estudos.

Para os estudos dos elementos integrais, necessita-se de um conhecimento preliminar da teoria dos módulos, na qual podemos interpretar como uma generalização dos espaços vetoriais, pois a sua diferença é que é definido para um Anel ao invés de um corpo. Veja, podemos definir um $A-$módulo a esquerda ou a direita quando o anel não é comutativo, mas caso o seja, não precisamos nos preocupar com a lateralidade. Neste poster só trabalharemos dentro da Álgebra comutativa. Um outro conceito que será muito utilizado é de $A-$módulo finitamente gerado: Um A-módulo M é chamado **finitamente gerado** se existem elementos $x_1, x_2, \cdots, x_n \in M$ tais que, para todo $m \in M$ é da forma $m = a_1x_1 + a_2x_2 + \cdots + a_nx_n$ com $n \in \mathbb{N}$ e $a_n \in A$. Neste caso, dizemos que $x_1, \cdots, x_n$ formam um sistema de geradores de M. A partir disso, podemos definir o que é um elementos integral: Seja A um subanel de R. Dizemos que um elemento $x \in R$ é integral sobre A se existem $a_0, a_1, \cdots, a_{n-1} \in A$ tais que

$$x^n + a_{n-1}x^{n-1} + \cdots + a_1x + a_0 = 0$$

ou seja, se x é raiz de um polinômio mônico com coeficientes em A. A equação acima é chamada equação de dependência integral de x sobre A. Uma forma de identificar elemento integral é através de uma proposição: Seja A um subanel de R e $x \in R$. São equivalentes:

(a) x é um elemento integral sobre A

(b) O anel $A[x]$ é um A-módulo finitamente gerado

(c) Existe um subanel B de R que contém A e x (isto é, $A[x] \subset B$) e que é um A-módulo finitamente gerado.

Um exemplo que temos é: Se A for subcorpo de R, temos que $x \in R$ é algébrico sobre A

Sejam A um subanel do anel R e $\{x_1, x_2, \cdots, x_n\}$ um conjunto finito de elementos de R. Se x_1 é integral sobre A e se, para todo $2 \geq i \geq n$, x_i é integral sobre $A[x_1, x_2, \cdots, x_{i-1}]$ então $A[x_1, x_2, \cdots, x_n]$ é um A-módulo finitamente gerado. Em particular, observe que se cada x_i do enunciado acima,$1 \geq i \geq n$, for integral sobre A, então $A[x_1, x_2, \cdots, x_n]$ é um A-módulo finitamente gerado.

Podemos perceber também que dado A um subanel de R e $x, y \in R$ integrais sobre A. Então $x + y$, $x - y$ e xy são integrais sobre A

Sabendo dos elementos integrais, podemos também definir seu fecho. Considere A um subanel de R.

(a) O subanel A' formado pelos elementos de R que são integrais sobre A é chamado de **fecho integral de A em R.**

(b) Se A é um domínio de integridade e $\mathbb{K}$ é o corpo de frações de A, então o fecho integral de A em $\mathbb{K}$ é simplesmente chamado de **fecho integral de** A

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Regularity of Rees algebras and application to a H. Dao problem

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The regularity (of Castelnuovo-Mumford) is a celebrated numerical invariant in commutative algebra and algebraic geometry. Regarding this invariant, our goal in this work is twofold. Firstly, we present recent results on the regularity of the Rees algebra of certain ideals, especially its close relationship with the reduction number of the given ideal (with which we generalize a result by A. Mafi), as well as its explicit determination in the case of Ulrich ideals. Finally, we utilize such regularity in our proposed solution to a recent question posed by H. Dao concerning what we now call "Dao numbers," which are intimately related to the celebrated "fullness" properties of ideals.

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Isotropy Group Of Lotka-Volterra Derivations

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We study the isotropy group of Lotka-Volterra derivations of $K[x_1, \cdots, x_n]$, i.e., a derivation d of the form $d(x_i) = x_i(x_{i-1} - C_i x_{i+1})$. If $n = 3$ or $n \geq 5$, we have shown that the isotropy group of d is finite. However, for $n = 4$, it is observed that the isotropy group of d need not be finite. Indeed, for $C_i = -1$, we observed an infinite collection of automorphisms in the isotropy group of d. Moreover, for $n \geq 3,$ and $C_i = 1$, we have shown that the isotropy group of d is isomorphic to the dihedral group of order $2n$.

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Formas Quadráticas e Topologia: aplicações no estudo dos Invariantes da Teoria dos Corpos

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Este trabalho tem como objetivo apresentar os conceitos fundamentais da teoria algébrica de formas quadráticas e suas aplicações na teoria de corpos, servindo de base para estudos avançados de mestrado. Mais especificamente, focamos na relação entre formas quadráticas, a construção e análise dos anéis de Witt e o seu comportamento subordinado às extensões de corpos, permitindo uma abordagem dos invariantes de corpos relacionados a formas quadráticas.

Os invariantes da teoria dos corpos desempenham um papel crucial ao estabelecer conexões entre Álgebra, Geometria e Topologia. Na Geometria, fornecem medidas que capturam aspectos fundamentais da forma e da estrutura dos objetos geométricos, enquanto na Topologia, são utilizados para investigar propriedades como conectividade, compacidade e orientabilidade de determinadas estruturas (espaços topológicos, variedades diferenciáveis ou algébricas, etc).

Um exemplo típico de invariante de corpos/anéis é o que chamamos de level. Mais especificamente, dado um anel comutativo R, o level (ou nível) de R é definido como

$$s(R) = \min\{n : -1 = e_1^2 + ... + e_n^2 : e_i \in R\}.$$

Caso -1 não seja uma soma de quadrados em R, denotamos $s(R) = \infty$. Calcular o level de um anel (ou corpo) específico é um problema em geral, difícil, e que pode envolver a interação entre várias áreas da Matemática.

Por exemplo, se considerarmos um corpo F, obtemos $s(F) = 2^k$ para algum inteiro positivo k. A situação muda drasticamente no caso dos anéis: para todo inteiro positivo n, o domínio

$$A_n := \mathbb{R}[x_1, ..., x_n]/(1 + x_1^2 + ... + x_n^2)$$

tem level n.

A prova de que $s(A_n) = n$ envolve, dentre outras coisas, a aplicação do emblemático Teorema de Borsuk-Ulam, o que inclusive, permite explorar os invariantes associados a formas quadráticas sobre corpos/anéis e sua relação com as propriedades topológicas dos espaços correspondentes.

No futuro, pretende-se aprofundar a compreensão dos temas acima, explorando por exemplo, as conexões entre ordens, valorações e formas quadráticas, bem como suas aplicações em temas recentes de pesquisa (como Teorias Abstratas de Formas Quadráticas, Multi-álgebras e Lógica).

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Koszul Cohomology and Clifford Index for singular curves

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The *Clifford Index* of a curve C is an invariant that measures its complexity. Strictly speaking, it measures how far is a curve from being hyperelliptic. On the other hand, given a variety X, a line bundle $L \in Pic(X)$ and a coherent sheaf $\mathcal{F}$, we can define the *Koszul complex* associated to L. If we verify the resulting Cohomology, it is possible to obtain relevant geometric information. In the 80s, Green established an important conjecture that related these notions. To be precise, he conjectured that given C a projective curve over a field of characteristic zero. So, according to [1],

$$\text{Cliff}(C) > l \Leftrightarrow K_{p,2}(C, \omega_C) = 0 \; \forall p \leq l.$$

In this case, ω_C denotes the canonical bundle. This conjecture is interesting, because the relation between intrinsic and extrinsic notions becomes clearer. Furthermore, it is a generalization of classic theorems such as Max-Noether and Enriques-Babbage-Petri. For the smooth case, there are strong results by Voisin in (see [2,3]). Our current work is studying how the Green's Conjecture main objects behave in the singular case. Therefore, some very initial results will be presented.

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SESSION 2

Algebraic methods in various areas

ORGANIZERS

Cristian Ortiz (IME-USP)
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Misha Dokuchaev (IME-USP)

S2 - Algebraic methods in various areas

Talks index

Intersection of real Bruhat cells: new developments and applications

Emilia Alves
UFF, Brazil

We examine intersections of a top dimensional cell with another Bruhat cell: such an intersection is naturally identified with a subset of the lower nilpotent group Lo_{n+1}^1. We are particularly interested in the homotopy type of such intersections. We present a stratification of such intersections. As a consequence, we obtain a finite CW complex which is homotopically equivalent to the intersection under analysis. Finally, both classical and new topological results about such intersections stem from our methods. We include a wide latitude of examples and perform explicit computations to illustrate our methods. This is a joint work with Nicolau Saldanha (PUC-Rio) and our Ph.D student Giovanna Leal.

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Operator algebras over the p-adic integers

Alcides Buss
UFSC, Brazil

In this talk we present the of p-adic operator algebras, which are nonarchimedean analogues of C*-algebras. We demonstrate that various classical examples of operator algebras - such as group(oid) algebras - have a nonarchimedean counterpart. The category of p-adic operator algebras exhibits a similar flavor to the category of real and complex C*-algebras, featuring limits, colimits, tensor products, crossed products and an enveloping construction permitting us to construct p-adic operator algebras from involutive algebras over $\mathbb{Z}_p$. Finally, we briefly discuss an analogue of topological K-theory for Banach $\mathbb{Z}_p$-algebras, and compute it in basic examples, like Cuntz algebras and rotation algebras.

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Partial algebras and non-formal deformation quantization

Alejandro Cabrera
UFRJ, Brazil

In this talk, the idea is to review the notion of deformation quantization of Poisson algebras and then motivate the appeareance of so called “partial algebras” in the case of non-formal deformation parameters. After that, we shall sketch a result in progress (joint with R.L. Fernandes) which relates faliure of associativity in these partial algebras to an underlying geometric feature of the Poisson brackets called “non-integrability”.

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Algebras of one-sided subshifts over arbitrary alphabets

Gilles G. de Castro
Universidade Federal de Santa Catarina (UFSC), Brazil

We define algebras and C*-algebras associated with a subshift over an arbitrary alphabet. These algebras are invariants to conjugacy of subshifts in the finite alphabet case and isometric conjugacy when the alphabet is countably infinite. The way of proving these results is by realizing these algebras as a groupoid algebra and as a partial crossed product. In the C*-algebraic setting, we can also compute the K-theory by using the results of Bates, Carlsen and Pask [3]. (Joint work with G. Boava, D. Gonçalves and D. van Wyk. [1,2])

References

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Newton Polyhedra, Whitney Equisingularity and invariants of determinantal varieties

Thais Maria Dalbelo
UFSCar, Brazil

Newton polyhedra are an important tool in the study of topological, geometric and algebraic properties of analytical varieties and their deformations. In Singularity Theory there are countless articles, where Newton polyhedra and non-degeneracy conditions, which are algebraic conditions, are applied in the study of hypersurfaces, complete intersection and toric varieties, for instance.

Using the elementary equivalence of matrices and Newton polyhedra, we present a condition which guarantees the Whitney equisingularity of a family of isolated determinantal singularities.

Joint work with Luiz Hartmann Jr. (UFSCar, Brazil) and Maicom Varella (Hanover, Germany).

References

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Finding and proving isomorphisms of W-algebras

Jethro van Ekeren
IMPA, Brazil

Vertex algebras are certain infinite dimensional graded algebraic objects with applications in theoretical physics, of which there are many and varied sources of examples, and whose partition functions often have interesting combinatorial and number theoretic properties. By studying the "high temperature" behaviour of these partition functions we are able to conjecture many unexpected isomorphisms between vertex algebras, and in some cases prove them. The cases I will discuss, namely W-algebras, are essentially quantum Hamiltonian reduction of loop groups, and if time permits I will remark on relations to superconformal QFT in 4 dimensions. Joint work with Shigenori Nakatsuka.

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The socle of subshift algebras

Daniel Gonçalves
UFSC, Brazil

In this talk, we present the recently defined unital algebra associated with a one-sided subshift over an arbitrary alphabet and show how Ott-Tomforde-Willis subshifts arise as the spectrum of a certain commutative subalgebra. We describe the socle of a subshift algebra in terms of the left minimal ideals generated by irrational paths, construct a graph such that the associated Leavitt path algebra is graded isomorphic to the socle, and apply this description to the conjugacy problem of Ott-Tomforde-Willis subshifts.

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A moment map for the variety of Jordan algebras

Claudio Gorodski
IME-USP, Brazil

We study the variety of complex n-dimensional Jordan algebras using techniques from Geometric Invariant Theory. More specifically, we use the Kirwan-Ness theorem to construct a Morse-type stratification of the variety of Jordan algebras into finitely many invariant locally closed subsets, with respect to the energy functional associated to the canonical moment map. In particular we obtain a new, cohomology-free proof of the well-known rigidity of semisimple Jordan algebras in the context of the variety of Jordan algebras. We also pose some open problems. (Joint work with I. Kashuba and M. E. Martin.)

References

[1] C. Gorodski, I. Kashuba and M. E. Martin, *A moment map for the variety of Jordan algebras*. Communications in Contemporary Mathematics (2024).

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Partial group actions and groupoids

Emmanuel Jerez
IME-USP, Brazil

A partial action of a group G on a set X is a tuple $\theta := \big(G, X, \{X_g\}_{g\in G}, \{\theta_g\}_{g\in G}\big)$ such that $\theta_g : X_{g^{-1}} \to X_g$ is a bijection and $\theta_g \circ \theta_h$ is a restriction of θ_{gh}. On the other hand, a groupoid is a small category where all the morphisms are isomorphisms. Groupoids and partial actions of groups share many similar definitions and constructions. For example, the concept of a groupoid action is similar to the idea of a partial action, and representations of groupoids and partial group representations exhibit similarities. Furthermore, both structures have the potential to be tools for studying local phenomena that global actions of groups cannot fully capture. It is well-known that any partial group action determines a natural groupoid called the partial action groupoid, and that any connected groupoid can be obtained from a (not necessarily unique) global group action. All these facts suggest the existence of strong connections between both concepts.

We will show that any discrete groupoid can be obtained as the partial action groupoid from a partial group action of a group G on a set X. Furthermore, we will prove that for any groupoid Γ, there exists a unique (up to unique isomorphism) universal partial group action that recovers the groupoid Γ.

We begin by defining the category of partial group actions **PA** such that both the group and the set may vary, this differs from the usual definition where one assumes that the group is fixed. In particular will show the existence of a pair of functors, denoted as Φ : **Grpd** $\to$ **PA** and Ψ : **PA** $\to$ **Grpd**, with the property that $\Psi\Phi \cong 1_{\mathbf{Grpd}}$. For a given groupoid Γ, we provide a characterization of all partial actions that allow the recovery of the groupoid Γ through Ψ. This characterization is expressed in terms of certain normal subgroups of a universal group constructed from Γ. Finally, we will discuss some consequences related to the connection between partial group actions and groupoids in the context of groupoid actions, the globalization of partial group actions, and (co)homology of groupoids and partial representations.

References

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Algebraic Framework for Genetic and Evolutionary Dynamics given by Gibbs Measures

Lucas R. de Lima
UFABC, Brazil

Genetic and evolution algebras arise naturally from applied probability and stochastic processes. Gibbs measures describe interacting systems commonly studied in thermodynamics and statistical mechanics with applications in several fields. Here, we consider that the algebras are determined by configurations of finite spins on a countable set with their associated Gibbs distributions. The model preserves properties of the finite-dimensional Gibbs algebras found in the literature and extend their results. We introduce infertility in the genetic dynamics when the configurations differ macroscopically. It induces a decomposition of the algebra into a direct sum of fertile ideals with genetic realization. The proposed infinite-dimensional algebras are commutative, nonassociative, with uncountable basis and zero divisors. The properties of Gibbs measures allow us to deal with the difficulties arising from the algebraic structure and obtain the results presented in this article.

References

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From 16-Hilbert problem to the monodromy problem. Differential equations and algebra

Daniel Lopez-Garcia
IME-USP, Brazil

The study of the monodromy action on vanishing cycles associated to a differential equation given by an algebraic vector field is an approximation to the 16-Hilbert problem. The latter consists of, considering a polynomial vector field in the plane, determining a bound for the number of isolated periodic solutions. This problem was posed by David Hilbert at the Paris conference of the International Congress of Mathematicians in 1900, and remains an open problem. However, there are several cases in which we may have some partial solutions to the problem. In this talk, we will discuss how by thinking about a weaker version of the 16-Hilbert problem, the characterization problem of when an Abelian integral is exactly zero naturally arises. This problem is known as The tangential-center problem, and its most notable results are based on the study of the monodromy action associated with certain polynomials.

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Singular locus of codimension q-logarithmic foliations

Ariel Molinuevo
UFRJ, Brazil

We determine the structure of the singular locus of generic codimension-q logarithmic foliations and its relation with the unfoldings of said foliations. In the case where the ambient variety is the projective space Pn we calculate the graded ideal defining the scheme of persistent singularities.

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Algebraic Invariants for Semi-Arithmetic Fuchsian Groups

Gisele Teixeira Paula
UFPR, Brazil

In this talk, I will describe some invariants of the commensurability class of arithmetic and semi-arithmetic Fuchsian groups, which is a special class of discrete groups of isometries of the hyperbolic plane. Some of these invariants are related to algebraic objects depending on the groups, such as its invariant trace field or its invariant quaternion algebra. After it, I will describe a recent finiteness results about semi-arithmetic groups with bounded invariants.

References

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Model theory of algebraic groups

Eugene Plotkin
Bar Ilan University, Israel

We will survey a series of recent developments in the area of first order descriptions of groups. The goal is to illuminate the known results and to pose new problems relevant to logical characterizations of linear groups. We also dwell on the principal problem of isotipicity of finitely generated groups and their Diophantine properties.

References

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Application of quotient matrices to reconstruction problems

Amanda Silva
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Let G be a graph. Consider the multiset of all *unlabelled* graphs obtained by deleting a vertex v of G together with all the edges incident with v. This multiset is called the **collection of vertex-deleted subgraphs** or the **deck** of G. The **Reconstruction Conjecture** asserts that every finite simple graph, with at least three vertices, is determined, up to isomorphism, by its collection of unlabelled vertex-deleted subgraphs. This conjecture was first formulated in 1941, by Kelly and Ulam (see [1]).

In 1964, Harary proposed the **edge reconstruction conjecture**, an edge analogue of the Reconstruction Conjecture. This conjecture says that a finite simple graph with at least four edges is determined, up to isomorphism, by its collection of **unlabelled edge-deleted subgraphs**, also called the **edge deck**.

An important linear algebra tool that has several applications in many reconstruction problems is the **quotient matrices**. In a general way, if we have a 01-matrix M together with an equitable pair of partitions of its rows and columns, then we can form a smaller quotient matrix Q. The quotient matrix Q inherits at least some of the eigenvalues of the original matrix and frequently some others useful algebraic properties of M. This technique has been used by Thatte [2] and by Ellingham et all [3] to prove some reconstruction results.

We will consider a variation of these reconstruction problems. Let X be a finite simple graph, $E(X)$ its edge set and g an application that assign to each edge of X a sign positive or negative $g\colon E(X) \to \{+, -\}$. Let G be the spanning subgraph of X consisting of all positive edges. We call (G, X) a **signed graph** with **underlying unsigned graph** X. We will denote by G^c the complement of G in X, that is, the spanning subgraph of X consisting of all negative edges. We say that two signed graphs (G, X) and (H, Y) are **isomorphic** if there is an isomorphism $f\colon V(X) \to V(Y)$ such that $f(G) = H$ and $f(G^c) = H^c$. We denote by $(G, X)_e$ the graph obtained by switching the sign on e. The multiset of unlabelled signed graphs $\{(G, X)_e \mid e \in E(G)\}$ is called **signed deck**. Is (G, X) determined, up to isomorphism, from the signed deck?

Our main goal is to show, using quotient matrices, that if (G, X) and (F, Y) are signed graphs, then the number of subgraphs of (G, X) that are isomorphic to (F, Y) is determined, under some conditions, from the signed deck. Note that this problem is intrinsically related with the group of automorphism of (G, X) and the number of ways we can embed (F, Y) in (G, X) with respect to the automorphism of this signed graph.

References

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The Group of Outer Automorphisms of the Category of Finitely Generated Nilpotent Free Algebras of Degree n

José Victor Gomes Teixeira
IME-USP, Brazil

In this work, which is a joint work with A. Tsurkov, we compute the quotient group $\mathfrak{A}_n/\mathfrak{Y}_n$ of all automorphisms $\mathfrak{A}_n$ of the category Θ_n^0 of all finitely generated free nilpotent algebras of degree n over a field $\mathbb{k}$, by the normal subgroup $\mathfrak{Y}_n$ of all inner automorphisms of this category. We call $\mathfrak{A}_n/\mathfrak{Y}_n$ the group of outer automorphisms of Θ_n^0. In the universal algebraic geometry setting, this group is very important, because it measures the possible difference between geometric and automorphic equivalences in the variety Θ_n of all nilpotent algebras of degree n. We prove that $\mathfrak{A}_n/\mathfrak{Y}_n \cong \mathbb{k}^* \rtimes Aut\mathbb{k}$, where $\mathbb{k}^*$ is the multiplicative group of all invertibles elements of $\mathbb{k}$ and $Aut\mathbb{k}$ is the group of all automorphisms of $\mathbb{k}$. It is interesting that if we consider the category Θ^0 of all finitely generated algebras over a field $\mathbb{k}$, the group $\mathfrak{A}$ of all automorphisms of this category and the group $\mathfrak{Y}$ of all inner automorphisms of this category, then also $\mathfrak{A}/\mathfrak{Y} \cong \mathbb{k}^* \rtimes Aut\mathbb{k}$.

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Automorphic equivalence of algebras

Arkady Tsurkov
UFRN, Brazil

Universal algebraic geometry allows considering of algebraic geometry of every universal algebra. When two algebras have same algebraic geometry? We must consider the categories of algebraic closed sets of these algebras to answer this question. The complete coincidence of these categories gives us a concept of the geometric equivalence of algebras. Some type of isomorphisms of these categories gives us a concept of the geometric automorphic of algebras. This concept has been considered since article of B. Plotkin (see [1]) in 2003. We will give by language of category theory one more elegant definition of this concept and recall some theorems related to this concept.

References

[1] B. Plotkin, *Algebras with the same algebraic geometry*. Proceedings of the Steklov Institute of Mathematics, MIAN, Vol. 242 (2003).

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Partial monoid actions on objects in categories with pullbacks and their globalizations

Francisco Gabriel Klock Campos Vidal
UFSC, Brazil

Following an idea in the article [1] by Hu and Vercruysse, we introduce partial morphisms in an arbitrary category **C**, so that partial actions of a monoid M on a set X correspond to certain maps from M to the set of isomorphism classes of partial morphisms from X to X in the category of sets. Inspired by that, we generalized the notion of a partial monoid action to act on objects in arbitrary categories with pullbacks, and studied the question of the globalization of such partial actions, finding necessary and sufficient conditions in terms of coproducts, coequalizers and pullbacks for a partial action in this sense to be globalizable.

References

[1] HU, J.; VERCRUYSSE, J. Geometrically partial actions. **Trans. Am. Math. Soc.**, v. 373, n. 6, p. 4085-4143, 2020.

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S2 – Algebraic methods in various areas

Posters index

Locally nilpotent derivations of evolution algebras

Angelo Calil Bianchi
UNIFESP, Brazil

The goal of this work is to investigate the Lie algebra of derivations of a finite-dimensional evolution algebra over a field of characteristic zero, with emphasis on the set of all locally nilpotent derivations.The main result is applied to the field of real numbers and states when the only locally nilpotent derivation is the trivial one.

This work is partially supported by FAPESP 2018/23690-6.

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Cohomology Ring and Topological Complexity

Douglas Vilela de Paiva Silva
UFMG, Brazil

At the end of the last century, Farber introduced a new topological invariant motivated by Control Theory problems. As it is a numerical invariant, one possible strategy is the introduction of lower and upper bounds for determining Topological Complexity. In this work, we will focus on how the algebraic structure of the cohomology ring of certain spaces allows us to determine lower bounds for Topological Complexity.

Farber, Michael (2005). "Collision Free Motion Planning on Graphs". Em: Algorithmic Foundations of Robotics VI. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 123-138. – (2017). "Configuration Spaces and Robot Motion Planning Algorithms". Em: Combinatorial and Toric Homotopy. World Scientific, pp. 263-303. – (2003). "Topological Complexity of Motion Planning". Em: Discrete and Computational Geometry 29.2, pp. 211-221.

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SESSION 3

Coalgebras, Hopf algebras, and related topics

ORGANIZERS

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Marcelo Muniz (UFPR)
Vitor Oliveira (IME-USP)

S3 - Coalgebras, Hopf algebras, and related topics

Talks index

Partial representation of pointed Hopf algebras

Marcelo Muniz Silva Alves
UFPR, Brazil

Partial representations of Hopf algebras were motivated by the theory of partial actions of Hopf algebras, and both came as developments of the theory of partial actions and representations of groups. As in the case of groups, a partial action of a Hopf algebra H on an algebra A leads to an H-comodule algebra, the partial smash product of A by H, which generalizes the smash product associated to a (global) action. The left modules over the partial smash product carry naturally a left A-module structure and a partial representation of H. Alves, Batista and Vercruysse introduced these partial representations and showed that those correspond to left modules over a Hopf algebroid H_{par}, the "partial Hopf algebra" associated to H. The focus of this thesis is the study of the algebraic structure and the representations of H_{par} for pointed Hopf algebras and also for cocomutative Hopf algebras. We prove that if A and H are two Hopf algebras and their smash product $A\#H$ is also a Hopf algebra, and A does not have any strictly partial representation, then each partial representation of the smash product $A\#H$ can be factorized via a global representation of A and a partial representation of H. This allows us to describe the partial Hopf algebra associated to a cocomutative Hopf algebra. We also prove that if a partial representation of a Hopf algebra H is global when restricted to the coradical of H, then it was already global to begin with. One result that follows directly from this is that any Hopf algebra with unidimensional coradical, such as an enveloping universal algebra of a Lie algebra and a combinatorial Hopf algebra, does not have any partial representation which is not global. We show that if H is a pointed Hopf algebras then H_{par} can be written as a direct sum of unital ideals, extending a previous decomposition obtained by Dokuchaev, Exel and Piccione for the case of group algebras. Finally we study the partial Hopf algebras associated with the family of Hopf algebras of dimension 2^n and coradical of dimension 2 described and classified by Caenepeel and Dascalescu. We prove that, in the same way that these form an ascending chain of Hopf algebras, the associated partial Hopf algebras also form a chain of algebras. Furthermore, one is contained within the other as a unital ideal. To conclude, we focus on the first two elements of the family, where the smallest one is the Sweedler Hopf algebra and the other one is a direct sum of the Sweedler Hopf algebra and a nilpotent ideal; we describe their associated partial Hopf algebras and study their partial representations.

This presentation brings together results obtained from joint work with Eliezer Batista, Joost Vercruysse, Arthur Rezende Alves Neto, and William Hautekiet.

References

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The Green ring of the Hopf algebra $\mathfrak{u}(\mathfrak{m})$

Dirceu Bagio
UFSC, Brazil

Let $\Bbbk$ be an algebraically closed field of characteristic 2 and $\mathfrak{s}$ the unique, up to isomorphism, not restricted simple Lie algebra of dimension 3 over $\Bbbk$ which has basis $\{e, h, f\}$ and bracket $[e, f] = h$, $[e, h] = e$ and $[f, h] = f$. The 2-closure $\mathfrak{m}$ of $\mathfrak{s}$ (that is, $\mathfrak{m}$ is the smallest restricted Lie algebra that contains $\mathfrak{s}$) is a 5-dimensional Lie algebra and its restricted enveloping algebra $\mathfrak{u}(\mathfrak{m})$ is generated by e, f, h with defining relations

$$ef + fe = h, \quad eh + he = e, \quad fh + hf = f, \quad e^4 = f^4 = 0, \quad h^2 + h = 0.$$

It was proven in [1] that $\mathfrak{u}(\mathfrak{m})$ is special biserial and hence it is of tame representation type [2]. The finite-dimensional indecomposable $\mathfrak{u}(\mathfrak{m})$-modules are string or band modules. We reinterpret these indecomposable modules as syzygye, cosyzygy and (r, r)-type modules. This new approach allows us to calculate the Green ring of $\mathfrak{u}(\mathfrak{m})$. This is a joint work with N. Andruskiewitsch, S. D. Flora and D. Flôres.

References

[1] N. Andruskiewitsch, D. Bagio, S. Flora and D. Flôres. *On the Drinfeld double of the restricted Jordan plane in characteristic 2*. arXiv:2303.02228
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Quantizations as Koszul algebras

Vladislav K. Kharchenko
Universidad Nacional Autónoma de México, México

The Koszul algebras arise in many areas of the modern mathematics: algebraic geometry, representation theory, noncommutative geometry, topology, number theory, theory of pseudoroots of noncommutative polynomials. We prove that in q-Weyl generators the multi-parameter Drinfeld-Jimbo quantizations of type A_n^+ and B_n^+ are quadratic-linear Koszul algebras, but the quantization of type G_2^+ is not a quadratic-linear Koszul algebra.

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On the combinatorial rank of quantum groups of excepcional type

Bárbara Pogorelsky
UFRGS, Brazil

The combinatorial rank of a Hopf algebra is the number of Hopf ideals in a chain specifically defined by Kharchenko and Alvarez. Our first purpose is to present the combinatorial rank of the positive part of the multiparameter version of the Lusztig small quantum group of a simple Lie algebra of classical type obtained by Kharchenko and collaborators. Finally, we approach this problem considering quantum groups of exceptional type.

References

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[2] V. Dylewski, B. Pogorelsky and C. Renz, On the combinatorial rank of quantum groups of type F4. Journal of Algebra and its Applications, Forthcoming.

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An adjunction between k-coalgebras and k-cospecies

Samuel Quirino
UFMG, Brazil

A k-cospecies is the dual concept of a k-species, the latter being introduced by Gabriel as a generalization of quivers where to each vertex corresponds a finite dimensional division algebra and to the set of arrows between two vertices corresponds a bimodule of the associated algebras. In this talk we prove that any basic k-coalgebra is an admissible subcoalgebra of the cotensor coalgebra of a k-cospecies for a perfect field k. Moreover, we present an adjoint pair of covariant functors between the category of k-cospecies and the quotient category of k-coalgebras by an equivalence relation on coalgebra homomorphisms, being the forementioned theorem a direct consequence of the unit of the adjunction. This result dualizes and generalizes a previous result from Dlab and Ringel which states that any finite dimensional basic k-algebra is a quotient of the tensor algebra of a k-species by an admissible ideal.

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Sobre fatorações exatas de categorias de fusão

Monique Müller Lopes Rocha
UFSJ, Brazil

O conceito de fatoração exata de categorias de fusão foi introduzida por Gelaki em 2017 e é uma generalização categórica para o conceito de fatoração exata de grupos finitos. Esta noção também generaliza o conceito de fatoração exata de álgebras de Hopf semisimples. Vamos mostrar algumas propriedades de fatoração exata de categorias de fusão e apresentar um resultado de como construir uma fatoração exata a partir de duas categorias de fusão e alguns dados. Este é um trabalho em andamento em conjunto com Héctor Martín Peña Pollastri e Julia Plavnik.

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Base algebras in monoidal categories

Virgínia Silva Rodrigues
UFSC, Brazil

Base algebras were extensively studied in [1], they are commutative algebras in the (braided) category of Yetter-Drinfeld modules over a Hopf algebra over a field $\mathbf{k}$. However, this concept can be extended to a monoidal category $\mathcal{C}$ and in this case base algebras are commutative algebras from a center $\mathcal{Z}(\mathcal{C})$ of $\mathcal{C}$. In this talk, we intend to present some recent results obtained with Daniel R. O. de la Peña regarding base algebras in monoidal categories, for example, under what conditions is $A \otimes B$ a base algebra in $\mathcal{C}$ if A and B are both base algebras in $\mathcal{C}$? Some others results related to dynamical categories over base algebras will also be presented, if time permits.

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Nonassociative coalgebras, the locally nilpotent radical and noncommutative Jordan algebras

Gilson R. Santos Filho
Brazil

We describe results obtained related to the following conjecture formulated by I. P. Shestakov: A variety of (not necessarily associative) algebras admits the locally nilpotent radical (in the sense of Amitsur-Kurosh) if, and only if, the associated coalgebras of said variety are always locally finite. We have a special interest in the following result described in [1]: There's a reasonably large class of varieties such that, for every variety in this class, if it admits the locally nilpotent radical, then the respective coalgebras are locally finite. This large class of varieties does not contains the variety of noncommutative Jordan algebras, for example. It is also known that this variety does not admit the locally nilpotent radical and there are examples of noncommutative Jordan coalgebras that are not locally finite. Our main goal is to study the conjecture on subvarieties of noncommutative Jordan algebras in which there is locally nilpotent radical (examples of such subvarieties can be found in [3]). We are particularly interested in the construction of nonlocally finite coalgebras, similarly as those constructed in [2].

This is a joint work with Ivan P. Shestakov (USP) and Lucia S. I. Murakami (USP).

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Enlargements of Inverse Categories and Morita Equivalences

Willian Velasco
UFPR, Brazil

The concept of partial actions of groups was formulated by Ruy Exel in his field of study, operator algebras, in the 1990s. A few years later, in the work "Associativity of crossed products by partial actions", in collaboration with Mikhailo Dokuchaev, a purely algebraic version of the notion of partial action of a group on an algebra was introduced. In addition to this innovation, the authors present a condition for the algebra associated with a partial action of a group on an algebra to be Morita equivalent to the algebra resulting from the globalization of this action.

From the perspective of the structures involved, we can deduce information about algebras from the structures that act and the induced semidirect products. In the theory of inverse semigroups and groupoids, there is the concept of "enlargement", as presented in "Inverse semigroups - The theory of partial symmetries" by Lawson. In a way, the previous concepts, when combined with the Steinberg isomorphism between inverse semigroup algebras and groupoids ("A groupoid approach to discrete inverse semigroup algebras"), allow us to conclude that the algebras of the inverse semigroup pair and their enlargements are Morita equivalent (analogous for groupoids).

In this lecture, we will present a generalization of these constructions and applications to the case of inverse categories. These categories are natural generalizations of groupoids and also inverse monoids. In our categorical approaches, we will use the concept of Morita equivalent categories and the idempotent completion of a category. These tools allow us to obtain properties regarding the pair of algebras formed by the algebra of an inverse category and the algebra of its enlargement.

This work was carried out in collaboration with Marcelo M. Alves (UFPR), and we will present unpublished results stemming from the speaker's doctoral thesis, titled "Algebras of expanded structures".

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S3 – Coalgebras, Hopf algebras, and related topics

Posters index

Invariants of Hopf algebras actions on free algebras

Lucas Seidy Ogawa
IME-USP, Brazil

It's known that if H is a Hopf algebra and V is an H-module, then $T(V)$, the tensor algebra on V has a natural structure of H-module algebra. It's known that its invariant subalgebra is always free and almost never finitely generated (see [1],[2],[3]). Koryukin proved that if H is cocomutative and semisimple then $T(V)^H$ is finitely generated considering the actions of symmetric groups (see [1]). This construction could be done because the action of H commutes with the action of symmetric groups. If H is quasitriangular, then the action of braided groups commutes with the action of H as well, and we can ask if $T(V)^H$ is finitely generated in a similar way. We will show some results obtained concerning this problem.

Joint work with Vitor O. Ferreira and Lucia S.I. Murakami.

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Subvarieties of Varieties of Almost Polynomial Growth

Márcio Ribeiro de Oliveira Filho
UFMG, Brazil

Supervisor: Ana Cristina Vieira.

Let F be a field of characteristic zero, A be an F-algebra and $var(A)$ the class of all algebras satisfying the polynomial identities of A. Since every T-ideal is an ideal of polynomial identities satisfied by a variety of algebras, problems related to T-ideals can be translated into the language of varieties. Determine the generators of the set $Id(A)$ of all identities of A can be a difficult task. Therefore, Regev introduced the concept of codimension sequence to measure the growth of identities satisfied by A. In 1979, Kemer characterized varieties of polynomial growth via exclusion of algebras from the variety. As a consequence of his theorem, it was possible to determine the existence of only two types of growth of identities satisfied by an algebra: polynomial and exponential. The result proved by Kemer shows the importance of two algebras: the infinite dimensional Grassmann algebra $\mathcal{G}$ and the algebra of 2×2 upper triangular matrices UT_2, since $var(\mathcal{G})$ and $var(UT_2)$ are the only varieties of almost polynomial growth, that is, they have exponential growth, but any proper subvariety of them has polynomial growth. In this work we present the results of D. La Mattina $[1]$ about the classification of all subvarieties of the varieties of almost polynomial growth. Furthermore, we introduce the concept of minimal varieties of polynomial growth and observe that her classifications show that if $var(A)$ is a proper subvariety of $var(\mathcal{G})$ or $var(UT_2)$ then $var(A) = var(B_1 \oplus \cdots \oplus B_k)$, where $var(B_i)$ is a minimal variety.

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Márcio Ribeiro de Oliveira Filho was partially supported by Capes.

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On the combinatorial rank of quantum groups

Vitória Gomes de Oliveira
UFRGS, Brazil

Joint work with Bárbara Pogorelsky.

In this work we introduce the definition of the combinatorial rank of a Hopfalgebra. Then we present the results which are already known, for quantumgroups of type An, Bn, Cn and Dn. These results have been obtained by V. Kharchenko, M.L. Díaz Sosa and A. Álvarez. Finally we approach thisproblem for the quantum groups of type G2, F4 and E6.

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Hopf-Ore Extensions of Connected Groupoid Algebras

Rafael Haag Petasny
UFRGS, Brazil

Ore extensions of Hopf algebras were used by M. Beattie et al (2000) to give a negative response to the tenth Kaplansky's conjecture and by A. Nenciu (2001) to study quasitriangular pointed Hopf algebras. In [2], Panov gave necessary and sufficient conditions to extend the Hopf algebra structure of a given algebra H to a Ore extension $H[X;\sigma,\delta]$ with X being a $(g,1)$-primitive element and, in [3], Santos et al extended Panov's theorem to weak Hopf algebras. In this exposition, we use Panov's theorem for weak Hopf algebras to present the classification of Hopf-Ore extensions of connected groupoid algebras over a commutative ring.

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SESSION 4

Finite Fields and Applications

ORGANIZERS

Herivelto M. Borges Filho(ICMC-USP)
Cesar Polcino (IME-USP)
Cicero Carvalho (UFU)

S4 - Finite fields and applications

Talks index

On the number of elements with prescribed norm and trace

Roberto Alvarenga
IBILCE-UNESP, Brazil

Let $\mathbb{F}_q$ be the finite field with cardinality q, where q is a prime power. Given a finite field extension $\mathbb{F}_{q^n}$ over $\mathbb{F}_q$ and $a, b \in \mathbb{F}_q^*$, we investigate in this talk the number $N_n(a,b)$ of elements in $\mathbb{F}_{q^n}$ whose norm equals a and trace equals b.

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Well-Rounded Lattices via Twisted Embedding from Real Quadratic Fields

Carina Alves
UNESP, Rio Claro, Brazil

A lattice Λ is a discrete additive subgroup of $\mathbb{R}^n$. Lattices are used in applications of different areas, particularly in information theory and more recently in cryptography. A lattice of full rank in Euclidean space is called *well-rounded* if its set of minimal vectors spans the whole space. Well-rounded lattices are important in discrete optimization, in particular in the study of sphere packing, sphere covering, kissing number problems [1], as well as in coding theory [2, 3, 6]. Algebraic lattices are lattices constructed by the canonical embedding of an algebraic number field [5]. We can also obtain algebraic lattices via a twisted embedding. In [4], the authors showed that the image of the ring of integers of a quadratic number field $\mathbb{K}$ by canonical embedding is a well-rounded lattice if $\mathbb{K} = \mathbb{Q}(i)$ or $\mathbb{K} = \mathbb{Q}(\sqrt{-3})$. In this work we investigate when algebraic lattices obtained via a twisted embedding in $\mathbb{R}^2$ coming from real quadratic fields are well-rounded. This work was supported by FAPESP, Proc. 2023/15735-8, 2019/20800-8 and CNPq 405842/2023-6. The opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of FAPESP and CNPq.

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Cyclotomic function fields over finite fields with irreducible quadratic modulus

Nazar Arakelian
UFABC, Brazil

Let $\mathbb{F}_q$ be the finite field of order q and $F = \mathbb{F}_q(x)$ the rational function field. We will present a characterization of the cyclotomic function fields $F(\Lambda_M)$ with modulus M, where $M \in \mathbb{F}_q[T]$ is a monic and irreducible polynomial of degree two. More precisely, we show that $F(\Lambda_M)$ is the only function field, up to $\mathbb{F}_q$-isomorphism, with $q+1$ $\mathbb{F}_q$-rational places, genus $(q+1)(q-2)/2$ and a subgroup of automorphisms over $\mathbb{F}_q$ isomorphic to $\mathbb{F}_{q^2}^*$. We also provide the full automorphism group of $F(\Lambda_M)$ in odd characteristic, extending results of [1] where the automorphism group of $F(\Lambda_M)$ over $\mathbb{F}_q$ was computed.

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Orientations of supersingular elliptic curves

Sarah Arpin
Universiteit Leiden, The Netherlands

Supersingular elliptic curve isogeny graphs have seen renewed interest recently due to applications in post-quantum cryptography. The complexity of the noncommutative endomorphism rings of elliptic curves combined with the low computation cost of isogenies results in the perfect combination for cryptographic protocols, such as CSIDH [1], SQISign [2], and SCALLOP [3]. Mathematicians are motivated to understand the structure of supersingular elliptic curve endomorphism rings more deeply. Coló-Kohel [4] introduced the idea of orientations on supersingular elliptic curve endomorphism rings, which are embeddings of imaginary quadratic fields into the endomorphism algebra of an isogeny class of supersingular elliptic curves. Wesolowski and Page [5] have shown that knowledge of one such embedding can provide nontrivial information towards computing the entire endomorphism ring of a curve in the isogeny class. In this talk, I will describe joint work [6] with James Clements, Pierrick Dartois, Jonathan Komada Eriksen, Péter Kutas, and Benjamin Wesolowski where we provide an algorithm which computes an orientation given access to an oracle which decides if such an orientation exists. We also provide new algorithms for finding imaginary quadratic embeddings into an abstract quaternion algebra, improving upon the best known bound for such algorithms.

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Good codes from twisted group rings

Samir Assuena
Centro Universitário da FEI, Brazil

In this talk, we shall describe the structure of k-Galois LCD constacyclic codes over a finite commutative chain rings in terms of the classical involution using twisted group ring structure and present some good codes.

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MDS array codes via Vandermonde matrices

Cintya Wink de Oliveira Benedito
UNESP, Brazil

MDS array codes have been a strategy of great interest in recent applications of distributed storage systems, as in *Redundant Array of Independent Disks*, popularly known as RAIDs. RAID 6 technology uses the Galois field structure to encode data on drives to protect data from errors or erasure. The maximum distance separable (MDS) codes, are codes in which the minimum distance is the maximum possible. This characteristic is important because, in coding theory, the minimum distance is related to the error correction capacity of the code in addition to providing maximum protection against failures of a device for a given amount of redundancy. Array codes are two-dimensional error correction codes whose main characteristic is the ability to correct burst errors, that is, errors that occur in consecutive bits. In this talk we will present a construction of MDS array codes, in order to approach a burst correction strategy in these codes. To obtain a code with this property, the parity check matrix is constructed by using superregular matrices, in particular Vandermonde matrices. Also, the Frobenius companion matrix obtained through a primitive polynomial over $\mathbb{F}_q[x]$ is used. Also, a decoding algorithm will be presented to correct up to two bursts of errors in MDS array codes with parameters $[m+k, k, m+1]$ over $\mathbb{F}_q^b$, for all $m \geq 4$, and applications of these codes in distributed storage systems, in particular, as an alternative to the technology used in RAID 6. Joint work with Débora B. C. Zanitti, Carina Alves and Ivan A. A. Garde. Supported by Fapesp 2017/17948-8, 2019/02720-7 and 2013/25977-7, FINEP 0527/18 and CNPq 405842/2023-6.

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On the number of rational points of curves over a surface in $\mathbb{P}^3$

Elena Berardini
CNRS; IMB, Université de Bordeaux, France

Joint work with Jade Nardi (CNRS; Université de Rennes).

In this talk, we will show that the number of rational points of an irreducible curve of degree δ defined over a finite field $\mathbb{F}_q$ lying on a surface S in $\mathbb{P}^3$ of degree d is, under certain conditions, bounded by $\delta(d+q-1)/2$. Within a certain range of δ and q, this result improves all other known bounds in the context of space curves. The method we used is inspired by techniques developed by Stöhr and Voloch [2]. In their seminal work of 1986, they introduced the Frobenius orders of a projective curve and used them to give an upper bound on the number of rational points of the curve. After recalling some general results on the theory of orders of a space curve, we will study the arithmetic properties of curves lying on a surface in $\mathbb{P}^3$, to finally prove the bound.

The talk is based on [1].

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About the factorization of Dickson Polynomials

Fabio E. Brochero Martínez
UFMG, Brazil

For $n \geq 1$ and $a \in \mathbb{F}_q$, the Dickson polynomials of the first and second kind, denoted by $D_n(x;a)$ and $E_n(x;a)$, respectively, are the polynomials in $\mathbb{F}_q[x]$ defined by the functional equations

$$D_n(y + \frac{a}{y}; a) = y^n + \left(\frac{a}{y}\right)^n$$

and

$$E_n(y + \frac{a}{y}; a) = \frac{y^{n+1} - (a/y)^{n+1}}{y - (a/y)}.$$

Let $rad(n)$ be the product of all prime factors of n. Assuming some special condition on $\mathrm{rad(n)}$, we determine the irreducible factors of $D_n(x;a)$ and $E_n(x;a)$ in $\mathbb{F}_q[x]$

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On certain generalized monomial codes

Cícero Carvalho
UFU, Brazil

In this talk we will present a class of evaluation codes defined on the points of a subset of an affine space over a finite field, whose vanishing ideal admits a Gröbner basis of a certain type. We determine properties of the polynomials in this basis which allow the determination of the footprint of the vanishing ideal. From this we define a class of generalized monomial evaluation codes and find information on their duals, and the dimension of their hulls. This class encompasses, among others, well-known codes such as Reed-Solomon codes, Reed-Muller codes and affine cartesian codes.

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On a graph representation of binary linear codes

John H. Castillo
Universidad de Nariño, Colombia

A binary $[n,k]$-linear code $\mathcal{C}$ is a k-dimensional subspace of $\mathbb{F}_2^n$. For $\boldsymbol{x} \in \mathbb{F}_2^n$, the set $\boldsymbol{x}+\mathcal{C}$ is a coset of $\mathcal{C}$. It can be defined a partial ordering on the set of cosets of a binary linear code $\mathcal{C}$ of length n: for $\boldsymbol{x}, \boldsymbol{y} \in \mathbb{F}_2^n$, $\boldsymbol{x} \preceq \boldsymbol{y}$ provided that $supp(\boldsymbol{x}) \subseteq supp(\boldsymbol{y})$, and we construct its associated Hasse diagram. More precisely, for a binary linear code $\mathcal{C}$, we denote by $\Gamma(\mathcal{C}) = (V_{\mathcal{C}}, E_{\mathcal{C}})$ the graph constructed such that the set of vertices $V_{\mathcal{C}} = \mathfrak{cl}(\mathcal{C})$ and $\mathcal{C}_1\mathcal{C}_2 \in E_{\mathcal{C}}$ if $\mathcal{C}_1 \prec \mathcal{C}_2$ and $wt(\mathcal{C}_1) = wt(\mathcal{C}_2) - 1$. If $\mathcal{C}_1\mathcal{C}_2$ is an edge of $\Gamma(\mathcal{C})$, $\mathcal{C}_1$ is called a *child* of $\mathcal{C}_2$, and $\mathcal{C}_2$ is a *parent* of $\mathcal{C}_1$. Actually, the graph $\Gamma(\mathcal{C})$ is known as the *Hasse diagram* of the poset $(\mathfrak{cl}(\mathcal{C}), \preceq)$. It is clear that $|V_{\mathcal{C}}| = 2^{n-k}$.

In this talk, we give general and particular examples that help to understand the concept and we obtain general properties of this graph. This is a joint work with Lisbeth Delgado-Ordoñez (Universidad del Cauca) and Alexander Holguín-Villa (Universidad Industrial de Santander).

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Stable binomials over finite fields

Arthur Fernandes
UFMG, Brazil

Let $\mathbb{F}_q$ be the finite field with q elements and let $f(x)$ be a polynomial in $\mathbb{F}_q[x]$. The polynomial f is stable if f and all of its iterates are irreducible over $\mathbb{F}_q$. It was shown by Jones and Boston that quadratic polynomials are stable over finite fields if and only if the orbit of its critical points contain only square free elements. In this talk we will discuss the stability of binomials $f(x) = x^t - b$ over $\mathbb{F}_q$. We obtain a criterion based on the forward orbit of 0 under the map $z \mapsto z^t - b$. In particular, this criterion extends the one obtained by Jones and Boston. We will also discuss an application to obtain an explicit 1-parameter family of stable quartics over some prime fields.

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How fast can we compute the endomorphism ring of a supersingular elliptic curve?

Annamaria Iezzi
Université Grenoble Alpes, France

The endomorphism ring of a supersingular elliptic curve defined over a finite field is a maximal order inside a quaternion algebra. Computing this order is a hard problem and this assumption is central to the security of protocols in isogeny-based cryptography, which, as the name suggests, are based on the mathematical problem of finding an isogeny between two given elliptic curves.

In this talk, we will discuss recent advances about this problem. In particular, we will highlight the main ideas behind an algorithm which computes the endomorphism ring of a supersingular elliptic curve over a finite field in $O(\sqrt{p}(\log p)^2(\log\log p)^3)$ bit operations, only assuming the Generalized Riemann Hypothesis. This algorithm is the result of a collaboration with Jenny G. Fuselier, Mark Kozek, Travis Morrison and Changningphaabi Namoijam.

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Evaluation of iterated polynomials

André Leroy
Université d'Artois, France

We will discuss various kind of skew polynomials with a particular view on their evaluations. Depending of the kind of "Ore" extensions that are at hand different problems can occur. Very often linearization via sets of pseudo linear maps is useful. The base ring can be any ring, in particular it can be a finite field. In this case, in view of evaluations and factorization, we have a way of replacing an Ore polynomial with n variables by a commutative polynomial in commutative variables.

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Entangled polynomials and quasi-cyclic codes

Sergio Lopez-Permouth
Ohio University, USA

The family of quasi-cyclic codes plays a central and significant role in contemporary coding theory. Sixty years after their inception, however, and unlike the case for other generalizations of cyclic codes, there is no single algebraic model that describes all codes in the family. We will present the recently introduced algebras of m-nomials and entangled polynomials, as a context in which abundant and arbitrarily long quasi-cyclic codes may be constructed as left or right ideals or even as modules over smaller algebras. Part of the talk will be devoted to describe the origin of entangled polynomials in a context outside coding theory.

This talk is based on ongoing research with Thang Manh Vo.

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Goppa–like AG codes from $C_{a,b}$ curves and the dimension of the square of their dual

Jade Nardi
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McEliece cryptosystem is one of the last code-based candidates for standardization of post-quantum cryptrographic to the NIST competition since the third round. It guarantees the smallest ciphertexts among all the candidates, but it suffers from the largest public keys. Over the past forty years, there were many attempts in replacing the family of binary Goppa codes by other structured families of codes in order to reduce the key size.

In this talk, we will introduce a new family of codes that can be used in this context, called *Goppa–like AG codes*. These codes generalize Goppa codes and can be constructed from any curve of genus $\mathfrak{g} \geq 0$. As subfield subcodes, they resist to the known structural attacks to AG codes [4].

Recently, Mora and Tillich established a bound for the dimension of the dual of Goppa codes, which for high rate Goppa codes is abnormally small compared to random codes. This makes high rate Goppa codes distinguishable from random ones, which does not threaten the McEliece cryptosystem but is likely to break the code–based CFS signature [3]. As Mora and Tillich's bound relies on some properties of Reed–Solomon codes that they share with AG codes, notably their behaviour under component–wise product, it is natural to wonder how it applies to Goppa–like AG codes.

After studying Mora and Tillich's strategy to bound the dimension of the dual of classical Goppa codes, we will present how we generalize it to a family of Goppa–like AG codes from $C_{a,b}$ curves and we propose numerical experiments to measure how much our bound is sharp.

The talk is based on the preprint [6] which is available on ArXiv.

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Special elements in finite fields in arithmetic progression

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Let $\mathbb{F}_{q^n}$ be a finite field with q^n elements. For a positive divisor r of $q^n - 1$, the element $\alpha \in \mathbb{F}_{q^n}^*$ is called r-primitive if its multiplicative order is $(q^n - 1)/r$. Also, for a non-negative integer k, the element $\alpha \in \mathbb{F}_{q^n}$ is k-normal over $\mathbb{F}_q$ if $\gcd(\alpha x^{n-1} + \alpha^q x^{n-2} + \cdots + \alpha^{q^{n-2}} x + \alpha^{q^{n-1}}, x^n - 1)$ in $\mathbb{F}_{q^n}[x]$ has degree k. In this talk we discuss the existence of elements in arithmetic progression $\{\alpha, \alpha + \beta, \alpha + 2\beta, \ldots, \alpha + (m - 1)\beta\} \subset \mathbb{F}_{q^n}$ with $\alpha + (i-1)\beta$ being r_i-primitive and at least one of the elements in the arithmetic progression being k-normal over $\mathbb{F}_q$. We obtain asymptotic results for general $k, r_1, \ldots, r_m$ and concrete results when $k = r_i = 2$ for $i \in \{1, \ldots, m\}$. Joint work with Josimar Aguirre, Abílio Lemos and Sávio Ribas.

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The number of rational points of a class of superelliptic curves

Daniela Alves de Oliveira
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In this paper, we study the number of $\mathbb{F}_{q^n}$-rational points on the affine curve $\mathcal{X}_{d,a,b}$ given by the equation $y^d = ax\text{Tr}(x) + b$,where Tr denote the trace function from $\mathbb{F}_{q^n}$ to $\mathbb{F}_q$ and d is a positive integer. In particular, we present bounds for the number of $\mathbb{F}_q$-rational points on $\mathcal{X}_{d,a,b}$ and, for the cases where d satisfies a natural condition, explicit formulas for the number of rational points are obtained. Particularly, a complete characterization is given for the case $d = 2$. As a consequence of our results, we compute the number of elements α in $\mathbb{F}_{q^n}$ such that α and Tr(α) are quadratic residues in $\mathbb{F}_{q^n}$.

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Symmetric systems over a finite field and applications

Mariana Pérez
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In this talk, we study the set of common $\mathbb{F}_q$-rational solutions of smooth systems of multivariate symmetric polynomials with coefficients in a finite field $\mathbb{F}_q$. We show that, under certain conditions, the set of common solutions of such polynomial systems over the algebraic closure of $\mathbb{F}_q$ has a good geometric behavior. This allows us to obtain precise estimates on the corresponding number of common $\mathbb{F}_q$-rational solutions. In the case of hypersurfaces we are able to improve the results. We illustrate the interest of these estimates through their application to certain classical combinatorial problems over finite fields.

Work together with Nardo Giménez (Universidad Nacional de Hurlingham), Guillermo Matera (Universidad Nacional de General Sarmiento, CONICET), and Melina Privitelli (Universidad Nacional de Hurlingham, CONICET)

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An approach to the moments subset sum problem through systems of diagonal equations over finite fields

Melina Privitelli
Universidad Nacional de Hurlingham y Conicet, Argentina

Let $\mathbb{F}_q$ be the finite field of q elements. Let m, k be positive integers, $\boldsymbol{b} \in \mathbb{F}_q^m$ and $D \subset \mathbb{F}_q$ with $k \leq |D|$. Our aim is to determine the existence of a subset $S \subset D$ of cardinality k such that $\sum_{a \in S} a^i = b_i$ for $i = 1, \ldots, m$. This problem is known as the *moment subset sum problem*. We take a novel approach to this problem by establishing a connection between the existence of such a subset S with the problem of determining if a certain system of diagonal equations has at least one rational solution with distinct coordinates. To achieve this, we study some relevant geometric properties of the set of solutions of the mentioned system. This analysis allows us to provide estimates on the number of rational solutions of systems of diagonal equations and we subsequently apply these results to address the *moments subset sum problem*.

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On the non-existence of perfect codes in the Niederreiter-Rosenbloom-Tsfasman metric

Claudio Qureshi
Universidad de la República, Uruguay

In this work we consider codes in $\mathbb{F}_q^{s\times r}$ with packing radius R regarding the NRT-metric (i.e. when the underlying poset is a disjoint union of s chains with the same length r) and we establish necessary condition on the parameters s, r and R for the existence of perfect codes. More explicitly, for $r, s \geq 2$ and $R \geq 1$ we prove that if there is a non-trivial perfect code then $(r+1)(R+1) \leq rs$. We also establish a correspondence between perfect codes with $r > R$ and those with $r = R$. Using this correspondence we prove the non-existence of non-trivial perfect codes in the cases $s \geq R+2$ over arbitrary alphabet and $s = 3$ over non-binary alphabet. This talk is based on joint work with V. Gubitosi and A. Portela.

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Paley-like graphs from vector subspaces

Lucas Reis
UFMG, Brazil

Motivated by the well-known Paley graphs over finite fields and their generalizations, in this talk we explore a multiplicative-additive analogue of such graphs arising from vector spaces in finite fields. Namely, if $U \subsetneq \mathbb{F}_{q^n}$ is an $\mathbb{F}_q$-vector space, G_U is the (undirected) graph with vertex set $V(G_U) = \mathbb{F}_{q^n}$ and edge set $E(G_U) = \{(a, b) \in \mathbb{F}_{q^n}^2 \mid a \neq b, ab \in V\}$. We discuss the structure of an arbitrary maximal clique in G_U and provide bounds on the clique number $\omega(G_U)$ of G_U. If we have time, we also propose some open problems.

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Essential Projective Idempotents

André Luís dos Santos Duarte da Silva
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In this talk, we introduce the concept of projective essential idempotents. These are primitive central idempotents in a twisted group algebra. The first main result provides conditions for the existence of them. In the second main result, we prove that every q-ary simplex code can be seen as an ideal of a twisted group algebra generated by a projective essential idempotent. We conclude by describing a decoding process using projective essential idempotents.

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Lattices from chains of BCH codes

Franciele do Carmo Silva
UNICAMP, Brazil

BCH codes constitute a subclass of cyclic codes with special properties that have applications in communications, cryptography and combinatorial design [1,2]. In particular, classes of primitive and/or narrow-sense BCH codes have received special attention, due to their algebraic characterizations [1, 3] and their possibility to provide an efficient list-decoding algorithm [4, 5]. Although the performance of BCH codes in high dimensions can be not optimal, binary primitive BCH codes of lengths up to 127 are among the best linear codes known [3]. Additionally, some of their associated subfield subcodes can be used in chains of codes to produce Construction D lattices with good density [6] and with practical decoding [4]. In this talk, we aim to present a brief overview of the properties of particular classes of BCH codes and propose the use of their duals in the chain of codes to produce lattices via Construction D' through the connection between trace codes and subfield subcodes (Delsarte's Theorem). This is a work in progress supervised by Prof. Sueli Costa which includes the study of properties and possible applications of this lattice constructions from BCH codes and also from some classes of quasi-cyclic codes.

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Tate-Shafarevich results for quartic twists in characteristic 2
João Paulo Guardieiro Sousa
ICMC-USP, Brazil

One of the main problems on the study of algebraic curves defined over a field $\mathbb{K}$ is the determination of its $\mathbb{K}$-rational points. On the case of elliptic curves, a result due to Mordell and Weil states that the set of such points is a finitely generated abelian group.

Therefore, it is of great interest to study the rank of such a group. On the case where $\mathbb{K} = \mathbb{F}_q(t)$ is a function field defined over a finite field $\mathbb{F}_q$, Tate and Shafarevich (for the odd characteristic case) and Elkies (for the even one) proved that there is no absolut bound for such a rank, so it can be arbitrarily large (on the sense that it can grow as the cardinality of $\mathbb{F}_q$ grows).

In this talk, I will present an application of the theory developed by Tate and Shafarevich on quartic twists of a given elliptic curve defined over $\mathbb{F}_2$. More precisely, we provide the expression of such twists and obtain the exact rank of its Mordell-Weil group by studying the Jacobian of an auxiliary curve. From that, we could also obtain, like Elkies, families of elliptic curves defined over function fields of even characteristic with arbitrarily large rank.

This is a joint work with Herivelto Borges (ICMC - USP), Cecília Salgado and Jaap Top (University of Groningen).

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Construction π_A lattices from balanced set of codes

Juliana G. F. Souza
UNICAMP, Brazil

Joint work with Sueli I. R. Costa and Cong Ling.

Lattices are discrete additive subgroups of R^n and have several applications in communication systems. An approach to constructing lattices from linear codes over finite rings, such as $\mathbb{Z}_q$, integer rings over number fields or maximal orders over division algebras, is called Construction A [1 – 3]. These lattices demonstrate favourable properties for transmission over channels affected by additive white Gaussian noise (AWGN) [4]. An important result, the Minkowski-Hlawka theorem, has been used to demonstrate that Construction A lattices are suitable for AWGN channel coding [5]. However, the effectiveness of good properties for this lattice codes depends on employing linear codes with large cardinality, resulting in complex decoding processes. In order to reduce this complexity, a lattice construction known as Construction π_A has been proposed considering rings of integers such as $\mathbb{Z}$, Gaussian integers $\mathbb{Z}[i]$, and Eisenstein integers $\mathbb{Z}[w]$ [6]. Construction π_A is a special Construction A applied to codes over finite fields R/p_iR, where $R = \mathbb{Z}, \mathbb{Z}[i]$, or $\mathbb{Z}[w]$, and p_i are prime numbers in the respective integer rings. This construction is associated to the ring isomorphism established by the Chinese Remainder Theorem (CRT). Due to its structure, Construction π_A lattices offer the advantage of multilevel decoding. Recently it has been extended to the ring of Hurwitz quaternion integers [7]. In this talk, we show following the approach described by *Loeliger* [5], that Construction π_A from a balanced set of codes are Poltyrev-good for AWGN channels.

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On curves left invariant by maximal subgroups of PGL(3,q)

Pietro Speziali
IMECC-UNICAMP, Brazil

Joint work with: Herivelto Borges and Gabor Korchmáros

Let G be one of the seven maximal, non-sporadic subgroup of the three-dimensional projective group PGL$(3, q)$ defined over a finite field $\mathbb{F}_q$ of order q. In this talk investigate the (projective, irreducible) plane curves defined over K that are left invariant by G. In each case, we compute the minimum degree $d(G)$ of G-invariant curves, provide a classification, as well as, explicit models of all G-invariant curves of degree $d(G)$, and determine the first gap $\varepsilon(G)$ in the spectrum of the degrees of all G-invariant curves. Interestingly, depending on G, the curves of degree $d(G)$ may be uniquely determined by G, or belong to a pencil, or to a net.

Further, we also point out that these families of curves may have interesting geometric features, as well as, an unusual variation of the number of $\mathbb{F}_{q^i}$-rational points.

Finally, we discuss future research directions branching from our classification.

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Weierstrass Semigroups on a Maximal Curve With the Third Largest Genus

Lara Vicino
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An $\mathbb{F}_{q^2}$-maximal curve $\mathcal{X}$ of genus $g(\mathcal{X})$ is defined to be a projective, absolutely irreducible, non-singular algebraic curve defined over $\mathbb{F}_{q^2}$ such that the number of its $\mathbb{F}_{q^2}$-rational points attains the Hasse-Weil bound.

Maximal curves, especially those with large genus, are of particular interest in coding theory since they give rise to excellent AG codes. It is well known that, for an $\mathbb{F}_{q^2}$-maximal curve $\mathcal{X}$, it holds $g(\mathcal{X}) \leq \frac{q(q-1)}{2}$ and equality is reached if and only if $\mathcal{X}$ is $\mathbb{F}_{q^2}$-isomorphic to the Hermitian curve. Also the second largest genus of $\mathbb{F}_{q^2}$-maximal curves is known, as well as a characterization of the maximal curves attaining it, with respect to $\mathbb{F}_{q^2}$-isomorphism. Instead, the value of the third largest genus is known to be equal to $g_3 := \left\lfloor \frac{q^2-q+4}{6} \right\rfloor$, but finding a characterization of maximal curves with such a genus is a well-known open problem.

In this talk, I will present our work concerning the Weierstrass semigroups on a curve which is known to have genus equal to g_3. One surprising result is that, unlike what happens for all the known maximal curves where the Weierstrass points are known, the set of Weierstrass points of this curve is much richer than the set of its $\mathbb{F}_{q^2}$-rational points.

Joint work with Peter Beelen and Maria Montanucci (Technical University of Denmark).

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S4 – Finite fields and applications

Posters index

Constructions of superregular matrices

Sara D. Cardell
UNESP, Brazil

Joint work with professor Dr. Gustavo Terra Bastos (UFJR).

Superregular matrices, also known as MDS matrices, are matrices where all square submatrices are non-singular. There is a high demand in the communications field for constructing these matrices over finite fields; for instance, they are crucial in building MDS codes [1] and are also applied in the design of modern encryption systems; in particular they are involved in the diffusion layer of block ciphers, for instance, the AES cipher [2] or the Camellia cipher [3].

A b-block superregular matrix is a more restrictive concept, where all square submatrices of order a multiple of b are non-singular. Superregular block matrices are used in the construction of $\mathbb{F}_q$-linear codes over finite fields [4,5,6].

In this work, we propose a construction of block superregular matrices based on the Kronecker product. Furthermore, we use these block superregular matrices and the ring isomorphism proposed in [6], where the image of a superregular matrix was a block superregular matrix composed of powers of the companion matrix of a primitive polynomial, in order to construct superregular matrices over extension fields.

This work was supported by *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) - Brazil - process 405842/2023-6.

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The AKS algorithm and high order elements in finite fields

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The AKS algorithm is a deterministic primality test that runs in polynomial time. Created and published in 2002 by Agrawal, Kayal and Saxena (see [1]), when no such an algorithm existed. It is remarkable by its enormous theoretical importance notwithstanding its simplicity, and the fact that the proof of its time complexity and correctness are elementary. The key ideas lies in the use of classical algebraic results, such as the following identity in the ring $\mathbb{Z}_n[X]$, where n is a prime number:

$$(X + a)^n = X^n + a.$$

The latter is just a generalization of Fermat's Little Theorem. In this work we give an overview on the proof of the AKS algorithm, focusing in a key step of the proof that provides explicit constructions of large subgroups in the multiplicative group of a finite field. This is of major importance in applications such as the Discrete Logarithm Problem [2]. Motivated by this, we also discuss the construction of elements of high multiplicative order in finite field extensions arising from Artin-Schreier polynomials [3].

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On the footprint of an ideal and the minimum distance from the toric code

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In this work, we introduce the notion of the "footprint" of an ideal within the polynomial ring $\mathbb{K}[X_1, \ldots, X_n]$, which is an important concept in the theory of Gröbner Bases. We will explore the relationships between the affine variety and the footprint of its corresponding ideal, and we will also present Buchberger's Theorem. This theorem provides us with a basis for the $\mathbb{K}$-vector space $\mathbb{K}[X_1, \ldots, X_n]/I$, which arises from classes of monomials within the footprint of the ideal $I \subset \mathbb{K}[X_1, \ldots, X_n]$.

Moreover, by reformulating the definition of an evaluation code presented in [1], we will demonstrate how to use the footprint of an ideal to retrieve the results therein. This includes obtaining several important properties of toric codes of degree d.

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The Hexagonal Lattice via Quadratic Fields and the Well-Roundedness Property

Nicoll Vanessa Jerez Nieves
UNESP, Brazil

Joint work with Carina Alves.

Abstract of poster: One of the techniques to generate lattices and evaluate their packing density is through the application of certain homomorphisms to certain free $\mathbb{Z}$-modules of rank n contained in a number field K of degree n. The lattices generated by this method are known as algebraic lattices. The advantage of obtaining lattices by this method is that we can identify the points of the lattice in $\mathbb{R}^n$ with the elements of K. In this way, we can use some properties of the field K, which have a richer algebraic structure in the study of such lattices. Thus, the study of parameters related to the probability of error, which from a geometric point of view are difficult to calculate, can be translated into an algebraic context. In this work, we use the theory of quadratic fields to present an algebraic construction of the hexagonal lattice Λ_{Hex}, which is the lattice with the highest packing density in dimension 2. We also analyze whether Λ_{Hex} is a well-rounded lattice, that is, if its set of minimal vectors spans the whole space. This work was supported by FAPESP, Proc. 2023/15735-8. The opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of FAPESP.

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Applications in Combinatorial Number Theory of generalized versions of the Chevalley Warning and Ax-Katz Theorems

Caio Monteiro de Oliveira
UFMG, Brazil

Let V be the set of common zeros of a collection of polynomials over a finite field $\mathbb{F}_q$ of characteristic p, Chevalley Warning's Theorem establishes that $|V|$ is divisible by p as long as the number of variables is sufficiently large when compared to the degree of these polynomials. In turn, the Ax-Katz Theorem generalizes this fact by providing limits for the divisibility of $|V|$ by a power of p.

In the present work, based on [2], generalizations for these theorems will be addressed with a view to applications in Combinatorial Number Theory. Using Wilson's arguments [3] in his elementary proof of the Ax-Katz Theorem for the case $\mathbb{F}_p$ it is possible to prove the Chevalley Warning Theorem for the case where we allow varying prime power moduli and also the following generalization for the Ax - Katz Theorem:

Let $B = I_1 \times ... \times I_n$, with each $I_j \subseteq \mathbb{Z}$ a complete system of residue modulo p, be $f_1, ..., f_s \in \mathbb{Z}[X_1, ..., X_n]$ a collection of non-zero polynomials and let $V = \{a \in B : f_1(a) \equiv 0 \text{ mod } p^{m_1}, ..., f_s(a) \equiv 0 \text{ mod } p^{m_s}\}$. Then:

$$|V| \equiv 0 \text{ mod } p^m$$

as long as $n > (m-1)\max_{i \in [1,s]}\{p^{m_i - 1} \text{ deg } f_i\} + \sum_{i=1}^{s} \frac{p^{m_i}-1}{p-1} \text{ deg } f_i$.

The introduction of the set B adds a certain degree of flexibility, which combined with the appropriate use of Hensel's Lemma to choose the complete system of residues I_j, allows many combinatorial applications of Chevalley Warning and Ax-Katz Theorems previously valid only for $\mathbb{F}_p^n$, extending with bare minimal modification the validity for an arbitrary finite abelian p-group G.

Some applications of this fact are a new proof of the exact value of Davenport Constant $D(G)$ for finite abelian p-groups, a simplified proof of the Kemnitz Conjecture and also new results on a finite abelian group G with exponent q, referring to the constant $s_{kq}(G)$, a generalization of the Erdös-Ginzburg-Ziv constant and which is defined as the smallest positive integer l such that any sequence of l terms of G must contain a subsequence of length kq whose sum is zero.

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Zeros da equação diagonal sobre corpos finitos

Samuel Felipe de Oliveira
UFMG, Brazil

Seja $\mathbb{F}_q$ o corpo finito com q elementos e $f(x_1, ..., x_n)$ um polinômio com coeficientes em $\mathbb{F}_q$. Se N denota o número de soluções da equação $f(x_1, ..., x_n) = 0$ em $\mathbb{F}_q^n$ então é conhecido que $q^a|N$ onde a é o maior inteiro menor do que n/d, sendo d o grau de f (veja [2]). Com base em tal resultado, no presente trabalho, baseado em [1], será estudada a equação

$$c_1x_1^{d_1} + ... + c_nx_n^{d_n} = c$$

onde $c_i \in \mathbb{F}_q^*, c \in \mathbb{F}_q$ e $d_i|q-1$. Sendo mais específico, se existe um número inteiro $b \geq 1$ tal que $d_1^{-1} + ... + d_n^{-1} > b$ então $q^b|N$. Tal resultado generaliza o fato de que, nas mesmas condições, $p|N$ que foi provado em [3].

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Códigos Produto e Construção A de Reticulados
Makson Miller Alves Ribeiro
UNICAMP, Brazil

Há uma classe de códigos corretores de erros (subespaços lineares), os quais checam a paridade das palavras enviadas, denominados SPC (*simple parity-check)*. Tais códigos são comumente usados em diversas aplicações devido a sua performance. O que fizemos foi estudar o produto tensorial entre estes códigos e os associamos a reticulados através da Construção . A partir código gerado (código produto) obtido via produto tensorial de Kronecker conseguimos exibir parâmetros relevantes a estes reticulados, como o número de vizinhos (associado ao número de palavras de peso mínimo do código produto) e matriz do reticulado associado. Na forma matricial, podemos colocar o código como imagem de uma transformação linear e com uma matriz geradora G.
Pela observação da forte estrutura da matriz geradora apresentamos o seguinte resultado O número de palavras de peso mínimo 4 do código produto $G = \begin{bmatrix} I_n & \mathbf{1} \end{bmatrix} \otimes \begin{bmatrix} I_n & \mathbf{1} \end{bmatrix}$ é dado por:

$$\frac{n^4 + 2n^3 + n^2}{4}.$$

Quando um código não está na forma padrão então a matriz do reticulado associado é obtida via Formal Normal de Hermite . Posto isso, podemos então considerar o código produto Para o código linear $\mathcal{C} = \begin{bmatrix} I_n & \mathbf{1} \end{bmatrix} \otimes \begin{bmatrix} I_n & \mathbf{1} \end{bmatrix}$. O que encontramos então é que a matriz do reticulado obtido por Construção A, do código produto é

$$\begin{bmatrix} I_n & \mathbf{1} & \mathbf{0} & \dots & \dots & \dots & \mathbf{0} & I_n & \mathbf{1} \\ \mathbf{0}_{1\times n} & 2 & 0 & 0 & \dots & \dots & 0 & 0 & 0 \\ \mathbf{0} & 0 & I_n & \mathbf{1} & \dots & \dots & \mathbf{0} & I_n & \mathbf{1} \\ \mathbf{0}_{1\times n} & 0 & \mathbf{0} & 2 & \dots & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots \\ 0 & \dots & 0 & \dots & 2 & 0 & \dots & 0 & 0 \\ \mathbf{0} & \dots & \mathbf{0} & \dots & \mathbf{0} & I_n & \mathbf{1} & I_n & \mathbf{1} \\ \mathbf{0} & \dots & \mathbf{0} & \dots & \mathbf{0} & \mathbf{0} & & 2I_{n+2} & \end{bmatrix}.$$

Encontramos também o *kissing number* do reticulado associado ao código produto $\begin{bmatrix} I_n & \mathbf{1} \end{bmatrix} \otimes \begin{bmatrix} I_n & \mathbf{1} \end{bmatrix}$ com uma expressão fechada. A saber, $\frac{n^4+2n^3+n^2}{4} \cdot 2^4 + (n+1)^2 \cdot 2.$
Com isso apresentamos um estudo de códigos e reticulados associados em que parâmetros relevantes de cada um deles foram encontrados devido a forte simetria da matriz geradora do código produto. Ainda estamos buscando mais resultados sobre estes códigos e reticulados associados, encontramos a hierarquia de pesos e agora estamos interessados no espectro deste código produto.

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Rédei Permutation Polynomials

Brenda Letícia Rodrigues Silva
UFMG, Brazil

Let $\mathbb{F}_q$ be the finite field with q elements, where q is a prime power. In the case when $f(x) \in \mathbb{F}_q[x]$ induces a permutation of the elements of $\mathbb{F}_q$, we say that f is a permutation polynomial. The cycle structure of the permutation generated by f captures important information about the dynamic of the permutation. For instance, this structure is known for families of permutation polynomials like permutation monomials and Dickson Polynomials. In this work, we study the structure of cycles of the Rédie Permutations that satisfies some special condition.

Let $\mathbb{P}^1(\mathbb{F}_q) = \mathbb{F}_q \cup \{\infty\}$ be the projective space over $\mathbb{F}_q$ of dimension 1. We note that the binomial $(x+\sqrt{y})^m$ can be expand as $N(x,y) + D(x,y)\sqrt{y}$. For $m \in \mathbb{N}$ and $a \in \mathbb{F}_q$, the Rédei function $R_{m,a} : \mathbb{P}^1(\mathbb{F}_q) \to \mathbb{P}^1(\mathbb{F}_q)$ is defined by

$$R_{m,a}(x,y) = \begin{cases} \frac{N(x,y)}{D(x,y)}, & \text{if } D(x,y) \neq 0 \text{ and } x \neq \infty, \\ \infty & \text{otherwise.} \end{cases}$$

Let $\chi : \mathbb{F}_q \to \{-1,1,0\}$ be the multiplicative quadratic character. For each $a \in \mathbb{F}_q^*$, $R_{m,a}$ induces a permutation on $\mathbb{P}^1(\mathbb{F}_q)$ if and only if $gcd(m, q-\chi(a)) = 1$. We will show some results about the Rédei permutations with cycles of the same length or same structure.

Using some number-theoretic results, we characterize Rédei permutations with cycles of length 1 and p, for a prime integer p. An interesting case for cryptography is when $p = 2$. We also present a necessary and sufficient condition to ensure that $R_{m,a}$ and $R_{m,b}$ have the same cycle structure. Other interesting result is that the only isolated Rédei permutations (i.e. no other Rédei permutation has the same cycle structure) are the isolated Rédei involutions.

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Applications of Finite Fields in Cryptography: A Comprehensive Study

Lídia Campelo Da Silva
UNESP, Brazil

Joint work with professor Dr. Sara D. Cardell (Unesp).

Cryptography, as a pivotal field in ensuring secure communication and data integrity, constantly seeks innovative techniques to fortify its foundations. One such realm of exploration lies in the application of finite fields, offering a diverse array of tools and methodologies to bolster cryptographic protocols. This abstract delves into an in-depth examination of the utilization of finite fields in various cryptographic schemes, particularly focusing on their integration within the Advanced Encryption Standard (AES) substitution layer [1,2] and elliptic curve cryptography [1,2].

Within the AES context, finite fields provide a fundamental framework for implementing the substitution layer, contributing to the robustness and efficiency of the encryption process. By exploring the intricacies of finite field arithmetic, researchers have uncovered novel approaches to enhance the security and performance of AES-based systems.

Additionally, finite fields serve as a cornerstone in elliptic curve cryptography, offering a rich landscape for cryptographic operations. Through the exploration of finite field structures, researchers have developed sophisticated cryptographic algorithms leveraging elliptic curves, enabling secure key exchange, digital signatures, and other cryptographic primitives.

This work encapsulates a comprehensive survey of the applications of finite fields in cryptography, shedding light on their indispensable role in advancing the security landscape.

This work was partially supported by *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) - Brazil - process 405842/2023-6.

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SESSION 5

Group Theory

ORGANIZERS

Luis Augusto Mendonca (UFMG)
Martino Garonzi (UnB)
Slobodan Tanushevski (UFF)

S5 - Group Theory

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A story concerning the birth of group representations

Gurmeet Kaur Bakshi
Panjab University, Chandigarh, India

The aim of this lecture is to recount the story related to the birth of representation theory of finite groups. We shall discuss how Dedekind proposed to Frobenius the problem of factoring a certain homogeneous polynomial arising from a determinant (called the "group determinant") associated with a finite group G. In the later half of the lecture, we will discuss the contributions of William Burnside, and how he enters the scene.

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Moufang permutations over small abelian groups

Dylene Agda Souza de Barros
Universidade Federal de Uberlândia (UFU), Brazil

Moufang permutations are certain permutations on an abelian group X that differ from an automorphism of X by a symmetric alternating biadditive mapping. It is known that every finite split abelian-by-cyclic 3-divisible Moufang loop is obtained from a Moufang permutation of the abelian normal subgroup. In this paper we investigate Moufang permutations for small abelian groups. We prove that the a finite abelian group X possesses non-automorphic Moufang permutations if and only if the 2-primary component of X is of order more than four and is not cyclic. The automorphism group of X acts by conjugation on the set of Moufang permutations of X and the orbits of this action provide a partial answer to the corresponding isomorphism problem. We explicitly find all Moufang permutations for small abelian groups, including small elementary abelian 2-groups.

This is a joint work with Petr Vojtěchovský (University of Denver).

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On weak commutativity in p-groups

Raimundo de Araujo Bastos Junior
UnB, Brazil

The weak commutativity group $\chi(G)$ is generated by two isomorphic groups G and G^φ subject to the relations $[g, g^\varphi] = 1$ for all $g \in G$. We present new bounds for the exponent of $\chi(G)$ and its sections, when G is a finite p-group. This is a joint work with E. de Melo, R. de Oliveira and C. Monetta.

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Lannes T-functor and mod-p cohomology of profinite groups

Marco Boggi
UFF, Brazil

The Lannes-Quillen theorem relates the p-cohomology of a finite group G with the p-cohomology of centralizers of abelian elementary p-subgroups of G, for $p > 0$ a prime number. This theorem was extended to profinite groups whose p-cohomology algebra is finitely generated by Henn. In a weaker form, the Lannes-Quillen theorem was then extended by Symonds to arbitrary profinite groups. Building on Symonds' result, we formulate and prove a full version of this theorem for all profinite groups. For this purpose, we develop a theory of products of sheaves of discrete torsion modules which is dual, in a very precise sense, to the theory of coproducts of sheaves of profinite modules developed by Haran, Melnikov and Ribes. In the last section, we give applications to the problem of conjugacy separability of finite p-subgroups.

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Conjugacy separability of groups of geometric nature

Sheila Chagas
UnB, Brazil

We shall talk on conjugacy separability of standard arithmetic subgroups of a special orthogonal group. The same property for 3-orbifolds also will be discussed.

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On wreath product occurring as subgroup of automata group

Alex Carrazedo Dantas
UnB, Brazil

A finitely generated group is said to be automata group provided it admits a faithful self-similar finite-state representation on some regular m-tree. In this presentation we show that if G is a subgroup of an automata group, then for each finitely generated abelian group A the wreath product $A \wr G$ is a subgroup of an automata group. We obtain, for example, that $C_2 \wr (C_2 \wr \mathbb{Z})$, $\mathbb{Z} \wr (C_2 \wr \mathbb{Z})$, $C_2 \wr (\mathbb{Z} \wr \mathbb{Z})$ and $\mathbb{Z} \wr (\mathbb{Z} \wr \mathbb{Z})$ are subgroups of automata groups. In the particular case $\mathbb{Z} \wr (\mathbb{Z} \wr \mathbb{Z})$ we prove that it is a subgroup of an automata group in a two-letters alphabet; this solves Problem 15.19 - (b) of the Kourovka Notebook proposed by A. M. Brunner and S. Sidki in 2000. This is joint work with Junio R. Oliveira and Tulio M. G. Santos.

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Novos exemplos de grupos residualmente finitos

Esteban de Jesus Garcia Hernandez
UNICAMP, Brazil

Em colaboração com a professora Dessislava Hristova Kochoukova e usando a construção do produto tensorial não abeliano de grupos introduzido por Brown e Loday em [7] (ver também [3]) foi possível construir uma nova família de grupos residualmente finitos. Lembremos que um grupo G é residualmente finito quando a interseção dos seus subgrupos normais de índice finito é trivial. Nesse sentido, usando os grupos de Baumslag-Solitar $B(m,n) = \langle a, x \mid x^{-1}a^m x = a^n \rangle$, vamos mostrar que os grupos $B(m,n) \otimes B(m,n)$ são residualmente finitos em todos os casos em que $B(m,n)$ é residualemente finito. Veremos que para chegar nesse resultado foram usadas ferramentas da Teoria de Homologia assim como resultados sobre as estruturas do grupo de Sidki $\mathcal{X}(G)$ [8] (ver também [2]) e do grupo $\nu(G)$, introduzido por Rocco em [6].

keywords: Residualmente Finito. Produto Tesorial não abeliano. Teoria de Homologia.

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An invariant for singular knots

Ênio Carlos da Silva Leite
UFBA, Brazil

Let SG_n be the group of singular braids and VTL_n be the virtual Temperley-Lieb algebra. In this work, we introduce a Jones-type invariant for singular knots, using a Markov trace in the VTL_n algebra and singular braid theory. Furthermore, we show that there is a representation of the group SG_n in the algebra VTL_n.

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Non self-similar metabelian groups

Melissa de Sousa Luiz
UNICAMP, Brazil

Joint work with Dessislava Hristova Kochloukova (UNICAMP).

Let $\mathcal{T}_m$ denote the infinite one-rooted m-tree and $\mathcal{A}_m$ its group of automorphisms. We call a group G self-similar if there's an m such that G is a state-closed subgroup of $\mathcal{A}_m$.

On the other hand, a group G is said to be metabelian if there is an exact sequence of groups

$$0 \to A \to G \to Q \to 0,$$

where A and Q are abelian. In this case, we define an action of $Q \simeq G/A$ on A by conjugation and we consider A as a $\mathbb{Z}Q$-module. Supose $G = A \rtimes Q$, where Q is a finitely generated abelian group and A is a finitely generated $\mathbb{Z}Q$-module of Krull dimension 1 and

$$C_Q(A) := \{q \in Q \mid A(q-1) = 0\} = 1.$$

Kochloukova and Sidki proved in 2020 that G is a transitive self-similar group[1].

In this talk, I intend to present some new results obtained with professor Dessislava about metabelian groups $G = A \rtimes Q$, where A is a $\mathbb{Z}Q$-module of Krull dimension 2, which are not self-similar.

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Block Theory of Profinite Groups

John William MacQuarrie
UFMG, Brazil

Block Theory for finite groups is an approach to the representation theory of finite groups: it starts from the simple observation that the group algebra can be written as a direct product of indecomposable algebras, and it's enough to study the modules for each factor separately. A profinite group is a (probably infinite) topological group that can be well-understood in terms of its finite quotients. Many facts about finite groups have "profinite analogues". In this talk, I'll explain these things and discuss the block theory of profinite groups, arriving at the observation that the finite/profinite analogy in block theory seems to be even stronger than usual! It's work from distinct projects with Ricardo Franquiz Flores (UFLA) and Peter Symonds (University of Manchester).

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Cut groups: Some old and new developments

Sugandha Maheshwary
Indian Institute of Technology Roorkee, India

A group G is called a cut group if all central units of its integral group ring are trivial, i.e., $\pm g,\ g \in G$. It is equivalently defined with different group theoretic and ring theoretic approaches. The various notions thus developed exhibit a highly interesting interplay between group theory, representation theory, K -theory etc. Though the term "cut" groups was coined only recently, this class of groups seemingly was initially studied in 1987. In this talk, I shall present these equivalent notions and some recent advancements on the properties of cut groups. This includes basic properties of cut groups, various classes of cut groups, questions on prime spectrum and Gruenberg Kegel graph of solvable cut groups, and possible extensions of this class.

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Inverse semigroup cohomology and crossed module extensions of semilattices of groups by inverse semigroups

Mayumi Makuta
UFPR, Brazil

We define and study the notion of a crossed module over an inverse semigroup and the corresponding 4-term exact sequences, called crossed module extensions. For a crossed module A over an F-inverse monoid T, we show that equivalence classes of admissible crossed module extensions of A by T are in a one-to-one correspondence with the elements of the third order-preserving inverse semigroup cohomology group $H^3_\leqslant(T^1, A^1)$. Joint with Mikhailo Dokuchaev (USP) and Mykola Khrypchenko (UFSC).

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On finite groups with the Magnus property

Claude Marion
Universidade do Porto, Portugal

We investigate finite groups with the Magnus property (MP), where a group is said to have the Magnus property if whenever two elements generate the same normal subgroup then the elements are conjugate or inverse-conjugate. In particular we observe that a finite MP group must be solvable and give the classification of the finite primitive MP groups. This has a couple of applications such as the fact that the Fitting height of a finite MP group is at most 2 and the characterisation of the primes dividing the order of a finite MP group. We also present some results on MP finite direct products of finite groups. Finally, we describe the chief factors of a finite MP group. This is joint work with Martino Garonzi.

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Half-automorphisms of some code loops

Rosemary Miguel
UFF, Brazil

The concept of half-isomorphism becomes trivial for groups and Moufang groups of odd order. However, certain classes of loops have nontrivial half-automorphisms. We research the existence of nontrivial half-automorphisms of some code loops, by utilizing the characteristic vectors and groups of elementary applications associated with them. Consequently, we determine which code loops of rank 3 have only trivial half-automorphisms and which have nontrivial half-automorphisms. Additionally, we present a method to obtain the group of half-automorphisms of these loops from the group of automorphisms.

This is a joint work with Dylene Agda Souza de Barros (Universidade Federal de Uberlândia).

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Geometry and arithmetic in discrete groups

Plinio Guillel Pino Murillo
UFF, Brazil

The goal of this talk is to discuss relations between geometry and number theory that we can find in the modular and Bianchi groups, and how this connection can lead to answering some questions of a geometric nature, mainly via the study of closed geodesics in hyperbolic spaces.

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Non-abelian tensor products of groups and finiteness conditions

Irene Nakaoka
UEM, Brazil

In this talk we will present some results on non-abelian tensor products of groups, especially those that give conditions on the groups G and H and its compatible actions for the non-abelian tensor product of G and H to be finite or locally finite.

This is a joint work with R. Bastos and N. R. Rocco.

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Finite quotients of reflection groups

Yuri Santos Rego
University of Lincoln, UK

Combinatorial, asymptotic, and geometric group theory have shown us over the past century that distinguishing infinite groups is a delicate issue. In recent decades, there has been particular interest in distinguishing groups with interesting geometric features by means of their finite quotients. In this talk we shall focus on the case of Coxeter groups, which are abstract counterparts – or rather generalizations – of classical (spherical, Euclidean, or hyperbolic) reflection groups. We will discuss recent results and open problems around profinite rigidity of such groups. Based on joint work with Petra Schwer.

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The q-tensor square of polycyclic groups and related constructions

Noraí Romeu Rocco
UnB, Brazil

In this talk we address certain structural properties and computational aspects of the q-tensor square $G \otimes_q G$ of a group G, where q is a non-negative integer, via the group $\nu_q(G)$, a related construction which is an extension of $G \otimes_q G$ by $G \times G$. Special attention will be given to polycyclic groups, particularly to certain classes of finite p-groups G, where issues involving exponents, nilpotency class and number of generators will be considered.

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On the projective representations of p-solvable groups

Nicola Sambonet
UFBA, Brazil

The Itô–Michler Theorem states that a prime p does not divide the degrees of the ordinary irreducible representations of a finite group G if and only if G has a normal abelian Sylow p-subgroup P. For the projective irreducible representations it is only known that if p does not divide the degrees then P is abelian. This result, despite being limited to one of the implications and not mentioning the normality of P, is fundamental in the proof of Brauer's Height Zero Conjecture given by Gluck and Wolf for p-solvable groups and completed recently by Malle, Navarro, Schaeffer Fry, and Tiepp. For p-solvable groups, we determine some equivalent conditions that correspond to the normality of P in the ordinary case, moreover, we show that in general the p-part of the degree of a primitive projective irreducible representation of G is the degree of a projective irreducible representation of P.

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Intransitive self-similar groups

Tulio Marcio Gentil dos Santos
UFRJ, Brazil

We will discuss results obtained in collaboration with A. C. Dantas and S. N. Sidki.

In recent decades, there has been significant interest in groups acting on $\mathcal{T}_m$ by automorphisms. This interest is largely due to the construction of counterexamples to famous conjectures in group theory within these groups. For example, the Grigorchuk group (1980) and the Gupta-Sidki group (1983) were constructed as automorphism groups acting on one-rooted regular trees. These were the first examples of infinite finitely generated torsion groups and the first examples of a group of intermediate growth.

A group G is self-similar if it acts on a one-rooted m-regular tree $\mathcal{T}_m$, where the states of its elements are elements of G. Additionally, G is transitive self-similar if it induces a transitive action on the first level of the tree. If a self-similar group G does not admit a transitive action, we refer to it as an intransitive self-similar group.

A successful method for constructing self-similar groups is based on the notion of virtual endomorphisms of groups, introduced by Nekrashevych and Sidki [1]. However this produced groups which act transitively on the first level of the tree. We extended the notion of a single virtual endomorphism to a set of virtual endomorphisms, by which all self-similar groups could be constructed. Using this new approach, we produced faithful self-similar representations, some of which are also finite-state, for a number of groups such as$\mathbb{Z}^\omega$, $\mathbb{Z} \wr \mathbb{Z}$ and $(\mathbb{Z} \wr \mathbb{Z}) \wr C_2$, [2].

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Practical algorithms for recognising exterior square and symmetric square representations of classical groups

Csaba Schneider
UFMG, Brazil

Efficient computations with matrix groups require that we should be able to handle the small-dimensional representations of the quasisimple groups efficiently. In this talk, I'll outline a method, originally suggested by Charles Leedham-Green, for constructively recognizing the representations of the classical groups defined over finite fields that are isomorphic to either the exterior square or the symmetric square of the natural representation.The algorithms that I present are implemented in the computational algebra system Magma and is distributed inside the standard library of the system.

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Generalized torsion elements in groups

Danilo Sanção da Silveira
UFOP, Brazil

A group element is called a generalized torsion if a finite product of its conjugates is equal to the identity. Torsion elements are trivially generalized torsion elements, but the converse does not hold in general. In the talk we will prove that in a nilpotent group or FC-group, the generalized torsion elements are all torsion elements.

This is a joint work with Raimundo Bastos from *Universidade de Brasília* and Csaba Schneider from *Universidade Federal de Minas Gerais*.

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A generalization of a theorem of Weiss

Marlon Stefano
UFMG, Brazil

Let G be a finite p-group with normal subgroup N. The most powerful detection theorem for $\mathbb{Z}_p G$-permutation modules is due to A. Weiss. It identifies a permutation module in terms of its restriction to N and the action of G/N on its N-invariants. The theorem has fundamental applications when attacking difficult conjectures in diverse areas of algebra, including algebraic number theory and block theory. Weiss' Theorem applies only to a lattice that is free when restricted to N. In this talk, we present a generalization of the theorem, allowing the lattice restricted to N to have both free and trivial summands.

References

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Conjugacy in Monod's Group

Altair Santos de Oliveira Tosti
Universidade Estadual do Norte do Paraná (UENP), Brazil

Monod's group $H := H(\mathbb{R})$ was introduced in [4] and it is defined as a group of piecewise projective orientation-preserving homeomorphisms of $\mathbb{R} \cup \{\infty\}$ which stabilize infinity and is another counterexample of the von Neumann-Day conjecture. The group H can also be regarded as homeomorphisms of $\mathbb{R}$: an element f is in H if there are finitely many points $t_1, t_2, \ldots, t_n$ such that on each interval $[t_i, t_{i+1}]$

$$f\colon t \mapsto \frac{a_i t + b_i}{c_i t + d_i}, \text{ where } a_i d_i - c_i b_i = 1, \text{ for suitable } a_i, b_i, c_i, d_i \in \mathbb{R}$$

and $f\colon t \mapsto (a_0 t + b_0)/d_0$ on $(-\infty, t_1]$ and $f\colon t \mapsto (a_n t + b_n)/d_n$ on $[t_n, +\infty)$. Given a subring A of $\mathbb{R}$, the subgroup $H(A)$ of H consists of all elements which are piecewise in $PSL_2(A)$ with breakpoints in $\mathcal{P}_A$, the set of fixed points of hyperbolic elements of $PSL_2(A)$.

In this talk we discuss results from [3] on the study of the conjugacy problem and centralizers in H and its subgroups by generalizing techniques developed in [1,2].

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Prosoluble subgroups of free profinite products

Pavel Zalesski
UnB, Brazil

We shall discuss prosoluble subgroups of free profinite products towards a complete characterization of them in terms of the intersections with the free factors.

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S5 – Group Theory

Posters index

On an Ahmadkhah-Zarrin Conjecture for simple groups about same-size conjugate set

Camila Gomes de Almeida
UnB, Brazil

Em um trabalho recente, N. Ahmadkhah e M. Zarrin (AZ) estudaram o conjunto de classes de conjugação de mesmo tamanho para um grupo G, denotado por $U(G)$. Em geral, $U(G)$ não é suficiente para caracterizar G. No entanto, eles caracterizaram alguns grupos simples via $U(G)$, isto é, se G um grupo simples e $S = PSL(3,3)$ ou $PSL(2,q)$ com $q \in \{5,7,8,9,17\}$, então $U(G) = U(S)$ se, e somente se, G é isomorfo a S. E eles conjecturam que se G é um grupo e S é um grupo simples, então $U(G) = U(S)$ se, e somente se, G é isomorfo a S. Neste trabalho, exploramos propriedades e exemplos do conjunto conjugado de mesmo tamanho e analisamos, com auxílio do GAP (Groups, Algorithms and Programming), algumas condições sobre a Conjectura de AZ.

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Applications of group theory

Luís Carlos Britner Junior
UNESP, Brazil

Joint work with professor Dr. Sara D. Cardell (Unesp).

This work explores the applications of group theory in various domains, ranging from solving complex puzzles like the Rubik's Cube [1,2] to enhancing communication systems [3]. The study investigates how fundamental principles of group theory are leveraged to tackle challenges in these diverse areas, offering valuable insights into improving efficiency and security. By examining the intersection of mathematical concepts with real-world applications, this research demonstrates the interdisciplinary nature of group theory and its profound impact on problem-solving methodologies. Through examples drawn from gaming and telecommunications, we illustrate the practical significance of employing group-theoretic approaches, paving the way for innovative advancements across multiple fields.

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Grupo F de Thompson

Gabriel Alexsander de Carvalho
UENP, Brazil

Em 1965, R. Thompson introduziu os grupos F, T e V de Thompson, na criação de grupo finitamente gerado com problema da palavra insolúvel. Estes grupos são os primeiros exemplos conhecidos de grupos simples infinitos finitamente apresentados e ainda são assunto de pesquisas em teoria de grupos.

O objetivo desse projeto de iniciação científica é estudar o grupo F de Thompson, que pode ser descrito como o grupo de homeomorfismos lineares por partes do intervalo $[0,1]$ em que cada parte é uma função afim em que a taxa de variação é uma potência de 2 e todos os seus pontos de quebras possuem coordenadas racionais diádicas , e algumas de suas propriedades.

Autor: Gabriel Alexsander de Carvalho Orientador: Altair Santos de Oliveira Tosti

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Residual and Separability Properties in Groups

Renan Vanderlei Fernandes
UnB, Brazil

A group G is said to be LERF if every finitely generated subgroup of G is closed in the profinite topology of G. We say that a group G satisfies LR if every finitely generated subgroup is virtually embedded in a finite index subgroup of G. In this work, we will address a theorem by N. Andrew concerning a result of Burns-Romanovski on the free product of LERF groups, using the Bass-Serre Theory. Additionally, we will discuss some properties of LR groups based on the work of A. Minasyan, a result from R. Gitik, S. W. Margolis and B.Steinberg on the free product of LR groups. We will observe how LERF and LR properties behave for direct products, semidirect products, wreath products, free groups, free product and amalgamated, as well as HNN-extension.

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A new function on supersoluble subgroups in finite groups and the GAP (Group, Algorithms and Programming) program

Leonardo Santos
UnB, Brazil

The aim of this work was to deepen the studies on multiplicative functions, seeking to correlate desired and known properties to a function developed and computationally implemented based on supersoluble groups. The project included the study of other multiplicative functions, which had relationships with the function under study, based on the number of subgroups of a group and the number of cyclic subgroups of a group ($\beta(G)$-function and $\alpha(G)$-function). In this sense, it was essential to study and understand modern and classical results of group theory, related to soluble, supersoluble, and nilpotent groups, as well as the fundamental use of the computational algebra software GAP.

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Grupo de Galileu

Eduarda Lima Silva
Universidade Estadual do Norte do Paraná (UENP), Brazil

O Princípio da Relatividade é enunciado como *As leis da física são as mesmas em qualquer referencial inercial [1]*. Com este princípio, existe, de maneira implícita, uma ligação entre referenciais diferentes usados para descrever um fenômeno dado, o que garante que as leis da física são as mesmas, independentemente do referencial.

O objetivo desse projeto de iniciação científica é estudar teoria de grupos e o trabalho [2] para compreender como a teoria de grupos nos auxilia a investigar o Princípio da Relatividade, utilizando a representação do grupo de Galileu no espaço-tempo, que chega às transformações de Galileu entre referenciais inerciais.

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Groups in which every subgroup has subnormal defect at most 2

Millena Andrade da Silva
UnB, Brazil

A subgroup H of G is called n-subnormal if there is an ascending chain of subgroups

$$H = G_m \trianglelefteq G_{m-1} \trianglelefteq \cdots \trianglelefteq G_1 \trianglelefteq G_0 = G \tag{1}$$

of size $m \geq 0$. The size of the smallest chain (1) is the subnormal defect of H in G. We study groups in which every subgroup has subnormal defect up to 2. For groups which every subgroup has subnormal defect 1, called dedekindian groups, we present the Theorem of Dedekind-Baer, which gives us a classification of non-abelian dedekindian groups. For groups in which every subgroup has subnormal defect at most 2, we present the classes S, A and T and relates them. Based on Heineken and Mahdavianary, we also give results on the nilpotency of groups in these classes.

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Propriedades combinatórias de tranças virtuais

Mirele Pereira da Silva
UFBA, Brazil

Neste poster traremos algumas propriedades combinatórias das tranças virtuais, tais como a série central inferior do grupo de tranças virtuais VB_n e também os núcleos de duas projeções diferentes de VB_n no grupo simétrico S_n. Esses núcleos são respectivamente o grupo de tranças puras virtuais VP_n e o fecho normal do grupo das tranças de Artin, que vamos denotar por H_n e é também conhecido como KB_n. Descrevemos as relações entre H_n e VP_n e o grupo de tranças puras estendidas EP_n que é o núcleo da projeção de H_n em S_n.

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On the solubility of the n-centralizers groups

Sharmenya J. A. C. de Sousa
UnB, Brazil

Let G be a group and denote by $\mathrm{Cent}(G)$ the set of all centralizers of elements of G. We say that G is a n-centralizer group when $|\mathrm{Cent}(G)| = n$. A natural question is if we fixed $|\mathrm{Cent}(G)|$, is it possible to obtain a caracterization of G. This question has already been answered for finite (and infinite) groups for certain values of n.

In this work, our aim is to obtain a solubility criterion for such groups. At first, we deal with finite groups. After, using the concept of isoclinism, we will extend this result for infinite groups. Both results were obtained by Zarrin (see [5,4]) and here we will summarize his work.

For a group G denote by $\omega(G)$ the maximum size of a set of pairwise non-commuting elements. It can be proved that $\omega(G) \leq |\mathrm{Cent}(G)| - 1$. This result is part of the Pyber-Zarrin theorem (see [3,5]). With this inequality, and draw upon with the ideas of Endimioni (see [1]), and we prove that any n-centralizer finite group with $n \leq 21$ is solvable. Moreover, this estimate is sharp, once know that A_5 it has 22 centralizers.

Now, we need to deal with infinite groups. For this, we will use the concept of isoclinism. In 1940, Hall (see [2]) seeking classification results for p-groups, introduced a weaker concept than isomorphism. This concept was called isoclinism. In general lines, two groups G and H are said isoclinics when there is an isomorphism between the quotient groups $\frac{G}{Z(G)}$ and $\frac{H}{Z(H)}$ that induces an isomorphism in its derived subgroups.

The main application of this tool in our work is that, if G is a infinite n-centralizer group, then there exists a n-centralizer finite group H which is isoclinic to G. With this, if H is solvable, then G will also be. So, by using that any finite n-centralizer group with $n \leq 21$ is solvable, we can extend this result for infinite n-centralizers groups.

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On Power Automorphisms with Elementary Abelian 2- Groups Centralizers

Gabriella Cristina de Souza
UnB, Brazil

Let φ be an automorphism of a group G. We denote by $C_G(\varphi)$ the centralizer of φ in G, that is, the subgroup of the fixed points of φ to G. It is known that various properties of G are in a certain sense close to the corresponding properties of the subgroup $C_G(\varphi)$. In the case where φ is a power automorphism, we have that all elements having order 2 are fixed by φ. For this reason, we consider the case where $C_G(\varphi)$ is an elementary abelian 2-group. A power automorphism φ is said to be a pre-fixed-point-free power automorphism if $C_G(\varphi)$ is an elementary abelian 2-group. When a group G admits a pre-fixed-point-free power automorphism, we say that G is an E-group. In this work, we determine all E-groups and their pre-fixed-point-free by power automorphisms. In particular, we use some results on power automorphisms to show a characterization of finite abelian groups.

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About the Sylow numbers of finite groups

Ayrton Anjos Teixeira
UNICAMP, Brazil

Let G be a finite group. We denote by $N(G) = \max\{n_p(G) \mid p \in \pi(G)\}$ where $n_p(G)$ is the number of Sylow p-subgroups of G. We prove that if $N(G) \leqslant 9$ then G is solvable. Moreover, there are some gaps in the values assumed by $N(G)$. We show that if p is a prime and n, m are positive integers such that $2^n p^m - 1$ is a prime number, then there is no group with $N(G) = 2^n p^m$.

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SESSION 6

Lie Algebras

ORGANIZERS

Luiz Enrique Ramirez (UFABC)
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S6 - Lie algebras and their representations

Talks index

Characterization of contact Lie superalgebras

María Alejandra Alvarez
Universidad de Antofagasta, Chile

We present the concept of finite-dimensional complex homogeneous contact Lie super- algebra. The $\mathbb{Z}_2$-graded homogeneous cases are studied in detail producing some rele- vant examples. We characterize homogeneous contact Lie superalgebras in terms of their Berezinian and their structure matrix. These Lie superalgebras are also characterized by means of deformation theory, and as an application we obtain the complete classification of low dimensional Lie superalgebras of this type.

References

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Combinatorics of Gelfand - Tsetlin modules

Juan Camilo Arias-Uribe
Universidad de los Andes, Colombia

Gelfand - Tsetlin modules are generalizations of the ideas of I. Gelfand and M. Tsetlin about tableaux representations of irreducible modules for the general linear Lie algebra. They were introduced by Y. Drozd, V. Futorny and S. Ovisienko and has been studied systematically thanks to its explicit description and because the Gelfand-Tsetlin modules have a very good behavior with respect to a certain maximal commutative subalgebra of the universal enveloping algebra and it is known that regardless of the choice of the maximal commutative subalgebra, the categories of resulting Gelfand-Tsetlin modules are equivalent. In this talk, I will show an action of the symmetric group S_n on the set of graphs associated with tableaux. Each element on the S_n-orbit corresponds with a maximal Gelfand - Tsetlin and Cartan subalgebra and so, we can construct the corresponding Gelfand - Tsetlin module. This action allows us to identify the structure of the module such us, to be highest weight or to be admissible. This is a joint work with Luis Enrique Ramirez (UFABC) and Oscar Morales (U. de Porto).

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Partitions with parity and representations of quantum toroidal superalgebras

Luan Pereira Bezerra
SUSTech, China

The representation theory of quantum toroidal (super)algebras is a very technical and difficult subject. On the other hand, a large class of modules where the central element C acts by 1 have an easy description through the combinatorial framework of partitions with parity. This combinatorics is not only interesting in its own right, but it is expected to be related to other concepts such as crystal bases, BPS states, and equivariant K-theory.

In this talk, I will explain how to construct these modules.

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Nil Hecke algebras and determinantal formula for quantum affine sl(n)
Matheus Brito
UFPR, Brazil

We introduce a new family of simple representations of quantum affine sl(n) which generalizes both prime snake modules and the so called HL-modules. We show that such modules are prime, real and admit a determinantal formula in terms of the action of the Nil Hecke algebra on the monoid of multisegments. This generalizes the determinantal formula of Tadic-Lapid-Minguez for ladder representations of p-adic groups via affine Hecke algebras and a Schur–Weyl duality.

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Lie algebra homology and wheeled operads

Vladimir Dotsenko
Université de Strasbourg, France

I shall recall the definition of a wheeled operad (introduced by Merkulov about 15 years ago) and explain how homotopy invariants of wheeled operads appear naturally when computing stable homology of Lie algebras of derivations of free algebras. This a common generalization of the Loday–Quillen–Tsygan theorem on additive K-theory of an associative algebra, and the Fuchs' stability theorem for homology of the Lie algebra of vector fields.

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Isomorphisms among quantum Grothendieck rings and their cluster theoretical interpretation

Ryo Fujita
University of Kyoto, Japan

Quantum Grothendieck ring in this talk is a deformation of the Grothendieck ring of the monoidal category of finite-dimensional modules over the quantum loop algebra, endowed with a canonical basis consisting of the so-called simple (q,t)-characters. We discuss a collection of isomorphisms among the quantum Grothendieck rings of different Dynkin types respecting the canonical bases, via which the (q,t)-characters of non-simply-laced type inherit several good properties from those of the unfolded simply-laced type. We also discuss their cluster theoretical interpretation, which particularly yields non-trivial birational relations among the (q,t)-characters of different Dynkin types. This is a joint work with David Hernandez, Se-jin Oh, and Hironori Oya.

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Algebraic Exponential and its application

Alexandre Grichkov
IME-USP, Brazil

Let L be a finite dimensional Lie algebra over the field $\mathbb{R}$ of real numbers, G be a corresponding Lie group, and $Exp : L \to G$ be the classical algebraic exponential map. Then for any Lie subalgebra $P \subseteq L$, we get that $Exp(P) \subseteq G_P$, where G_P is a Lie subgroup of G, $\dim L = \dim G_P$ and Lie algebra of the group G_P is isomorphic to P. By definition, if G is an algebraic group and L is the corresponding Lie algebra, then a map $AE : L \to G$ is an algebraic exponential map, if AE is birational isomorphism and for every closed algebraic closed subgroup $H \subseteq G$ we have $AE(L(H)) \subseteq H$. We proved that an algebraic exponential map $AE : L \to G$ there exists iff G is a solvable algebraic group of rank < 2.

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Sobre a conjectura de Vergne para álgebras nilpotentes em dimensões baixas

Oscar Francisco Márquez-Sosa
UFSC, Brazil

A conjectura de Vergne postula que não há álgebras rígidas na variedade de álgebras de lie nilpotentes. Neste palestra discutiremos alguns resultados sobre esta conjectura para álgebras de dimensão ≤ 7.

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Relaxed Gelfand-Tsetlin modules

Oscar Armando Hernández Morales
University of Porto, Portugal

The classification of relaxed highest-weight modules over simple affine vertex algebras of arbitrary rank is known under the hypotheses of their weight spaces being finite-dimensional. However, explicit construction of these representations remains a mystery and the Gelfand-Tsetlin theory can help to solve this problem. In this talk, we will discuss Gelfand-Tsetlin theory in the previously mentioned context and how it can be used to formulate some generalizations.

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Noncommutative Noether's Problem in prime characteristic

João Fernando Schwarz
UFBAC, Brazil

Noether's problem is a famous problem of invariant theory which asks, for which finite groups of automorphisms G of the field of rational functions $k(x_1, \ldots, x_n)$, the invariant subfield is again purely transcendental. Let $A_n(k)$ be the rank n Weyl algebra and $F_n(k)$ its skew field of fractions. Alev and Dumas, in 2006, proposed a noncommutative version of Noether's problem: for $G < GL_n(k)$, when we have $F_n(k)^G$ isomorphic to $F_n(k)$? Since the definition of the Weyl algebra makes sense in prime characteristic, and it is again a Noetherian domain, we adress the same question in prime characteristic. Many interesting cases are obtained, using as a main technical tool a modification of Grothendieck's rings of differential operators: crystalline rings of differential operators.

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Globalization for partial group actions on semiprime Lie algebras

José Luis Vilca-Rodríguez
IME-USP, Brazil

We give necessary and sufficient conditions for the existence of a semiprime globalization for a partial group action on a semiprime Lie algebra L, and with an additional reasonable condition, we show that this semiprime globalization is unique up to isomorphism. Moreover, under the same condition we prove that any globalizable partial group action on L induces a globalizable partial group action on its maximal quotient algebra.

The results presented here are part of a work in collaboration with M. Dokuchaev.

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Commutativity-transitivity Lie algebras and p-adic Lie groups

Theo Zapata
UnB, Brazil

We shall classify finite dimensional Lie algebras with the property that each of its nonzero elements has abelian centralizer thus completing the description of such algebras over the local fields of characteristic zero. Applications to p-adic analytic groups will be mentioned.

This is a joint work with L. Mendonça (UFMG) and Th. Weigel (U. Milano-Bicocca).

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S6 – Lie algebras and their representations

Posters index

Sobre a especialidade de álgebras não-associativas

Matheus Augusto Pock de Oliveira
UFPA, Brazil

Este trabalho é um pequeno fragmento de minha dissertação de mestrado que tem por objetivo estudar a i-excepcionalidade de álgebras de Jordan de dimensão inferior a 13. No trabalho intitulado "Speciality of Lie-Jordan Algebras" [1] dos autores Grishkov e Shestakov, é apresentado que dada uma álgebra associativa A sobre um corpo de característica diferente de 2, é possível obter uma álgebra de Lie que também compõe um sistema triplo de Jordan. Tal álgebra possui a propriedade de ser sempre especial e logo torna-se relevante o estudo da i-especialidade dessas estruturas. Os exemplos estudados aqui são a princípio álgebras de Jordan de dimensão 3 sobre um corpo algebricamente fechado com característica diferente de 2 oriundos do trabalho intitulado "Deformações e isotopias de álgebras de Jordan" [2] de Martin. Buscamos em cada exemplo verificar, nos elementos da base, quais álgebras não anulavam a identidade de Glennie e para tanto utilizamos o auxílio do software Maple.

Joint work with J. Morbach (UFPA).

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Howe duality for some Lie superalgebras

Adina Veronica Remor
UFPR, Brazil

Joint work with Matheus Batagini Brito (UFPR).

The goal of this work is to study the so-called Howe duality, which involves commuting actions for classical Lie groups and Lie superalgebras. This theory was introduced in 1976, by Roger Howe (1945-). Given a vector superspace $U = U_{\overline{0}} \oplus U_{\overline{1}}$, Howe defined the superalgebra $\mathcal{A}(U)$, defined as a quotient from the tensorial algebra by the relations $x \otimes u - u \otimes x$ and $w_1 \otimes w_2 + w_2 \otimes w_1$, for $x \in U_{\overline{0}}, w_1, w_2 \in U_{\overline{1}}$ and $u \in U$. He regarded U as a natural representation for some classical Lie group G and considered $\mathcal{A}(U)$ as the induced G-module. Howe also defined a family of operators that act on $\mathcal{A}(U)$ and generate the algebra $\mathfrak{W}(\mathbf{U})$, known as the Weyl-Clifford algebra. This work focuses on the study of the decomposition of $\mathcal{A}(U)$ in $(G, \mathfrak{W}(\mathbf{U})^G)$-modules. One can also identify the set of generators of $\mathfrak{W}(\mathbf{U})^G$ with a basis for a Lie superalgebra $\mathfrak{g}$, explicitly described depending on G and U. In particular, $\mathfrak{W}(\mathbf{U})^G$ is a quotient of $\mathfrak{U}(\mathfrak{g})$ and $(G, \mathfrak{g})$ is called a Howe dual pair. To finish our work, we will present a particular case of Howe duality in which we considered the Howe dual pair $(O_k(\mathbb{C}), \mathfrak{sl}_2)$.

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Computação explícita da álgebra de invariantes de uma álgebra de Lie nilpotente

Igor Martins Silva
UFMG, Brazil

seja L uma álgebra de Lie nilpotente de dimensão finita, com base $x_1, \ldots, x_n$. Definimos F[L] para ser a álgebra de polinômios nas variáveis $x_1, \ldots, x_n$. Para cada x em L, podemos estender a ação adjunta ad(x) por linearidade e pela regra de Leibniz, de modo a obter uma derivação na álgebra F[L] (aqui, por abuso de notação, usaremos o símbolo ad(x) também para indicar a derivação). Como F[L] é um domínio, podemos considerar seu corpo de frações, denotado por F(L). Pela regra do quociente, podemos estender a derivação ad(x) a uma derivação em F(L) (também denotada pelo mesmo símbolo). A álgebra de invariantes racionais é a interseção do núcleo de ad(x), para todo x em L. Nosso trabalho, desenvolveu uma procedimento, com base no Método das Características, que dada uma álgebra de Lie nilpotente, devolve os geradores algebricamente independentes da álgebra de invariantes racionais

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SESSION 7

Number Theory

ORGANIZERS

Diego Marques (UnB)
Jean Lelis (UFPA)
Sinai Robins (IME-USP)

S7 - Number Theory

Talks index

Ring-LWE and Poly-LWE in lattice-based cryptography and number-theoric problems coming from them

Robson Ricardo de Araujo
IFSP - Instituto Federal de São Paulo (campus Catanduva), Brazil

In the 1990s, the mathematician Peter Shor presented a quantum algorithm for finding the prime factors of an integer, which means that the most widely used cryptographic protocols today (e.g., RSA and ECC's) will not survive the advent of quantum computers [1]. Since then, several scientists have been looking for new cryptosystems resistant to quantum computers - this is called post-quantum cryptography. The most promising cryptographic protocols that have been proposed by experts are those based on lattices, especially algebraic lattices (as the CRYSTALS-Kyber algorithm [2]). Algebraic lattices are obtained as image of ideals on ring of algebraic integers of number fields through the Minkowski embedding or one of its twisted version. Some of computational problems behind these new protocols are the Ring-LWE (Ring-Learning With Errors) and the Poly-LWE (Polynomial-Learning With Errors) [3,4]. The Ring-LWE is set on ring of algebraic integers, while the Poly-LWE is a simplified version of the first problem set on polynomial rings. Some interesting problems in number theory have emerged or been motivated by Ring-LWE, Poly-LWE, and the relationship between these two problems [5]. In this work, we intend to present an overview of Ring-LWE and Poly-LWE, point out some of our contributions to this topic and highlight some open problems in number theory arising from Ring-LWE and Poly-LWE.

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Convolution of periodic multiplicative functions and the divisor problem

Marco Aymone
UFMG, Brazil

In a joint work with Maiti, Ramaré and Srivastav, we proved omega bounds for the partial sums of the convolution between two periodic multiplicative functions that appeared in the Erdös Discrepancy Problem solved by Tao, and thus confirming one of my conjectures. A nice connection between these sums with the error term in the classical Dirichlet divisor problem – denoted by Delta - appeared in my previous paper. In this talk I will show how we needed to study correlations between the function Delta(x) and Delta(ux), where u is a fixed real number, to solve our main problem. Surprisingly, this correlation behaves quite differently if u is rational or if it is irrational, and we can deduce even more properties if u has a finite irrationality measure.

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O Teorema Erdös-Ginzburg-Ziv em grupos, anéis e grafos

Lucas Colucci
IME-USP, Brazil

O Teorema de Erdös-Ginzburg-Ziv é um resultado de 1961 que afirma que, dados quaisquer 2n-1 inteiros, existem n dentre eles cuja soma é múltipla de n. Nesta palestra, veremos diversas generalizações desse resultado e problemas relacionados, incluindo versões em grupos abelianos, anéis e grafos.

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Newman's proof of the Prime Number Theorem: a treasure map to a mysterious land

Luan Alberto Ferreira
IFSP, Brazil

Newman's proof of the Prime Number Theorem is a landmark in Number Theory, celebrated both for its ingenuity and its brevity. In this talk, I'll show how this proof can be adapted to study the problem of how many prime numbers there are in small intervals. In particular, this solves (for all sufficiently large numbers) some old conjectures about prime numbers, such as Legendre's conjecture about the existence of primes between consecutive squares, and Sierpi?ski's conjecture about the existence of primes in the entries of certain square matrices.

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Computations of Canonical Liftings of Elliptic Curves

Luís Renato Abib Finotti
The University of Tennessee, USA

Given an ordinary elliptic over a perfect field of positive characteristic, there is a unique elliptic curve over the ring of Witt vectors of that field (which has characteristic 0) for which we can lift the Frobenius. One can find explicit formulas for these lifts, but the computations over Witt vectors are extremely demanding. After a general introduction to the topic, we will discuss theoretical results that lead to considerable improvements to these computations.

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Partitions, two-line matrices and t-squared partitions
Hemar Teixeira Godinho
UnB, Brazil

A natural number m is said to admit a t-squared partition if we can find $c_1, \ldots, c_t \in \mathbb{N}$ such that

$$m = (c_1 + c_2 + \cdots + c_t)^2 \; + \; 2(c_1^2 + c_2^2 + \cdots + c_t^2).$$

In this seminar, we present a complete characterization of integers that admit t-squared partitions, and we will also introduce a correspondence between the number of partitions of n, both with and without constraints, and the number of representations of integers $m \in (1, n^2)$ as t-squared partitions (this presentation is based on articles written in co-authorship with J.P.O. Santos).

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Integral points on elliptic curves

Marc Hindry
Université Paris Cité, France

We will discuss general knowledge on integral and rational points on elliptic curves, as well as some long standing conjectures. We will complement this survey with new results explicitly determining the set of integral points on some families of elliptic curves; the latter part is joint work with Hemar Godinho and Diego Marques (UnB).

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On the Exceptional Set of p-adic Transcendental Analytic Functions

Jean Carlos de Aguiar Lelis
UFPA, Brazil

In this work, we study the exceptional sets S_f of p-adic transcendental analytic functions f with rational and algebraic coefficients. We establish a necessary condition for a subset $S \subseteq \overline{\mathbb{Q}} \cap B(0,\rho)$ to be the exceptional set of a p-adic transcendental analytic function with rational coefficients, demonstrating that, in general, the answer to Mahler's Problem C over $\mathbb{C}_p$ is negative. However, we prove that if S is closed under algebraic conjugation and contains 0, there exist uncountably many transcendental analytic functions $f \in \mathbb{Q}_\rho[[z]]$ such that $S_f = S$. Additionally, we demonstrate that any $S \subseteq \overline{\mathbb{Q}} \cap B(0,\rho)$ containing 0 can be the exceptional set of uncountably many transcendental analytic functions $f \in \overline{\mathbb{Q}}_\rho[[z]]$. Joint work with Bruno De Paula (IFPA).

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Momentos de funções L através de uma fórmula de traços relativa

Ramon Nunes
UFC, Brazil

Nós discutiremos um método para estudar somas de produtos de funções L de Rankin-Selberg adaptando ideias da fórmula de traços relativa de Jacquet em um contexto mais quantitativo. Como aplicação de nossos resultados obtemos uma sequência de representações Π de GL(n) com condutor tendendo para o infinito e tais que $L(1/2, \Pi \times \pi_1)$ e $L(1/2, \Pi \times \pi_2)$ não se anulam, onde π_1 e π_2 são representações fixas de GL(n-1).

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Orthogonal periods of a GL(4) Eisenstein series

Valdir José Pereira Júnior
USP, Brazil

We will show an identity between an orthogonal period of an Eisenstein series on $GL(4)$ induced from characters on the Levi subgroup of type $(2,2)$ and the Whittaker coefficients of an Eisenstein series on the metaplectic double cover of $GL(4)$, thereby providing evidence in favor of a conjecture of Jacquet. The main tool used in the proof is a formula for the number of two-dimensional sublattices of $\mathbb{Z}^4$ with fixed discriminant, which connects this problem with Gauss's three squares theorem and the previous work [1]. This is joint work with Gautam Chinta (see [2]).

References

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Factorizations, elasticities and zero-sum sequences

Sávio Ribas
Universidade Federal de Ouro Preto (UFOP), Brazil

The *Fundamental Theorem of Arithmetic* states that every natural number $n \geq 2$ can be written, except for the order of the factors, in a unique way as a product of primes. In other algebraic structures, the factorization may not exist or may not be unique. For example, for an element a of a monoid H, it is possible that $a = u_1 \dots u_k = v_1 \dots v_m$, where u_i, v_j are distinct irreducibles. The *set of lengths* of $a \in H$, $\mathsf{L}(a) = \{k \in \mathbb{N} \mid \exists\, u_1, \dots, u_k$ irreducible with $a = u_1 \dots u_k\}$, and the *system of sets of lengths*, $\mathcal{L}(H) = \{\mathsf{L}(a) \mid a \in H\}$, are ways of describing the non-uniqueness of factorizations in H. For $k \in \mathbb{N}$, let $\mathcal{U}_k(H) = \{m \in \mathbb{N} \mid \exists u_1, \dots, u_k, v_1, \dots, v_m$ irreducibles with $u_1 \dots u_k = v_1 \dots v_m\}$, $\lambda_k(H) = \min \mathcal{U}_k(H)$ and $\rho_k(H) = \sup \mathcal{U}_k(H)$ (*k-th elasticity*). The sets $\mathcal{L}(H)$ and $\mathcal{U}_k(H)$ are, in general, well structured and, under reasonably weak hypotheses, one has $\mathcal{U}_k(H) = [\lambda_k(H), \rho_k(H)]$. It is known that $\lambda_k(H)$ can be written as a function of $\rho_k(H)$. On the other hand, by a *sequence* over a group we mean a finite sequence of terms of the group whose order is disregarded and repetition is allowed. A sequence S over an abelian group $(G, +, 0)$ is *zero-sum* if the sum of its terms is 0. The *Davenport constant* of a group G, $\mathsf{D}(G)$, denotes the largest possible length among all minimal zero-sum sequences. There is an intrinsic relationship between $\rho_k(H)$ and $\mathsf{D}(G)$, where G is the group of ideal classes of H. This makes $\rho_k(H)$ and $\mathsf{D}(G)$ two of the most important objects for describing non-uniqueness of factorizations in H. In this talk, we will introduce the relationship between factorization theory, focused on non-uniqueness, and zero-sum problems. We will present the main results and conjectures about $\rho_k(H)$.

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Generators and splitting fields of the Shioda's elliptic surfaces $y^2 = x^3 + t^m + 1$

Sajad Salami
UERJ, Brazil

The splitting field of an elliptic surface $\mathcal{E}$ defined over $\mathbb{Q}(t)$ is the smallest subfield $\mathcal{K}$ of $\mathbb{C}$ such that $\mathcal{E}(\mathbb{C}(t)) \cong \mathcal{E}(\mathcal{K}(t))$. In this Talk, we will speak on the splitting field $\mathcal{K}_m$ and a set of linearly independent generators for the Mordell–Weil lattice of the Shioda's elliptic surface with generic fiber given by $\mathcal{E}_m : y^2 = x^3 + t^m + 1$ over $\mathcal{Q}(t)$ for positive integers $1 \leq m \leq 12$.

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S7 – Number Theory

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Uma família de corpos puros binários

Antonio Aparecido de Andrade
UNESP, São José do Rio Preto, Brazil

A Teoria Algébrica dos Números é um ramo da teoria dos números em que o conceito de número é expandido para o de número algébrico, que são raízes de polinômios com coeficientes racionais. Um corpo de números algébricos é uma extensão de corpo finita (e por isso algébrica) dos números racionais. Estes domínios contêm elementos análogos aos inteiros, os chamados inteiros algébricos. Quando trabalhamos com um corpo de números, existem vários elementos que podem ser estudados, e dois deles, fundamentais em várias áreas da álgebra e na aplicação em reticulados, é o trabalho de determinar o anel de inteiros e o discriminante desses corpos de números. Um trabalho de interesse trata-se do artigo "Integral basis and relative monogenity of pure ortic fields", de Hameed e Nakahara, publicado em janeiro de 2015. Também, em abril de 2017, Laszlo Remete publicou o artigo intitulado "Integral basis and monogenity of pure fields", onde define explicitamente as bases integrais e os índices dos corpos de grau 3 a 6 e 8, utilizando o software Magma. Em fevereiro de 2021, Yakkou e Fadil exploraram a monogetividade e não monogetividade de alguns corpos puros cujo grau é uma potência de primo, no trabalho "On monogenity of certain pure number fields definied by $x^{p^r} - m$". Também em 2021, tivemos a contribuição de Linara Facini em sua dissertação de mestrado "Uma introdução aos corpos não abelianos de grau menor ou igual a 6", onde usando o polinômio característico, foi dado o anel de inteiros e o discriminante dos corpos puros de grau 2 a 6. Mais recentemente, em 2023, temos também o trabalho de Fadil e Kchital "On monogenity of certain pure number fields defined by $x^{2^r 7^s} - m$", que com base na teoria de polígonos de Newton, estudam a monogetividade do corpo puro de grau $2^r 7^s$ e m livre de quadrados. Para este trabalho, trabalhamos com corpos de números puros cujo grau é um potência de 2, pois ao analisar o trabalho do Hammeed sobre o grau 8, essa generalização se daria naturalmente, e essa foi a ideia principal na construção do anel de inteiros e discriminante. Deste modo, neste trabalho, exploramos alguns resultados que remetem aos corpos de números do tipo $\mathbb{K} = \mathbb{Q}(\sqrt[2^n]{d})$, com d livre de potência 2^n-ésima. Além disso, consideramos que esses resultados serão de grande utilidade para determinar o anel de inteiros algébricos dos corpos $\mathbb{K} = \mathbb{Q}(\sqrt[n]{d})$, para outros valores de n.

Suportado pela Fapesp, Processo 2022/02303-0.

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The zero-sum problema over $C_n \ltimes_s C_2$

Danilo Avelar
UFF, Brazil

In this poster we will show the results obtained by Avelar, Brochero Martinez and Ribas regarding the zero-sum problem for groups $C_n \ltimes_s C_2$. More precisely, we will show the Gao constante, the η-constante and the Erdös-Ginzburg-Ziv constant for these groups and their respective inverse problems.

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The Dirichlet Theorem

Andrei Doronin
USP, Brazil

The Dirichlet Theorem is a fundamental result in number theory that addresses the distribution of arithmetic progressions in the set of prime numbers. More specifically, it states that, if a and b are coprime integers, then the arithmetic progression $a + nb$, where n is a positive integer, contains infinitely many prime numbers. The Dirichlet Theorem serves as an important result in analytic number theory, facilitating the study of prime numbers and their distribution through techniques such as Dirichlet series and Dirichlet L-functions.

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Fermat's Last Theorem for Regular Primes

Homero Pacheco
ICMC-USP, Brazil

The Fermat Last Theorem is a great example of how an unsolved problem can stimulate the development of an entire research area. Stated by Pierre de Fermat around 1630 in the margin of a copy of Diophantus's Arithmetica, the nowadays theorem assert that the equation

$$x^n + y^n = z^n$$

has no integers solutions with $xyz \neq 0$ for $n > 2$. After 358 years, Fermat's last theorem is proved by Andrew Wiles. More than the proof itself, the development on number theory made to prove Fermat's conjecture is of immeasurable value. While Wiles's proof is awkward for a scientific initiation, we might study some particular cases already knew by Kummer in 1844. Hence, we intend to achieve the proof of Fermat's last theorem for the cases where (i) the integral closure of the integers in an extension of the rationals by a root of unity is factorial and (ii) when this root of unity is a p-root of unity with p a regular prime number.

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SESSION 8

Representation theory

ORGANIZERS

Flavio Coelho (USP)
John William Macquarrie (UFMG)
Viktor Bekkert (UFMG)

S8 - Representations of algebras

Talks index

Stratifying systems via nested family of torsion pairs

Edson Ribeiro Álvares
UFPR, Brazil

Due to the importance of the homological properties of standard modules, K. Erdmann and C. Sáenz introduced the notion of stratifying systems in the category of modules. Subsequently, H. Treffinger and O. Mendoza obtained stratifying systems using tau-tilting theory. They demonstrated that from a tau-rigid module, one can obtain at least one stratifying system, whose size is bounded by the rank of the Grothendieck group. In this presentation, we will show that every stratifying system is induced by a certain family (nested family) of torsion pairs, thus generalizing the work of Mendoza-Treffinger. If time permits, we will also demonstrate that not every stratifying system can be obtained from a tau-rigid module, including stratifying systems of infinite size.

Coauthors: Matheus Vinicius dos Santos (Universidade Federal do Paraná-UFPR-Brazil).

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On piecewise hereditary tree algebras

Viktor Bekkert
UFMG, Brazil

In this talk, I will review some old and recent results about the problem of classification of piecewise hereditary tree algebras and of their hereditary types.

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The composite of irreducible morphisms

Viktor Chust
IME-USP, Brazil

The composite of n irreducible morphisms between indecomposable modules always belongs to the n-th power of the radical of the module category. However, if $n > 1$, there are many examples of non-zero composites belonging to the $n+1$-th power or even higher powers of the radical. The general problem of determining when this happens has been studied in several articles, most of them by C. Chaio, F. U. Coelho, P. Le Meur and S. Trepode. In this talk we expect to share some new developments in this topic, with the comparison between the module category and the related mesh-category through the use of Riedtmann's well-behaved functors. This work is under supervision by Flávio U. Coelho and is supported by FAPESP, grant 2020/13925-6.

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Describing blocks of profinite groups with cyclic defect group and infinite dihedral defect group

Ricardo J. Franquiz
Universidade Federal de Lavras (UFLA), Brazil

The block theory of finite groups studies modules for the group algebra by writing the group algebra as a product of indecomposable algebras, called blocks, and studying the modules one block at a time. To each block we can associate a subgroup of G called its defect group. Understanding the structure of blocks of a finite group with given defect group is one of the central problems of this theory. In some cases, such a description is known. For example, blocks with cyclic defect group have an explicit description as Brauer tree algebras. In other cases, blocks with a dihedral defect group are described (up to Morita equivalence) as finite dimensional path algebras associated with explicit quivers and relations.

Recently, a block theory for profinite groups has been formulated by myself and J. MacQuarrie. In this talk, I will give a brief introduction to the block theory of finite and profinite groups. I will explain how to describe blocks of a profinite group with a cyclic defect group as a Brauer tree algebra, and then I will give a description of the blocks of profinite groups with an infinite dihedral defect group, as the complete path algebra for specific quivers with relations. In both cases, such a description is given in strict analogy with the finite case.

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Relations between the Strong Global Dimension, Complexes of Fixed Size and Derived Categories

Felipe Gallego-Olaya
Universidad de Antioquia, Colombia

Work joint with Hernán Giraldo and Yohny Calderón-Henao.

Let $\mathbb{Z}$ be the integer numbers, $\Bbbk$ an algebraically closed field, Λ a finite dimensional $\Bbbk$-algebra, $\mathrm{mod}\Lambda$ the category of finitely generated right Λ-modules, $\mathrm{proj}\Lambda$ the full subcategory of $\mathrm{mod}\Lambda$ consisting of all projective objects, and $\mathrm{C}_n(\mathrm{proj}\Lambda)$ the bounded complexes of projective Λ-modules of fixed size for an integer $n \geq 2$. We describe an algorithm to calculate the strong global dimension of Λ, when Λ has finite strong global dimension and is derived-discrete, by using the Auslander-Reiten quiver of the category $\mathrm{C}_n(\mathrm{proj}\Lambda)$. Moreover, we also show the relationship between the Auslander-Reiten quiver of the bounded derived category $\mathrm{D}^b(\mathrm{mod}\Lambda)$ and the Auslander-Reiten quiver of $\mathrm{C}_{\eta+1}(\mathrm{proj}\Lambda)$, where η is the strong global dimension of Λ.

For an integer $n \geq 2$, we denote by $\mathrm{C}_n(\mathrm{proj}\Lambda)$ the category of complexes whose terms are in $\mathrm{proj}\Lambda$ of fixed size n (as introduced by R. Bautista et al. in [1]). It follows from the results in [1], that $\mathrm{C}_n(\mathrm{proj}\Lambda)$ has almost split sequences. In [3], C. Chaio et al. proved that the Auslander-Reiten quiver of $\mathrm{C}_n(\mathrm{proj}\Lambda)$ can be constructed by using the well-known knitting algorithm.

Currently there is not a general method to calculate the strong global dimension for an arbitrary Λ. However, in [2], C. Chaio et al. determined the strong global dimension of certain piecewise hereditary finite dimensional algebras by considering their ordinary quivers with relations. We develop an algorithm to calculate the strong global dimension of Λ in the case Λ has finite strong global dimension and is derived-discrete. In order to do this, we use the techniques given in [3] to construct the Auslander-Reiten quiver of $\mathrm{C}_n(\mathrm{proj}\Lambda)$ with $n \geq 2$.

On the other hand, if Λ is piecewise hereditary, we prove that, up to translation, all irreducible morphisms and all almost split sequences in $\mathrm{C}_{\eta+1}(\mathrm{proj}\Lambda)$ are irreducible morphisms and almost split sequences in $\mathrm{C}_{\eta+i}(\mathrm{proj}\Lambda)$ for $i \geq 2$. Moreover, we also prove that, up to translation, a morphism is an irreducible morphism in $\mathrm{D}^b(\Lambda)$ if and only if is an irreducible morphism in $\mathrm{C}_{\eta+1}(\mathrm{proj}\Lambda)$ and given an Auslander-Reiten triangle in $\mathrm{D}^b(\mathrm{mod}\Lambda)$, there exists an almost split sequence $\mathrm{C}_{\eta+1}(\mathrm{proj}\Lambda)$, which induces an Auslander-Reiten triangle isomorphic to the given triangle.

Finally, we obtain the Auslander-Reiten quiver of $\mathrm{D}^b(\mathrm{mod}\Lambda)$ as $\mathbb{Z}$-copies of an special subquiver of the Auslander-Reiten quiver of $\mathrm{C}_{\eta+1}(\mathrm{proj}\Lambda)$.

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Skew Brauer graph algebras

Ana Clara Garsia Elsener
Universidad Nacional de Mar del Plata, Argentina

Brauer graph algebras are defined combinatorially through a graph with some additional data on their vertices, given by a function called multiplicity function and an order of the edges attached to each vertex. They appeared first in representation theory of groups, and were defined by Donovan and M R Freislich to classify indecomposable modules over quasi-Frobenious algebras.

A result by Schroll says that each Brauer graph algebra with multiplicity function identically one is the trivial extension of a gentle algebra. Skew-gentle algebras were defined by Geiss and De la Peña to study a subclass of matrix-problems. These algebras were also studied by V. BekkertMarcos and Merklen They generalize the class of gentle algebras as they are, by definition, skew-group algebras of gentle algebras.

In this project we define skew-Bruauer-graph algebras, a family that generalizes Brauer graph algebras. We prove that each skew-Brauer-graph algebra with multiplicity function identically one is the trivial extension of a skew-gentle algebra. We classify skew-Brauer graph algebras of finite representation type. We identify these skew-Bruauer-graph algebras with unbordered compact Riemann surface dissections, and see skew gentle algebras and their reflections as operations that add or change boundary pieces to the surface.

This was a joint project with Victoria Guazzelli (UNMdP Argentina) and Yadira Valdivieso (U. Puebla Mexico)

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A functorial approach to n-abelian categories

Vitor Emanuel Gulisz
Northeastern University, USA

We discuss how to view the axioms of an n-abelian category through its functor categories. Since these are abelian, this point of view allows the use of classical homological algebra to understand higher homological algebra phenomena. As an application, we present generalizations of the axioms "every monomorphism is a kernel" and "every epimorphism is a cokernel" of an abelian category to n-abelian categories. Moreover, by restricting our results to rings, we are able to describe when the category of finitely generated projective modules over a ring is n-abelian. This description leads to a correspondence for n-abelian categories with additive generators, which extends the Higher Auslander Correspondence.

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Dell

Marcelo Lanzilotta
Universidad de la República, Uruguay

Joint work with Marcos Barrios and Gustavo Mata, UdelaR, Uruguay, (work in progress).

Context: Artin algebras.

We start introducing the concept of Delooping level, defined by V. Gelinas in: The depth, the delooping level and the finitistic dimension; Adv. Math.394 (2022).
I will show the relation of this concept to the Findim (finitistic dimension). Examples will be given, and explicit calculations of this new homological tool. I will explicitly calculate delooping level for truncated algebras and give examples in monomial algebras. I will also see the interaction of this new homological tool with older homological tools associated with the finitistic dimension conjecture, such as Igusa Todorov functions.

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Strongly stratifying ideals, Morita contexts and Hochschild homology

Eduardo Marcos
IME-USP, Brazil

This talk is based on a joint work with Claude Cibils, Marcelo Lanzilotta and Andrea Solotar.

We consider stratifying ideals of finite dimensional algebras in relation with Morita contexts. A Morita context is an algebra built on a data consisting of two algebras, two bimodules and two morphisms. For a strongly stratifying Morita context - or equivalently for a strongly stratifying ideal - we show that Han's conjecture holds if and only if it holds for the diagonal subalgebra. The main tool is the Jacobi-Zariski long exact sequence. One of the main consequences is that Han's conjecture holds for an algebra admitting a strongly (co-)stratifying chain whose steps verify Han's conjecture. If Han's conjecture is true for local algebras and an algebra Λ admits a primitive strongly (co-)stratifying chain, then Han's conjecture holds for Λ.

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Modular Isomorphism Problem - progress, solution and open challenges

Leo Margolis
Universidad Autónoma de Madrid, Spain

Say we are given only the R-algebra structure of a group ring RG of a finite group G over a commutative ring R. Can we then find the isomorphism type of G as a group? This so-called Isomorphism Problem has obvious negative answers, considering e.g. abelian groups over the complex numbers, but more specific formulations have led to many deep results and beautiful mathematics. The last classical open formulation was the so-called Modular Isomorphism Problem: Does the isomorphism type of kG as a ring determine the isomorphism type of G as a group, if G is a p-group and k a field of characteristic p?

Starting with an overview on the state of knowledge on general Isomorphism Problems and the modular one in particular, I will present a negative solution found in 2021 with D. García-Lucas and Á. del Río as well as a generalization obtained recently with T. Sakurai, but also positive structural results and several problems remaining open.

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Cohomological properties of incidence algebras of posets.

Júlio Marques
UFMG, Brazil

The present study introduces an algorithm designed to compute the Hochschild cohomology groups of incidence algebras. As a corollary of this algorithmic framework, we derive an elimination criterion for specific points within the poset, preserving their cohomology groups.

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Quotient bifinite extension and the finitistic dimension conjecture

Fernando dos Reis Naves
Brazil

Let A be a finite dimensional associative algebra over a field. The (small) finitistic dimension fin.dim(A) of is defined to be the supremum of the projective dimensions of the finitely generated left A-modules having finite projective dimension. The famous finitistic dimension conjecture (for finite dimensional algebras over a field) asserts that the finitistic dimension of an arbitrary finite dimensional algebra is finite. The conjecture was state approximately in 1960 and still open until today, being proved only for special classes of algebra.

An extension of finite dimensional algebras is simply a finite dimensional algebra A with unital subalgebra B. A fruitful approach to the finitistic dimension conjecture is to compare the finitude of the finitistic dimensions of A and B when the extension is assumed to have certain properties.

Recentyly, following this line of thought, J. MacQuarrie and F. Naves define that an extension of B in A is quotient bifinite if A/B has finite projective dimension as a B-bimodule and proved that if an extension of B in A is quotient bifinite, then the finitistic dimension of B is finite if the finitistic dimension of A is finite.

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Homotopy category of R-module valued additive functors

Sinem Odabaşı
Universidad de Murcia, Spain

The homotopy and derived category of a ring are the main subjects of study in (Categorical) Homological Algebra. Both are obtained from the category of chain complexes of a ring, which is a particular case of functor categories. In [1], the authors show that under certain conditions on a small k-linear category Q, there exists a 'Q-shaped derived category' of a ring R, which is obtained by the projective/injective model structure on the functor category k-Lin$(Q, R$-Mod$)$. In this talk, we discuss if k-Lin$(Q, R$-Mod$)$ equipped with the object-wise trivial exact structure is a Frobenius category, which yields a kind of 'Q-shaped homotopy category of R.' The conditions imposed on Q would be subtly relaxed compared to those given in [1], and therefore, we could apply it to different kinds of categories. The talk contains certain results from a joint work with Sergio Estrada and Manuel Cortes Izurdiaga.

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Finiteness conditions of rings and ideals, and generalized weak coherency of rings

Marco A. Pérez
Universidad de la República, Uruguay

Let R be a ring (associative with identity). A (left) R-module F is called finitely n-presented (with n a nonnegative integer) if there exists an exact sequence

$$P_n \to P_{n-1} \to \cdots \to P_1 \to P_0 \to F \to 0$$

where each P_k is a finitely generated projective R-module. We shall say that a ring R is (left) (weakly) n-coherent if every finitely n-presented R-module is finitely $(n+1)$-presented (resp., if every finitely $(n-1)$-presented ideal of R is finitely n-presented). Every n-coherent ring is weakly n-coherent, and for the case $n = 1$ these two notions of coherency are equivalent. However, for the case $n \geq 2$, the question that if every weakly n-coherent ring is n-coherent is still an open problem, known as Costa's conjecture.

In this talk, we shall consider the Ext and Tor orthogonal complements of the set of quotients R/I, with I running over the set of finitely n-presented ideals of R. Specifically, we say that an R-module M is Baer FP_n-injective if $\mathrm{Ext}^1_R(R/I, M) = 0$ for every finitely n-presented ideal I of R. Dually, a (right) R-module N is Baer FP_n-flat if $\mathrm{Tor}^1_R(N, R/I) = 0$ for every finitely n-presented ideal I of R. We show several homological properties of these classes of modules, denoted by $\mathcal{BI}_n(R)$ and $\mathcal{BF}_n(R^{\mathrm{op}})$. Some of these properties are consequences of the fact that $(\mathcal{BF}_n(R^{\mathrm{op}}), \mathcal{BI}_n(R))$ is a duality pair under the functor $\mathrm{Hom}_{\mathbb{Z}}(-, \mathbb{Q}/\mathbb{Z})$. We also provide a characterization of weakly left n-coherent rings in terms of the equality between the classes $\mathcal{BI}_n(R)$ and $\mathcal{BI}_{n-1}(R)$ (resp., between $\mathcal{BF}_n(R^{\mathrm{op}})$ and $\mathcal{BF}_{n-1}(R^{\mathrm{op}})$).

This is a joint work with Rafael Parra (Universidad de la República).

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Piecewise hereditary Nakayama algebras

Tobias Fernando Pinto
Brazil

In this presentation we will introduce some tilting complex for acyclic Nakayama algebras and we will describe their endomorphism algebras. We will use such complexes to show that any acyclic Nakayama algebra is derived equivalent to an incidence algebra of poset. Furthermore, we will show a generalization of Happel and Seidel's result on the classification of piecewise hereditary truncated Nakayama algebras for two classes of Nakayama algebras: simple pullback and simple pushout of truncated Nakayama algebras.

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Controllable Extensions of Algebras

Roger Ramirez Primolan
IME-USP, Brazil

Recent results related the Finitistic Dimension Conjecture (FDC), a central problem for finite dimensional algebras, with the homological study of extensions of algebras $B \subseteq A$. For instance, in [1], Xi and Xu showed that, for finite dimensional algebras, the FDC is equivalent to a statement regarding extensions of algebras. In [2], Iusenko and MacQuarrie were able to show that, provided that some properties where satisfied, $\operatorname{findim}(B) < \infty$ if and only if $\operatorname{findim}(A) < \infty$, where findim is the finitistic dimension of an algebra.

Both results uses Hochschild' Relative Homological Theory for extensions of algebras, published in [3]. This theory is quite general, but such wide reach comes with a cost: it is difficult to compute homological objects for extensions of algebras.

In this talk, we will give a panoramic view of the results regarding the FDC and discuss the limitations of Hochschild's Theory. Then we introduce a new paradigm that aims to shift classical homological theory of algebras to the relative realm, i.e, the homological study of extensions of algebras. This new point of view is obtained by what we called Controllable Extensions and we use it to compute relative homological objects using homological techniques for finite dimensional algebras. We than give examples of controllable extensions showing several relative homological behaviours.

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A finite dimensional algebra with infinite delooping level

Jeremy Rickard
University of Bristol, UK

This is joint work with Luke Kershaw.

The finitistic dimension conjecture, over 60 years old, is one of the most celebrated open problems about finite dimensional algebras. Vincent Gélinas recently introduced a new invariant of finite dimensional algebras, the “delooping level”, and proved that the delooping level of an algebra is an upper bound for the finitistic dimension of the opposite algebra. This would mean that the finitistic dimension conjecture would follow if one could prove that the delooping level is always finite. Gélinas never conjectured that this was the case, although the term “delooping level conjectur” has subsequently appeared in the literature. After giving some background, I will describe what I believe to be the first known example of a finite dimensional algebra with infinite delooping level, based on an example of Ringel and Zhang of a “semi-Gorenstein-projective” module. But don’t get too excited: the opposite algebra is NOT a counterexample to the finitistic dimension conjecture.

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On skew gentle algebras

Sonia Trepode
Universidad Nacional de Mar del Plata, Argentina

This is a joint work with Yadira Valdivieso. Gentle Algebras play an important role in representation theory of finite dimensional k-algebras. Recently the skew gentle algebras have caught the attention of several researchers. In this talk we will discuss some properties and applications of skew gentle algebras. We study split extensions of skew gentle algebras, some examples are trivial extensions algebras, relation extensions algebras and partial relations extensions algebras. In order of study skew algebras of partial relation algebras we focus in admissible cuts of relation extensions algebras. We obtain a characterization, in terms of admissible cuts, of which algebras produce the same relation extension algebra. On the other hand, we obtain invariants as Hochschild cohomology of skew gentle algebras and representation dimension of skew gentle algebras.

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S8 – Representations of algebras

Posters index

Cofiniteness conditions on modules and rings

Johan Sebastian Cortes-Villamizar
UDELAR, Uruguay

Motivated by closure properties on short exact sequences satisfied finitely n-presented modules, and their relation with $n-$coherent rings, we propose the dual concepts of finitely $n-$copresented modules (as generalizations of finitely cogenerated modules) and $n-$cocoherent rings. We explore the homological properties of this class of modules and try to use them in order to find characterizations of these rings.

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Covering theory and string algebras

Daniel Lobo
IME-USP, Brazil

String algebras, originally defined in [1], form an important class of special biserial algeabras, whose representation theory is well understood. The indecomposable modules of such an algebra fall into two categories, the so called *string* and *band* modules. In this poster, I plan to introduce the necessary covering theory of locally bounded categories developed by Bongartz and Gabriel [4,5] to motivate these classes of indecomposable modules. This framework for working with monomial algebras has proved fruitful, for example, in the work of Crawley-Boevey [2] to classify morphisms between string modules, expanded later to band modules by Henning Krause [3].

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Bimódulos da álgebra de Jordan de matrizes simétricas de ordem 2 na classe das álgebras comutativas de potências associativas

Pablo Salermo Monteiro do Nascimento
UNIFESSPA, Brazil

A classificação dos bimódulos comutativos de potências associativas irredutíveis para as álgebras de Jordan de matrizes simétricas de ordem maior que 2 é conhecida [1]. Os módulos irredutíveis são suficientes para caracterizar a estrutura de módulos em geral para estas álgebras. Para a álgebra de Jordan de Matrizes simétricas de ordem 2 é possível descrever os módulos irredutíveis mas também verifica-se a existência de módulos de dimensão 3 que não são completamente redutíveis. A estrutura geral dos módulos pode ser completamente descrita como soma de módulos irredutíveis e os módulos que não completamente redutíveis encontrados.

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Teorema de representabilidade para álgebras G-graduadas

Pedro Quintino
UFMG, Brazil

Em 1988 [2] Kemer demonstrou o seu famoso teorema de representabilidade de PI-álgebras finitamente geradas sobre um corpo de característica zero. Estendendo o resultado original de Kemer, Aljadeff e Kanel-Belov demonstraram em 2010 [1] um resultado análogo para PI-álgebras finitamente geradas sobre um corpo de caracteristica zero, graduadas por um grupo finito G. Precisamente, os autores demonstraram que se A é uma PI-álgebra finitamente gerada sobre um corpo F de característica zero graduada por um grupo finito G, então existe uma álgebra G-graduada B de dimensão finita sobre uma extensão K de F que é equivalente a A. Nessa apresentação discutimos o resultado, a abordagem e as técnicas utilizadas por Aljadeff e Kanel-Belov em seu trabalho.

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n-cluster tilting subcategories in derived category

Gustavo Freire Schafhauser
UFPR, Brazil

In this work, we present an example of a module category that admits two n-cluster tilting subcategories (with different values of n), but only one is inherited by the derived category. In [1], Osamu Iyama introduced the concept of n-cluster tilting subcategories, initiating the Higher-dimensional Auslander-Reiten theory and the study of n-almost split sequences. Subsequently, in [2], he showed when a n-cluster tilting subcategory of a module category is inherited by the derived category. In [3], Christof Geiss, Bernhard Keller and Steffen Oppermann defined the $(n+2)$-angulated categories, generalizing triangulated categories, and showed that a n-cluster tilting subcategories of triangulated categories which are stable under the n-nd power of the suspension functor are $(n+2)$-angulated.

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SESSION 9

Rings

ORGANIZERS

Maria Eugenia Martin (UFPR)
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S9 - Rings

Talks index

Automorphisms of the category of free non-associative algebras with unit

Elena Aladova
IME-USP, Brazil

Let Θ be an arbitrary variety of algebras and Θ^0 the category of all free finitely generated algebras in Θ. The group $Aut(\Theta^0)$ of automorphisms of the category Θ^0 plays an important role in universal algebraic geometry (see [2,3]). It turns out that for a wide class of varieties, the group $Aut(\Theta^0)$ can be decomposed into a product of the normal subgroup $Inn(\Theta^0)$ of inner automorphisms and the subgroup $St(\Theta^0)$ of strongly stable automorphisms . The method of verbal operations provides a machinery to calculate the group $St(\Theta^0)$ of strongly stable automorphism (see [4-6]).

In this talk we give some clarifying remarks describing the place of Θ^0 and $Aut(\Theta^0)$ in the general set up of the universal algebraic geometry and discuss some new results concerning the group of strongly stable automorphisms for the variety of non-associative algebras with unit (see [1]).

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Trace identities for Special Jordan Algebras

Claudemir Fideles Bezerra Jr
UNICAMP, Brazil

It is natural to study polynomial identities and the Specht property in algebras of richer signature. For example, the coefficients of the characteristic polynomial of a matrix can be expressed in terms of traces of the powers of the matrix. Therefore the characteristic polynomial and its linearisations are trace polynomials, i.e., a polynomial in which we allow the coefficients to be polynomials in traces. As we know from Elementary Linear Algebra they are also trace identities for $M_n(K)$. One of the most general and influential results in PI theory was obtained independently by Razmyslov and by Procesi. They proved that in characteristic 0 all trace identities for $M_n(K)$ are consequences of the Cayley–Hamilton polynomial. Already, the problem of describing the trace identities in central simple Jordan algebras of degree > 2 was proposed by Shestakov in [1, Problem 2.127]. This issue has been open for more than 40 years. In 1992, motivated by this problem, Vasilovskii exhibited a finite basis for the trace identities for B_n for $n \geq 2$ over an infinite field of characteristic $\neq 2$. In additional, in [2] was proved that the variety of the Jordan algebras with trace generated by B_n has the Specht property. We mention that the problem proposed by Shestakov takes into account the Specht problem for such Jordan algebras, in particular. The main goal of this talk will communicate to the mathematical community that, over a field of characteristic zero, the problem of description of a basis for the ideal of the trace identities of central simple Special Jordan algebras was obtained. Furthermore we establish the Specht property of the ideal of all trace identities for these Jordan algebras as well. Our results are new, and this is a joint work with Koshulkov (IMECC-UNICAMP) and Shetakov (IME-USP).

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Derivations of evolution algebras

Paula Cadavid
UFRPE, Brazil

We study the space of derivations for non-degenerate finite-dimensional evolution algebras over a field of characteristic zero, depending on the twin partition of the associated directed graph. For evolution algebras with a twin-free associated graph we prove that the space of derivations is zero. For the remaining families of algebras we obtain sufficient conditions under which the space of derivations can be described. Our results are contained in [1,2].

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On differential identities of the Grassmann algebra

Onofrio M. Di Vincenzo
Università degli Studi della Basilicata, Italy

Differential polynomial identities constitute a natural and direct generalization of the notion of polynomial identities of an algebra. They take into account the identical relations holding for an algebra whose structure is enriched by the action of a Lie algebra of derivations. In recent years the study of differential identities on associative algebras received new impetus by using (see [1]) the combinatorial approach introduced by Regev in the ordinary case [2] and developed in all past decades in several settings [3].

In this talk, first we survey some recent results concerning the generators and the structure of the multilinear space of differential identities of finite dimensional algebras of some interest on PI-theory. Next we will look at the nature of any arbitrary derivation defined on the Grassmann algebra E . We will show some interesting examples and finally we will study the ideal of the differential identities of E under the action of a particular finite dimensional Lie algebra, solvable of lenght 3. The last result is a joint work with V. Nardozza.

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Identities and isomorphisms of finite graded matrix algebras

Diogo Diniz
Universidade Federal de Campina Grande (UFCG), Brazil

Let $\mathbb{F}$ be a finite field and let G be a group such that every finite subgroup of G is cyclic. In this talk we present a classification of the division gradings by cyclic groups on matrix algebras over $\mathbb{F}$. This yields the classification of the G-gradings on these algebras. Moreover, if G is abelian we prove that two matrix algebras over $\mathbb{F}$ with G-gradings satisfy the same graded identities if and only if they are isomorphic as graded algebras. This is joint work with Daniela Correa, Dimas Gonçalves and Plamen Koshlukov.

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Partial skew group rings and strong equivalence of group graded algebras

Mikhailo Dokuchaev
IME-USP, Brazil

We introduce the notion of a strong equivalence between group graded algebras and prove that any partially-strongly-graded algebra by a group G is strongly-graded-equivalent to the skew group algebra by a product partial action of G. We show that strongly-graded-equivalence preserves strong gradings and is nicely related to Morita equivalence of product partial actions of groups. Furthermore, we prove that strongly-graded-equivalent partially-strongly-graded algebras with orthogonal local units are stably isomorphic as graded algebras. This is a part of a joint work with Fernando Abadie and Ruy Exel.

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Graded algebras which are sums of homogeneous subalgebras

Pedro Fagundes
Brazil

In this talk we will discuss when a graded algebra which is a sum of two gr-PI homogeneous subalgebras is again gr-PI. In general such a sum is not always gr-PI, and we will show that an example can be found in case we have a $\mathbb{Z}_2$-grading. We will also present sufficient conditions on the subalgebras and on the identities satisfied by them in order to obtain the sum as a gr-PI algebra. This is a joint work with Plamen Koshlukov.

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On the algebraic classification of nilpotent algebras

Renato Fehlberg Júnior
Universidade Federal do Espírito Santo (UFES), Brazil

In this talk we will present a method for the algebraic classification of nilpotent algebras. This method, successfully applied in several cases, is based on the calculation of central extensions of nilpotent algebras of smaller dimensions from the same variety. In particular, we will discuss about the case of nilpotent Zinbiel algebras.

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Skew derivations of incidence algebras

Érica Zancanella Fornaroli
UEM, Brazil

Let X be a locally finite partially ordered set and let K be a field. The *incidence algebra* $I(X, K)$ of X over K is the K-space of functions $f : X \times X \to K$ such that $f(x, y) = 0$ if $x \nleq y$ with the convolution product

$$(fg)(x, y) = \sum_{x \le z \le y} f(x, z)g(z, y),$$

for any $f, g \in I(X, K)$ [2]. When X is a chain of cardinality n, then $I(X, K) \cong UT_n(K)$, the algebra of $n \times n$ upper triangular matrices over K.

In this talk we will describe φ-derivations of the incidence algebra $I(X, K)$ of a locally finite poset X over a field K, where φ is an arbitrary automorphism of $I(X, K)$. We show that they admit decompositions similar to that of usual derivations of $I(X, K)$ [1]. In particular, the quotient of the space of φ-derivations of $I(X, K)$ by the subspace of inner φ-derivations of $I(X, K)$ is isomorphic to the first group of certain cohomology of X.

This is a joint work with Mykola Khrypchenko.

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Modules for 2 x 2 Matrices over Commutative Power-Associative Algebra

Ma Isabel Hernández
CONAHCYT-CIMAT Mérida, Mexico

The aim of this paper is to describe the irreducible modules for the Jordan algebra of 2×2 matrices over an algebraically closed field of characteristic different from 2, 3 and 5 in the class of the commutative power-associative algebras. All irreducible non-unital modules, and irreducible unital modules up to dimension three are classified, namely we find seven non-parametrized and five families of parametrized modules of dimension three. For every $k \geq 2$, an irreducible module of dimension $3k$ is also constructed.

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Some ring-theoretic properties and its relations in group rings

Alexander Holguín Villa
Universidad Industrial de Santander, UIS, Colombia

Let RG denote the group ring of the torsion group G over a commutative ring R with identity. In this talk we establish some valid implications between the ring-theoretic conditions duo, reversible, SI property and symmetric in the setting of group rings. We further show that if the group ring RG possesses any of these properties, then G is a Hamiltonian group and the characteristic of R is either 0 or 2. Moreover, we characterize the same properties in group rings RG in the following cases: (1) RG is a semi-simple group ring and (2) R is a semi-simple ring and G any group. We prove new results, but also review previous ones.

This is a joint work with B.S. FLÓREZ BURBANO and J.H. CASTILLO.

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Free algebras in the Tits-Kantor-Koecher category

Iryna Kashuba
SUSTech, China

We study free algebras in the category of sl(2)-modules that are sums of copies of trivial and adjoint representations. This category is a home for Lie algebras which appear applying the celebrated Tits-Kantor-Koecher construction to Jordan algebras and therefore we call it the Tits-Kantor-Koecher category. The study of homological properties of free algebras (free associative, free commutative associative and free Lie algebra) is motivated by the conjecture of I.Kashuba and O.Mathieu that certain homologies of the free Lie algebra in TKK category vanish, which, if true, gives formulas for dimensions of homogeneous components of the free Jordan algebra. This is joint work with Vladimir Dotsenko.

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Gradings on block-triangular matrix algebras

Plamen Emilov Kochloukov
UNICAMP, Brazil

Upper triangular, and more generally, block-triangular matrices, are rather important in Linear Algebra, and also in Ring theory, namely in the theory of PI algebras. The group gradings on such algebras have been extensively studied during the last decades. In this paper we prove that for any group grading on a block-triangular matrix algebra, over an arbitrary field, the Jacobson radical is a graded (homogeneous) ideal. As noted by F. Yukihide this yields the classification of the group gradings on these algebras and confirms a conjecture made by A. Valenti and M. Zaicev in 2007.
This work was supported by FAPESP, Proc. 2018/23690-6.

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On Fundamental algebras with involution

Daniela La Mattina
University of Palermo, Italy

Fundamental algebras were essentially introduced by Kemer in his proof of the Specht conjecture in characteristic zero. They are finite dimensional algebras generalizing the notion of simple algebra or upper block triangular matrix algebra.

In the framework of the theory of polynomial identities, these algebras are the building blocks of a finite dimensional algebra: any finite dimensional algebra satisfies the same polynomial identities as a finite direct sum of fundamental algebras.

In this talk I will extend this notion to algebras with an involution $*$ and, starting from $*$-simple algebras I will show a whole class of examples of $*$-fundamental algebras that are not fundamental.

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Pairs of matrices with simple spectrum

Artem Lopatin
IMECC-UNICAMP, Brazil

We established two-sided Curto–Herrero conjecture for pairs of matrices, where the first matrix has a simple spectrum. Namely, it is shown that these pairs are separated by ranks of non-commutative polynomials in matrices. Moreover, we provided some upper bound on degrees of non-commutative polynomials which should be considered. This is a joint work with Jennyfer Juliana Calderón Moreno. arXiv: https://arxiv.org/abs/2310.00476

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On a problem by Nathan Jacobson for Malcev algebras
Victor Hugo López Solís
Universidad de Barranca, Peru

In this talk we describe a problem for a certain class of Malcev algebras, which is an analogous of an old problem posed by Nathan Jacobson for alternative algebras. Specifically we prove a coordinatization theorem for a class of Malcev algebras $\mathcal{M}$ containing the 3-dimensional simple Lie algebra $\mathfrak{sl}_2(\mathbb{F})$ such that $m\,\mathfrak{sl}_2(\mathbb{F}) \neq 0$ for any $0 \neq m \in \mathcal{M}$. We drop the last condition and we describe the structure of the same class of Malcev algebras $\mathcal{M}$ that contains $\mathfrak{sl}_2(\mathbb{F})$.

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A Jacobian mate defines the Jacobian pair

Leonid Makar-Limanov
Wayne State University, USA

A polynomial $f \in \mathbb{C}[x, y]$ is a Jacobian mate if the Jacobian $J(f, g) = 1$ for some $g \in \mathbb{C}[x, y]$. It is not known that then $\mathbb{C}[f, g] = \mathbb{C}[x, y]$ and a conjecture that this is the case is the Jacobian conjecture. In this note we will check that if f is given then the subalgebra $\mathbb{C}[f, g]$ is known and that g can be recovered up to a summand which is a polynomial in f.

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Some properties of partial skew groupoid rings

Víctor Marín
University of Tolima, Colombia

Let $\alpha = (A_g, \alpha_g)_{g\in G}$ be a group-type partial action of a connected groupoid G on a ring $A = \bigoplus_{z\in G_0} A_z$ and $B := A \star_\alpha G$ be the corresponding partial skew groupoid ring. We investigate the relation of several ring theoretic properties between A and B.

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Images of graded polynomials on full matrix algebras

Thiago Castilho de Mello
UNIFESP, Brazil

The well-known L'vov-Kaplansky conjecture asserts that the image of a multilinear polynomial evaluated on the full matrix algebra is a vector space. A solution for such conjecjture is known only for 2x2 matrices.

Recently, many variations of this problem have been considered. For instance, images of polynomials over the quaternion and octonion algebras, and over the algebra of upper triangular matrices. In these cases, with a positive solution.

In this talk we consider the problem of describing the image of a *graded polynomial* evaluated on the full matrix algebra (with a specific grading). We present a conjecture similar to that of L'vov-Kaplansky and we show such conjecture is true for polynomials of degree 2 over matrices of prime order, and for polynomials of arbitrary degree over matrices of order two.

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Finite presentation of Lie superalgebras

Victor Petrogradsky
UnB, Brazil

We prove that the Fibonacci Lie algebra is not finitely presented. We specify metabelian Lie superalgebras that are finitely presented. (Joint work with D.H. Kochloukova).

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Commutative power-associative representations of symmetric matrices

Juaci Picanço
UFPA, Brazil

The classification of irreducible unital commutative power-associative modules for $H_n(F)$, the algebra of symmetric matrices with the Jordan product, over a field F of characteristic not 2, 3 and 5 are given, for $n \geqslant 3$. It is proved that there exists, up to isomorphisms, only one irreducible module which is not Jordan. It is also shown that every finite dimensional unital commutative power associative module for this algebra is completely reducible.

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Lengths of non-associative algebras

Rodrigo Lucas Rodrigues
Universidade Federal do Ceará (UFC), Brazil

Let A be a unital (with identity element 1_A) finite dimensional not necessarily associative algebra over a field F. Any product of a finite number of elements of a finite subset $S \subset A$ is a word in the letters from S. The length of a word is equal to the number of letters different of 1_A in the corresponding product. By convention, 1_A is a word in any subset S of length 0.

If S is a generating system of the algebra A, that is, A is the smallest subalgebra of A containing S, then any element of A can be expressed as a linear combination of words in elements of S. If we can express all elements of A using words of length at most k, but we can not use only words of length at most $k-1$, we say that the length of the generating system is k. The length of a finitely generated algebra A, $l(A)$, is the maximal length of its finite generating systems.

Guterman and Kudryavtsev [1] started the study of length of non-associative algebras. In particular, they showed that any finite-dimensional non-associative algebra A has finite length, and if $\dim A = n > 2$, then the length is bounded by $l(A) \leq 2^{\dim A - 2}$.

The length of an algebra is an important invariant for the study of finite-dimensional algebras. In some sense it measures the multiplicative complexity of the algebra.

In this talk, we investigate realizable values for the length on non-associative algebras [2,3]. In particular, we give a complete description of algebras of length 1 over an arbitrary field F [4]. This is a joint work with O. V. Markova (Lomonosov Moscow State University, Russia), C. Martínez (University of Oviedo, Spain) and Carlos Silva (University of Sao Paulo, Brazil).

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Subvarieties of the variety of nilpotent loops of class two and of exponent two

Liudmila Sabinina
Universidad Autonoma del Estado de Morelos, Mexico

We prove that there are exactly 10 subvarieties of the variety of nilpotent loops of class two and of exponent two defined by identities with two variables.

This is a joint work with Alexander Grishkov and Marina Rasskazova.

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Invariants of free algebras

Ivan Shestakov
IME-USP, Brazil

Let V be a vector space of dimension d and let FV be a free algebra over V of some variety of algebras (associate, alternative, Lie, Jordan, etc). Let G be a subgroup of the group $GL(V)$, then one can extend the action of G over the algebra FV and consider the algebra of invariants FV^G. We will discuss the two problems:
- When the algebra FV^G is finitely generated?
- When the algebra FV^G is free?

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On minimal superalgebras and minimal varieties

Viviane Ribeiro Tomaz da Silva
Campus Alto Paraopeba - UFSJ, Brazil

Let F be an algebraically closed field of characteristic zero and let A be a minimal superalgebra with semisimple part $A_{ss} = A_1 \oplus \cdots \oplus A_n$, where each A_i is a simple superalgebra. We say that A is r-special if $n \geq 3$ and there exists $1 < r < n$ such that $A_r = M_{k_r}(F \oplus cF)$, with $c^2 = 1$, whereas, for the remaining indices s, $A_s = M_{k_s,l_s}(F)$. We classify the r-special minimal F-superalgebras and describe some necessary and sufficient conditions for the varieties generated by such superalgebras to be minimal of $\mathbb{Z}_2$-exponent $\dim_F(A_1 \oplus \cdots \oplus A_n)$. Moreover, we made explicit that the $\mathbb{Z}_2$-gradings play an important role in the minimality of some varieties.

Partially supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) - grant APQ-01149-18.

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PI-theory for low dimensional Jordan and Leibniz algebras

Manuela da Silva Souza
UFBA, Brazil

Leibniz and Jordan algebras are classes of non-associative algebras that are very important, especially for their applications. Let F be a field. An algebra J over F is a Jordan algebra if

$$ab = ba \text{ and } ((aa)b)a = (aa)(ba)$$

for all $a, b \in J$. They were first introduced by Pascual Jordan (1933) to formalize the notion of an algebra of observables in quantum mechanics. A Leibniz algebra L over F is an algebra equipped with a product that satisfies

$$x(yz) = (xy)z - (xz)y,$$

for all $x, y, z \in L$. Leibniz algebras are a "non-commutative" analogue of Lie algebras. Such algebras have undergone intensive study in the last three decades. Mainly, researchers have focused on extending results from Lie algebras to Leibniz algebras.

In this presentation, within the context of Polynomial Identities Theory (PI-theory), I aim to talk about my recent collaborations with Diogo Diniz (UFCG), Dimas Gonçalves (UFSCar), and Viviane Silva (UFMG) about two-dimensional Jordan algebras and the isomorphism problem. Additionally, I will discuss my work with my PhD student Janara Ramos (UFBA) about low-dimensional Leibniz algebras.

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Jordan-metabelianity in group rings

Paula M. Veloso
UFF, Brazil

Joint work with Osnel Broche Cristo (UFLA) and Rodrigo Lucas Rodrigues (UFC).

Let R be a commutative ring with 1 and G be a group. We denote by RG the group ring of G over R. Consider $*\colon G \to G$ to be a group involution in G (for instance, $*: g \mapsto g^{-1}$ for each $g \in G$). We denote by $\star$ the R-linear extension of $*$ to RG:

$$\left(\sum_{g\in G} a_g g\right)^{\star} = \sum_{g\in G} a_g g^*$$

(which is a ring involution). Given any subset S of RG, we denote by S^+ the set of *symmetric elements* of S under the involution $\star$:

$$S^+ = \{\alpha \in S : \alpha^* = \alpha\}.$$

Denoting by $\circ$ the Jordan product ($x \circ y = xy + yx$), we say that a subset X of a ring A is *Jordan metabelian* if $(a \circ b) \circ (c \circ d) = 0$, for all $a, b, c, d \in X$.

In this talk, we investigate conditions on a ring R, a group G and an ivolution $\star$ for the set $(RG)^+$ and the group ring RG itself to be Jordan metabelian.

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Posters index

Polynomial growth of PI algebras with an Hopf action

Sebastiano Argenti
Università della Basilicata, Italy

In PI theory it is interesting to study algebras with some additional structure. In this talk we will present some results on the growth of the polynomial identities of finite dimensional associative algebras. In particular, we are interested in characterizing varieties of almost polynomial growth.

This problem was solved for associative algebras [1], graded algebras [2], algebras with involution [3], trace algebras [4], algebras with derivations [5], etc... A common flavor of these results is the existence of a concrete list of algebras generating varieties of almost polynomial growth.

Many of the aforementioned structures can be viewed in the context of Hopf algebra actions. Using this approach, we show some general constructions and results.

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Classification of the Lie, Leibniz, and Jordan algebras with dimensions not greater than 2

Juliana Medeiros Barbosa
UFBA, Brazil

Lie algebras are crucial in different fields of mathematics and physics, leading to numerous generalizations over the years. For instance, Leibniz algebras can be viewed as a non-commutative generalization of Lie algebras. Jordan algebras, developed by Pascual Jordan to aid in the study of quantum mechanics, are closely associated with the class of non-associative algebras. In this theory, it is essential to focus on classifying these algebras up to isomorphisms to gain a deeper understanding of them. However, as the dimension of the algebra increases, the problem becomes more challenging. In this presentation will be classified, up to isomorphisms, Lie, Leibniz, and Jordan algebras of dimension one and two on an arbitrary field. In particular, in Jordan algebras, we consider the characteristic of the field different from 2. This work was conducted as part of an undergraduate research project under the supervision of Professor Manuela da Silva Souza.

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Isomorphism between two elementary gradings on UT$_n$

Rosiele Barbosa
IME-USP, Brazil

In this presentation, we will give a brief introduction to graded algebras, focusing on the group gradings of upper triangular matrices. We shall introduce the notion of graded polynomial identities. Our main objective is to show that two elementary gradings on UT_n are isomorphic if, and only if, they satisfy the same set of graded polynomial identities. Thus, in the context of upper triangular matrices, their graded polynomial identities suffice to completely determine the grading. The presentation is based on the article [1] by O. Di Vincenzo, P. Koshlukov and A. Valenti.

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Um estudo sobre semigrupos numéricos com dimensão de mergulho igual a três

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Um *semigrupo numérico* é um subconjunto S de $\mathbb{N}$ que é fechado sob a adição, $0 \in S$ e $\mathbb{N} \setminus S$ tem um número finito de elementos. O *gênero* $\mathsf{g}(S)$ e o *número de Frobenius* $\mathsf{F}(S)$ de um semigrupo numérico S são respectivamente a cardinalidade do conjunto $\mathbb{N} \setminus S$ e o maior inteiro que não pertence a S. É imediato que $\mathsf{F}(S)$ é o maior elemento do conjunto

$$\mathsf{PF}(S) = \{t \in \mathbb{Z} \setminus S \mid t + s \in S \text{ para todo } s \in S \setminus \{0\}\},$$

dito o conjunto dos *números pseudo-Frobenius* de S. É bem conhecido que todo semigrupo numérico S tem um único conjunto de geradores minimal finito, cuja cardinalidade $\mathsf{e}(S)$ é dita a *dimensão de mergulho* de S. Dado um semigrupo numérico S e $m \in S \setminus \{0\}$, o *conjunto de Apéry* de S com respeito a m é $\mathsf{Ap}(S, m) = \{s \in S \mid s - m \notin S\}$. Encontrar fórmulas que calculem $\mathsf{F}(S)$ e $\mathsf{g}(S)$ em termos de um conjunto de geradores de um semigrupo numérico S são problemas antigos famosos, conhecidos como o *problema de Frobenius* e o *problema do gênero*. Esses problemas estão relacionados com muitos outros problemas e têm aplicações em diversas áreas da Matemática, tais como Teoria dos Números, Combinatória, Geometria Algébrica e Probabilidade. É uma questão difícil determinar fórmulas gerais e explícitas que resolvam tais problemas. Ambos problemas foram resolvidos por J. J. Sylvester e Curran Sharp (1883) para semigrupos numéricos S com $\mathsf{e}(S) = 2$. Mais de um século depois, os problemas permanecem em aberto para semigrupos numéricos S com $\mathsf{e}(S) = 3$; no entanto, Johnson (1960) e Rødseth (1978) mostraram que para atacar esse caso é suficiente estudar semigrupos numéricos tais que os três geradores minimais são coprimos dois a dois

Seja S um semigrupo numérico com $\mathsf{e}(S) = 3$ e cujos geradores minimais são coprimos dois a dois. Em [1], Robles-Pérez e Rosales observam que existem inteiros positivos a, b, c, d tais que S é gerado por $\{a, b, bc - ad\}$ com $c < a$ e $d < b$. Além disso, no caso que $\left[\frac{a}{c}, \frac{b}{d}\right] \cap \mathbb{N} \neq \emptyset$, aqueles autores dão explicitamente, em termos de a, b, c e d, um conjunto de Apéry, o conjunto dos números pseudo-Frobenius e fórmulas para o gênero e o número de Frobenius de S. No presente trabalho, obtemos resultados similares aos anteriores no caso complementar em que $\left[\frac{a}{c}, \frac{b}{d}\right] \cap \mathbb{N} = \emptyset$, mas assumindo que $\left\{\frac{a}{c}\right\} \leq \frac{1}{2} \leq \left\{\frac{b}{d}\right\}$, em que $\{\cdot\}$ denota a parte fracionária.

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Algebras with polynomial identities: classifying varieties of small colength

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This poster is inserted on the study of algebras with polynomial identities, whose main purpose is to classify varieties of slow growth of the sequence of colengths in different contexts. This problem was initially explored by Giambruno and La Mattina $[3]$ in 2005 in the ordinary context, where the authors classified the varieties of colengths bounded by 2. In 2009, La Mattina $[4]$ classified the varieties of colengths 3 and 4. In the last years, the PI-theory has developed with a particular interest in the study of algebras with additional structures. In this sense, in 2011 Vieira $[7]$ classified the varieties of superalgebras whose sequences of $\mathbb{Z}_2$-graded colengths are bounded by 2. Later, in 2018 La Mattina, do Nascimento and Vieira $[5]$ investigated the context of algebras endowed with involution and presented a finite list of $*$-algebras generating all $*$-varieties whose sequences of $*$-colengths are bounded by 3. Finally, in 2019 do Nascimento and Vieira $[6]$ extended the classification to the context of $*$-superalgebras, classifying the $(\mathbb{Z}_2, *)$-varieties with $(\mathbb{Z}_2, *)$-colengths bounded by 3.

The main purpose of this poster is to generalize the previous results, considering also other structures, such as algebras graded by any finite group (see $[1]$) and algebras endowed with graded involutions (see $[2]$).

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Central codimensions of minimal varieties

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A variety of algebras $\mathcal{V}$ is said minimal of polynomial growth n^k if its codimension $c_n(\mathcal{V})$ grows as n^k, and any proper subvariety of $\mathcal{V}$ has polynomial growth n^t, with $t < k$. The classification of minimal subvarieties of the varieties var(G) and var(UT_2) of almost polynomial growth was given in [2].

In [1], the authors presented the description of the space of central polynomials of the minimal subvarieties of var(G). In this work, we make explicit the generators of the space of central polynomials of the minimal subvarieties of var(UT_2). Furthermore, we compute the central codimensions $c_n^z(\mathcal{U})$, where $\mathcal{U}$ is any of the minimal varieties cited above, and compare the value of $c_n^z(\mathcal{U})$ to the value of the codimension $c_n(\mathcal{U})$.

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The Jacobson radical and the center of an incidence algebra

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The incidence algebra of a locally finite poset X over a commutative ring R, denoted $I(X,R)$, was introduced in the mid 1960's in the study of combinatorial problems, but soon itself became an object of study. When $X = \{1,...,n\}$ with the usual order of $\mathbb{N}$, $I(X,R)$ is isomorphic to $UT_n(R)$, the algebra of $n \times n$ upper triangular matrices over R. In this poster we will present the description of the invertible elements, the Jacobson radical and the center of $I(X,R)$. As a particular case, we will also describe the invertible elements, the Jacobson radical and the center of $UT_n(R)$.

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Graded polynomial identities of the infinite-dimensional upper triangular matrices over an arbitrary field

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In this work we study the G-graded polynomial identities of the infinite dimensional upper triangular matrix algebra over an arbitrary field. If the grading group is finite, we demonstrate that the ideal of graded polynomial identities admits a finite basis. We find conditions under which a grading on such an algebra satisfies a nontrivial graded polynomial identity. Finally, we show examples of nonisomorphic gradings that have the same set of graded polynomial identities.

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Extensions of the Vukman's Functional Equation Problem

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Vukman [1] studied the equation $f(x)+x^2f(x^{-1})=0$ with f additive for associative division rings D with $\mathrm{Char}(D)\neq 2$ and concluded that $f(x)=0$.

Ferreira et al. in [2] studied a variant $f(x)+xg(x^{-1})=0$ with f and g additive for matrices over for associative division rings D with $\mathrm{Char}(D)\neq 2$ and for matrices over perfect fields D with $\mathrm{Char}(D)=2$, and they characterized completely the functions f ang g. They also posed two conjectures, one about the equation $f(x)+x^ng(x^{-1})=0$ with f and g additive and $n>2$ for associative division rings and other about the equation $f(x)+xg(x^{-1})=0$ with f and g additive in non-perfect fields D with $\mathrm{Char}(D)=2$.

Ferreira et al. in [3] studied the Vukman's equation $f(x)+x^2f(x^{-1})=0$ with f additive for alternative division rings D with $\mathrm{Char}(D)\neq 2$ and concluded that $f(x)=0$. They posed two conjectures, one about the equation $f(x)+x^2f(x^{-1})=0$ with f additive for split octonion algebras and other about the equation $f(x)+x^2g(x^{-1})=0$ with f and g additive for alternative division rings.

We obtained answers for all these four conjectures and will present them in this talk.

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The Galois Correspondence Theorem for Inverse Semigroup Actions on Commutative Rings

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In this work we will continue to generalize the Galois Theory and show a Galois correspondence theorem for inverse semigroup actions on commutative rings. For that, we will use resources from E-unitary inverse semigroup theory to translate the partial Galois Theory for groups and groupoids to the general case of inverse semigroups. The partial theories will give us a equivalence theorem for Galois extensions (not necessarily commutative) and from that we shall prove the Galois Correspondence Theorem for the commutative case.

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A new proof of the Ananin and Kemer theorem

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A variety $\mathcal{L}$ is distributive if $(\mathcal{V} \cap \mathcal{U}) \cup \mathcal{W} = (\mathcal{V} \cup \mathcal{W}) \cap (\mathcal{U} \cup \mathcal{W})$, for any subvarieties $\mathcal{V}, \mathcal{U}, \mathcal{W}$ of $\mathcal{L}$. In 1976, Ananin and Kemer classified distributive algebraic varieties based on a specific polynomial identity of the variety. The distributivity relation follows if, and only if, the multiplicities in the associated n-th cocaracter are bounded by 1. Thus, classifying varieties with multiplicities bounded by 1 is equivalent to require a specific polynomial identity satisfied by the variety. In the recent years, the class of algebras satisfying this property has been studied in differents contexts. Our main goal is to provide an original proof of Ananin and Kemer's result.

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Functional identity on division algebras

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Let D be a division algebra. In this paper we describe additive maps f, g satisfying the identity $x^{-1}f(x) + g(x^{-1}) = 0$ for every invertible $x \in D$. Even more, we provide descriptions of such maps on matrix algebra over the division algebra D.

Keywords: Additive maps; division algebras; functional identity.

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The graded maximal right ring of quotients of groupoid graded rings

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In Algebra, it useful to embed a ring in a other with better properties. Some examples are quotient fields, commutative localization and Ore localization. In this direction, the theory of the maximal ring of quotients was introduced in [5] and generalized to the group graded context in [1,3]. The Groupoid Graded Ring Theory [2] generalize the Group Graded Ring Theory. In this work, we study the graded maximal right ring of quotients of groupoid graded rings. In order to define and prove properties of these graded rings of quotients, we generalized several concepts and results from Ring Theory [4] and Group Graded Ring Theory [1] to the groupoid graded context [2], some of which did not exist in the literature yet. We characterize when the graded maximal right ring of quotients is a von Neumann gr-regular ring and when it is a gr-semisimple ring, generalizing [4, (13.36) and (13.40)] and [1, Proposition 44 and Theorem 13]. This work is part of the Master Thesis supervised by Javier Sánchez Serdà with financial support from FAPESP – grant #2021/14132-2.

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Polynomial identities for 3-dimensional Leibniz algebras $RR1$ and $RR2$

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In this work we study polynomial identities in two three-dimensional Leibniz algebras. For $RR1$ we display (when there exist) multilinear polynomial identities of degree less than or equal to 3 and for $RR2$ we display (when there exist) multilinear polynomial identities of degree less than or equal to 4 over a field K.

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Gradings, graded identities and graded $*$-identities of an algebra of upper triangular matrices

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Let $F\langle X\rangle$ be the free associative algebra generated over the field F by the countable set $X = \{x_1, x_2, \ldots\}$. If A is an associative F-algebra, we say that a polynomial $f(x_1, \ldots, x_n) \in F\langle X\rangle$ is a polynomial identity, or simply an identity in A if $f(a_1, \ldots, a_n) = 0$ for every a_1, …, $a_n \in A$.

Consider A as the subalgebra of $UT_3(F)$ given by:

$$A = F(e_{1,1} + e_{3,3}) \oplus Fe_{2,2} \oplus Fe_{1,2} \oplus Fe_{2,3} \oplus Fe_{1,3},$$

where $e_{i,j}$ denote the matrix units. The polynomial identities of A were described by Gordienko in [1], and the algebra A, with involution, was also considered in [2]. We investigate the gradings on the algebra A, determined by an abelian group, and prove that these gradings are elementary. Furthermore, we compute a basis for the $\mathbb{Z}_2$-graded identities of A, and also for the $\mathbb{Z}_2$-graded identities with graded involution. Moreover, we describe the cocharacters of this algebra.

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Fundamental graded algebras and polynomial identities

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Fundamental algebras were introduced by Kemer in his work for the solution of the Specht Problem in characteristic zero. In the present talk, we show how to extend this notion to algebras with a G-graded structure, such as a $\mathbb{Z}_2$-grading, and to develop the corresponding theory. Furthermore, we provide examples and explore connection with varieties of G-graded PI algebras which are minimal with respect to their G-graded exponent.

This is based on joint works with Eli Aljadeff, Antonio Giambruno and Ernesto Spinelli.

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Negative answer to the Bahturin and Regev's conjecture about regular algebras in characteristic $p > 2$

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In this poster, we briefly present some tools that we used to provide a negative answer to the Bahturin and Regev's conjecture in the context of regular algebras, which are graded by a finite abelian group.

The concept of regular algebras was introduced in 2005 by Regev and Seeman in [5], and subsequently explored in 2008 by Bahturin and Regev in [2], and in the same year by Bahturin, Regev, and Zeilberger in [3]. In [2], the authors introduced two conjectures. The one of our interest deals with the minimality of the regular decomposition of a regular algebra and relates it to the determinant of its decomposition matrix. More precisely, it has the following statement: Let A be a regular algebra with regular decomposition $A = A_1 \oplus \cdots \oplus A_r$. Then, the decomposition of A is minimal if and only if $\det M^A \neq 0$.

In 2015, Aljadeff and David in [1] gave a positive answer to the Bahturin and Regev's conjecture considering G-graded regular algebras over algebraically closed fields of characteristic zero, with G being a finite group. In order to analyze what happened considering regular algebras, which are graded by abelians groups over fields of characteristic $p > 2$, we used both a combinatorial approach and some tools from the cohomology.

Let K be a field of characteristic $p > 2$. If K is algebraically closed, we built an explicity counterexample of a regular algebra A which is graded by an abelian group of the form $\mathbb{Z}_m \times \mathbb{Z}_m$. More accurately, we conveniently chose a number m, $\xi \in K$ an m-th root of unity, and introduced a specific bicharacter $\beta : (\mathbb{Z}_m \times \mathbb{Z}_m) \times (\mathbb{Z}_m \times \mathbb{Z}_m) \to K^*$. In this way, if A denotes the relatively $\mathbb{Z}_m \times \mathbb{Z}_m$-graded regular algebra with bicharacter β, it can be shown that the regular decomposition of A is minimal but $\det M^A = 0$. This construction works with some adjustments if K is finite.

On the other hand, if K is a general infinite field of characteristic $p > 2$, the above argument may not work. So, in this case, we use some techniques introduced in [1] considering twisted group algebras. Namely, given G be an abelian group of order p^2, using a specific function introduced by Duarte, Polcino and Ferraz in [4], it can be shown the existence of a cocycle $\alpha \in H^2(G, K^*)$ such that $G_0 = \{s \in G : \alpha(s,x) = \alpha(x,s) \quad \text{for all} \quad x \in G\} \neq G$. Hence, if β is the bicharacter induced by α, then with the appropriate arguments we could see that the twisted group algebra $K^\alpha(G/G_0)$, which has bicharacter $\overline{\beta}$ associated to β, has minimal regular decomposition, but $\det M^{K^\alpha(G/G_0)} = 0$.

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A Characterization of Matrix Rings

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In ring theory, it is often useful to know whether a given ring is a matrix ring (i.e., $R \cong \mathbb{M}_n(S)$, for some ring S and $n \geq 2$) or not. Many mathematicians have been interested in finding some criteria such that it is a matrix ring of size n greater than or equal to two. All these criteria involves conditions on more than one element of ring R. In this talk, we will discuss a one element criteria, which is, that given a ring R is an $n \times n$ matrix ring if and only if there exists a (von Neumann) regular element x in R such that $l_R(x) = Rx^{n-1}$. This is quite useful in giving quick proofs of many results and strenghthing of some known results. For instance, we have proved that if a ring R has elements x and y such that $x^n = 0$, $Rx + Ry = R$ and $Ry \cap l_R(x^{n-1}) = 0$, then R is an $n \times n$ matrix ring. This improves upon a result of P. R. Fuchs where it is proved assuming further that the element y is nilpotent of index two and $x+y$ is a unit. In this poster, we also see that for an ideal I of a ring R, the ring $\begin{pmatrix} R & I \\ R & R \end{pmatrix}$ is an 2×2 matrix ring if and only if R/I is so. As an application of this, we can answer a question asked by Chatters in 1989 in more generalized version. We also discuss some interesting conditions given by many mathematicians for a ring to be a matrix ring and how our result is helpful in giving quick proof of all these results.

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Engel's Theorem for alternative and special Jordan superalgebras

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In this poster, we present a nilpotency criterion for finite dimensional alternative superalgebras inspired by the celebrated Engel's Theorem for Lie algebras [2]. As a consequence, it is obtained a similar result for finite dimensional special Jordan superalgebras over a field $\mathbb{F}$ of characteristic not 2, without restrictions in the cardinality of $\mathbb{F}$. In that case, the latter extends the Engel's Theorem for Jordan superalgebras constructed by Okunev and Shestakov [4] and it gives a partial positive answer to an open problem announced by Murakami et al., for Jordan superalgebras over finite fields [3]. We also establish some connections between the concepts of graded-nil and nilpotent alternative superalgebras. This is a joint work with Ma. Isabel Hernández (CONAHCYT-CIMAT Mérida) and Rodrigo L. Rodrigues (UFC) [1] .

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The Image of Multilinear Graded Polynomials on 2x2 Matrix Algebras

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The image of polynomials evaluated over algebras is an important point in noncommutative algebras and has been studied by several authors, mostly motivated by the Lvov-Kaplansky Conjecture, a well-known open problem. This problem asserts that the image of a multilinear polynomial in m noncommutative variables on the matrix algebra $M_n(K)$ is a vector subspace of M_n. While complete solutions to this conjecture are known for $m = 2$, which follows from a well-known result by Shoda and Albert and Muckenhoupt which states that any trace zero matrix is given by a commutator; and for $n = 2$, given by Belov and Malev and Rowen [1], for a quadratically closed field K, complete solutions have not been achieved for $n \geq 3$. Recently, some variations of this conjecture have been studied, one of them being the study of the image of multilinear graded polynomials over graded algebras, particularly, the G-graded identities, where G is a group. To get a better sense of, if A is a K-algebra, we say that A is a G-graded algebra if there exist subspaces A_g, for each $g \in G$, such that $A = \bigoplus_{g\in G} A_g$ and for each $g, h \in G$, $A_g A_h \subseteq A_{gh}$. Some graduations are well known: by the groups $\mathbb{Z}$ and $\mathbb{Z}_n$. However, several authors have proposed different graduations. In this poster, we present partial results on the study of the image of multilinear graded polynomial p on 2×2 matrix algebras over the gradings in [2], and we describe, when possible, the linear span of Im(p).

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$\mathbb{Z}_2$-graded polynomial identities for the adjoint representation of $sl_2(K)$

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Graded identities and weak identities have been active studying areas in PI theory. They were lifted mainly by their roles in Kemer's demonstration of the Specht property for associative algebras over a field of characteristic zero [2] and in Razmyslov's work determining a basis of identities for the associative algebra of matrices of order 2 over a field of characteristic zero [6], respectively. In this context, identities of representation have also risen. If L is a Lie algebra and $\rho : L \to gl(V)$ is a representation of L in a vector space V, a polynomial identity of the representation ρ is a polynomial $f(x_1, \ldots, x_n)$ such that $f(\rho(e_1), \ldots, \rho(e_n)) = 0$ for all $e_1, \ldots e_n \in L.$ Denoting by M the associative algebra generated by $\rho(L)$, the problem of determining the identities of the representation ρ of L is equivalent to the one of finding identities for the associative-Lie pair (M, L). In [7], Trishin exhibited a basis of identities for any irreducible representation of $sl_2(K)$, with K a field of characteristic zero. Over an infinite field F of characteristic different from 2, Koshlukov determined a basis of identities for the pair $(M_2(F), sl_2(F))$ in [3] and in [4] described a basis for the $\mathbb{Z}_2$-graded identities of $sl_2(F)$. In order to find a finite basis of identities for the pair $(M_2(F), gl_2(F))$, $\mathrm{char} F \neq 2$, Koshlukov e Krasilnikov, found a basis for the $\mathbb{Z}_2$-graded identities of the pair $(M_2(D), gl_2(D))$, where D is an infinite integral domain. With the same hypotheses for D, da Costa [1] exposed a basis for the $\mathbb{Z}_2$-graded pair $(M_2(D), sl_2(F))$ and he showed that this pair has the Specht property. In this work, we put together the ideas of [5] and [7] and we present a basis for the $\mathbb{Z}_2$-graded identities of the adjoint representation of $sl_2(K)$, where K is an infinite field, $\mathrm{char} K \neq 2$, using a symmetric non degenerated bilinear form.

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Asymptotic behaviour of central codimensions of finite dimensional $*$-superalgebras

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Let A be an algebra over F a field of characteristic zero and $f(x_1, \ldots, x_n) \in F\langle X \rangle$, where $F\langle X \rangle$ is the algebra of polynomials in non commutative variables over F. If the constant term of $f(x_1, \ldots, x_n)$ is zero and every evaluation by elements of A belongs to the center of A, then we say that $f(x_1, \ldots, x_n)$ is a central polynomial of A. The central polynomials of an algebra form a vector subspace of $F\langle X \rangle$ called the T-space of A and denoted by $Id^z(A)$. The study of central polynomials is an important part of the research in the field of PI-algebras.

One of the most important tools in the study of T-spaces is the n-th central codimensions of an algebra A, denoted by $c_n^z(A)$. There exists an important numerical invariant associated to them called the central exponent and defined as $\exp^z(A) = \lim_{n\to\infty} \sqrt[n]{c_n^z(A)}$, if the limit exists. The existence of this limit was proved by Giambruno and Zaicev [1].

A natural question that arises from the Giambruno and Zaicev result cited above is if we can find similar results for algebras with additional structures. In particular, the case of $*$-algebras (algebras with a linear operation $*$ such that $(a^*)^* = a$ and $(ab)^* = b^*a^*$ for all $a, b \in A$) was proved under some conditions by Martino and Rizzo in 2022 [2] and the case of finite dimensional G-algebras (algebras with vector subspaces A_g, $g \in G$ such that $A_g A_h \subseteq A_{gh}$ for all $a, b \in A$), where G is a finite abelian group, was proved under some conditions by La Mattina, Martino and Rizzo in 2022 [3].

In the current work [4], the authors obtained similar results for finite dimensional $*$-superalgebras, that is $\mathbb{Z}_2$-algebras with a graded involution (a graded involution is a involution that satisfies $(A_i)^* \subseteq A_i$ where $i \in \mathbb{Z}_2$).

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Lengths of algebras

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First studied by Azaria Paz in 1984, the length of an algebra is an invariant that has seen significant development in the past 20 years. We briefly discuss the history of the theory and introduce its fundamental concepts. With the tools properly presented, we analyse the behavior of the length function on different classes of algebras, including matrix algebras and alternative algebras. Additionally, we provide an overview of open problems ranging from associative to power-associative algebras.

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Semigroups and Graded Green's Relations

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One of the most important tools for understanding a semigroup is Green's relations. These relate elements of the semigroup depending on the ideals they generate and provide a lot of information about the structure of the semigroup and how the elements interact [3], [2]. In particular, Green's relations are used in demonstrating the Rees-Suschkewitsch Theorem which can be seen as an analogue to the Wedderburn-Artin Theorem [2, Theorem 3.2.3] or [3, Theorem 3.2.7]. One of the purposes of this work will be to study the validity of graded versions of classical results about semigroups, in particular, the study of graded Green relations. These relations define finer equivalence classes than the usual Green relations and have the potential to be an important tool for studying semigroup structure. For the case of semigroups graded by group, they were defined in [1, Section 9.1]. We also intend to define the Rees matrices which, in semigroup theory, are objects that can be considered analogous to the ring $M_n(D)$, where D is a ring with division and n a positive integer, and obtain a graded version for them. This work is part of the doctoral thesis supervised by Javier Sanchez Serdá.

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Gradings on Block-Triangular Matrix Algebras

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Upper triangular, and more generally, block-triangular matrices, are rather important in Linear Algebra, and also in Ring theory, namely in the theory of PI algebras (algebras that satisfy polynomial identities). The group gradings on such algebras have been extensively studied during the last decades. In this paper we prove that for any group grading on a block- triangular matrix algebra, over an arbitrary field, the Jacobson radical is a graded (homogeneous) ideal. As noted by F. Yasumura [Arch. Math. (Basel) 110 (2018), pp. 327-332] this yields the classification of the group gradings on these algebras and confirms a conjecture made by A. Valenti and M. Zaicev [Arch. Math. (Basel) 89 (2007), pp. 33-40]

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On Alternative Division Rings: Identities with inverses

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Let R denote an associative division ring and $f\colon R \to R$ and $g\colon R \to R$ be additive maps. In 1987, Vukman [3] studied the identity $f(x) + x^2 f(x^{-1}) = 0$ on R and concluded that $f(x) = 0$. Catalano [2] studied $f(x)x^{-1} + xg(x^{-1}) = 0$ for every invertible $x \in R$. She was motivated by Brešar's article [1], where he studied the identity $f(x)x - xg(x) = 0$. Each identity may be related to the study of *derivations*. The purpose of this talk/poster is to show how to characterize additive mappings satisfying certain identities studied by Vukman, Brešar, and Catalano previously on an associative division ring. (see [1,2,3]) These identities may be related to the study of derivations, which has a rich history and is important for applications.

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Simple algebras with additional structures

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Let F be a field of characteristic zero and A be an associative algebra over F endowed with an automorphism or antiautomorphism φ of order ≤ 2, such an algebra A will be called φ-algebra. Let us write $A = A_0^\varphi + A_1^\varphi$, where $A_0^\varphi = \{a \in A \,|\, \varphi(a) = a\}$ and $A_1^\varphi = \{a \in A \,|\, \varphi(a) = -a\}$. In case φ is an involution (antiautomorphism) $A_0^\varphi = A^+$ and $A_1^\varphi = A^-$, subspaces of symmetric and skew elements, respectively. If φ is an automorphism then A is a $\mathbb{Z}_2$-graded algebra, also called superalgebra, with grading (A^0, A^1), where $A_0^\varphi = A^0$ and $A_1^\varphi = A^1$. The elements of A^0 and A^1 are called homogenous of degree zero and degree one, respectively, and we have $A^0A^0 + A^1A^1 \subset A^0$ whereas $A^0A^1 + A^1A^0 \subset A^1$. In this work, our aim is to provide a classification of finite dimensional simple φ-algebras over an algebraically closed field of characteristic zero.

This work was partially financed by CNPq. Supervisor: Ana Cristina Vieira

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Radical formula of a module based on prime and weakly prime submodules

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One of the well-known facts for a commutative ring R is the equality between the set of all nilpotent elements of R and the intersection of all prime ideals of R. For an R-module M, the equality between the analogue of nilpotent elements and the intersection of prime submodules is not necessarily true. This situation leads to the development of the classification of rings and modules that satisfy the radical formula. In this talk, the generalised radical formula based on the prime and weakly prime submodules are discussed. The focus of this talk is the relation between a radical formula of a module and its submodules, factor modules, and localisations.

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Differential Identities of Upper Triangular Matrices under the action of 2×2 Upper Triangular Matrices

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Let A be an algebra over a field F and Der(A) be the subspace of End(A) of linear derivations of A. With the commutator $[,]$, Der(A) becomes a Lie algebra and then it is possible to consider A under the action of any subalgebra $L \subseteq$ Der(A). This new object is called an algebra with derivations or L-algebra. In this context, the notion of identities for algebras with derivations generalizes that of identities for associative algebras. Here we consider algebras over a field of characteristic 0. A generating set will be presented for the T_L-ideal of differential identities of the L-algebra U_m, the algebra formed by $m \times m$ upper triangular matrices under the action of a subalgebra $L \subseteq$ Der(UT_m) that is isomorphic to the Lie algebra of 2×2 upper triangular matrices. Our results extend theorems obtained in the last 3–4 years by Rizzo, by Di Vincenzo and Nardozza, and by Nardozza.

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On $*$-Clean SLC Group Rings

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A ring with involution $*$ is called $*$-clean if each of its elements is a sum of a unit and a projection ($*$-invariant idempotent). If R is a ring, by a linear extension of an involution $*$ in a group G, we can define an involution in the group ring RG, also denoted by $*$. There is a considerable number of articles dedicated to the study of $*$-cleaness in the group ring RG, when $*$ is the classical involution in G, i.e., $x^* = x^{-1}$ (see [1,3,4,5,6]).

A group G is called an SLC-group if $G/\mathcal{Z}(G) \simeq C_2 \times C_2$. In [2], it is proved that G is an SLC-group if and only if $G' = \{1, s\}$ and the map

$$x^* = \begin{cases} x & \text{if } x \in \mathcal{Z}(G) \\ sx & \text{if } x \notin \mathcal{Z}(G) \end{cases}$$

defines an involution in G, called the canonical involution.

In this work, we investigate the $*$-cleaness in group rings RG where G is an SLC-group equipped with the canonical involution, showing that if RG is $*$-clean, then $G \simeq Q_8 \times A$, where A is an abelian group, and we will also present conditions for $R(Q_8 \times A)$ to be $*$-clean.

This is a joint work with K. Almeida, M. Araujo and J. Cintra.

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