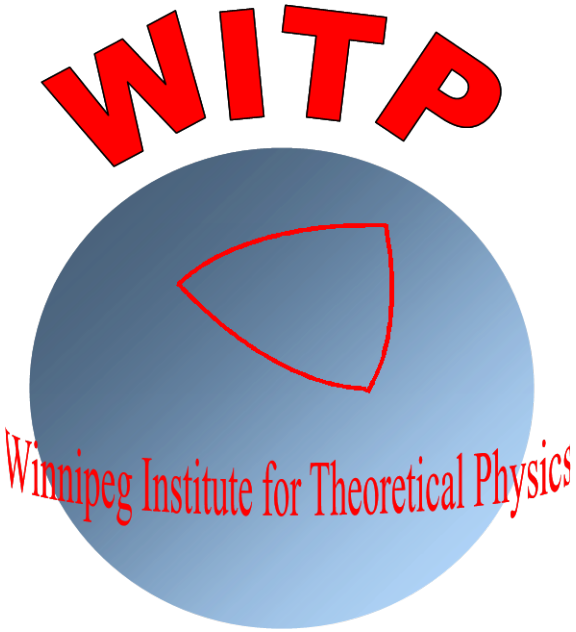
The Winnipeg Institute for Theoretical Physics Annual Report



September 2020 – August 2021

Web site: `http://www2.physics.umanitoba.ca/u/witp/`

Contents

1 Director's Narrative Report

The Winnipeg Institute for Theoretical Physics is a type III research Institute and a joint institute of the Universities of Manitoba and Winnipeg. It was created to support theoretical physics research in Manitoba. It has carried out this mandate by encouraging collaboration between members of the Institute and by financially supporting workshops, visiting colloquium speakers, and short and long term visits by research collaborators of international standing. The permanent members of this Institute are drawn from Brandon University, the University of Manitoba, and the University of Winnipeg. Associated with the Permanent Members are research associates, postdoctoral fellows, graduate students and summer undergraduate research assistants.

The past year was the 31st year of the Institute's existence. As usual, the Institute sponsored several research colloquia. The Institute has provided support for Canadian theoretical physics and astronomy meetings in the last several years, for example by sponsoring an international conference on quantum information theory hosted (online) in the Canadian Prairies. While many of our activities were altered by the pandemic (like every organization), they did continue. The WITP organized its annual summer student symposium online over Zoom on August 19, 2021, which included talks by 11 of our students. In order to emphasize the strong base of theoretical physics in Manitoba throughout the rest of Canada, the WITP also continues to co-sponsor a PhD thesis prize in conjunction with the Canadian Association of Physicists Division of Theoretical Physics.

For the previous five academic years, the list of visitors is found in section 3.1 and invited speakers in section 3.2. For 2020-21, please find a description of the WITP symposium in 3.3, the cumulative list of graduate degrees awarded in section 3.5, and the published research work of members in section 3.6. Section 4.1 contains a summary of income and expenditures for one year (since the filing of last year's report.) The plans for the coming year depend somewhat on the progression of the pandemic but include a program of invited speakers (via Zoom when appropriate), possibly visiting research collaborations, and the yearly WITP symposium with invited external speakers if possible.

All of the funds available to the Institute are spent for scientific research expenses, including conference support, seminar activities, and travel expenses of visiting scientists. The Institute has no technical support staff or administrative staff. All the administrative work is done on a volunteer basis by the members of the Institute. The Institute's funding is substantially supplemented by contributions from the NSERC grants of individual members in pursuing the Institute's mandate.

The WITP Executive Committee at January 1, 2021 consisted of A. R. Frey (UWinnipeg) as the Director and the P. Blunden (UManitoba) in the capacity of Past-Director. Starting January 1, 2022, the Director will be A. R. Frey (UWinnipeg), E. McDonough (UWinnipeg) will be Director-Elect, and P. Blunden (UManitoba) will serve in the capacity of Past Director.

Andrew Frey (Director, WITP)

2 Current List of Members (2020-21)

The WITP executive for 2021 consisted of

- Director: Andrew Frey, Winnipeg, 9th year on executive (2nd consecutive term)
- Past Director: Peter Blunden, Manitoba, 1st year

The WITP has no staff.

2.1 Permanent (Faculty) Members

- M.E. Alexander[2], *Ph.D. (Manchester University, UK)*
- P.G. Blunden[1], *Ph.D. (Queen's)* [Director, 93-94]
- M.E. Carrington[3], *Ph.D. (SUNY, Stony Brook)*
- J. D. Fiege[1], *Ph.D. (McMaster)*
- A.R. Frey[2] *Ph.D. (UCSB)* [Director, 13-14, 19-21]
- T.D. Fugleberg[3], *Ph.D. (UBC)*
- D. Krepski[1], *Ph.D. (Toronto)*
- E. McDonough[2], *Ph.D. (McGill)*
- C. O'Dea[1], *Ph.D. (Massachusetts)*
- S. Plosker[3], *Ph.D. (Guelph)*
- A. Prymak[1], *Ph.D. (Kyiv National Taras Schevchenko)*
- S. Safi-Harb[1], *Ph.D. (Wisconsin-Madison)*
- E. Schippers[1], *Ph.D. (Toronto)*
- A. Shalchi[1], *Ph.D. (Ruhr-Universität Bochum)*
- K.M. Shamseddine[1], *Ph.D. (Michigan State)* [Director, 15-16]
- J. Sirker[1], *Ph.D. (Universität Dortmund)* [Director, 17-18]
- R. Stamps[1], *Ph.D. (Colorado State University)*
- D.W. Vincent[2], *Ph.D. (Toronto)* [Director, 94-95]
- J.G. Williams[3], *Ph.D. (Birmingham)* [Director, 96-97]

Senior Scholars and Emeriti

- G. Kunstatter[2], *Ph.D. (Toronto)* [Director, 91-92, 09-12]
- P.D. Loly[1], *Ph.D. (London)* [Director, Fall 99, 00-01]
- M. Whitmore[1], *Ph.D. (McMaster)*
- B.W. Southern[1], *Ph.D. (McMaster)* [Director, 90-91, 07-09]
- J.P. Svenne [1], *Ph.D. (M.I.T.)* [Director, 95-96]
- G.C. Tabisz [1], *Ph.D. (Toronto)*
- J.M. Vail [1], *Ph.D. (Brandeis)* [Director, 98-99]

2.2 Associate and Student Members

The numbers of each class of associate and student member are as follows:

- 2 Research Associates
- 8 Postdoctoral Fellows
- 11 Ph.D. Students
- 10 M.Sc. Students
- 20 Undergraduate Research Students
- 2 High School Student Interns

These numbers may not include those whose supervisors did not provide an update for this report.

[1]University of Manitoba
[2]University of Winnipeg
[3]Brandon University

3 Research Activities

3.1 Visitors: 2017-2021

Due to the COVID-19 pandemic, WITP had no in-person visitors in 2021.

Date	Visitor	Institution	Host
Feb.-Aug. 2020	Naman Agarwal	SVNIT, India	A.R. Frey
Oct. 2018	Toka Diagana	University of Alabama in Huntsville	K. Shamseddine
Oct. 30-Nov. 3, 2017	Shirin Moein	Isfahan University of Technology	S. Plosker
July 17-21, 2017	Gilles Ferrand	RIKEN, Japan	S. Safi-Harb
May 23-26, 2017	Takaaki Tanaka	Kyoto, Japan	S. Safi-Harb
May 15-19, 2017	Rajesh Pereira	Universty of Guelph	S. Plosker
Apr 20-24, 2017	Shigehiro Nagataki	Riken, Japan	Safi-Harb
Feb. 13-17, 2017	Don Page	University of Alberta	G. Kunstatter

3.2 Seminars: 2017-2021

Date	Speaker	Title
Oct. 5, 2021	Seyda Ipek	"Why are we here? Matter – antimatter asymmetry of the universe"
Nov. 10, 2020	Robert Brandenberger	"Stephen Hawking - A Personal Perspective"
Aug. 12, 2020	Ada Chan	"Spectra properties of graphs and their quantum walks"
July 22, 2020	Omer Blaes	"Magnetohydrodynamics and Convection in Accretion Disks: From Dwarf Novae to Luminous Quasars"
July 7, 2020	Crisitina Bena	"Majorana and other boundary modes from impurity states via T-matrix"
June 4, 2020	Aaron Vincent	"Very small black holes at very large experiments"
May 8, 2020	Naman Agarwal	"Holographic Complexity: What, Why and How"
Oct. 9, 2019	Igor Proskurin	"From chiral optics to optospintronics"
Sept. 23, 2019	Gabor Kunstatter	"What can quantum gravity tell us about the beginning and end of time?"
March 8, 2019	Khodr Shamseddine	"On non-Archimedean Valued Fields and Applications in Physics"
Oct. 26, 2018	Toka Diagana	"Existence Results for some classes of Integro-Differential Equations of Gurtin-Pipkin Type"
July 20, 2017	G. Ferrand	"From the supernova to the supernova remnant"
May 25, 2017	T. Tanaka	"Shaping our Understanding of Supernova Remnants with the Fermi Large Area Telescope"
Feb. 16, 2017	D. Page	"Anthropic Estimates for ManyParameters of Physics and Astronomy"
Jan. 17, 2017	A. Nielson	"Binary Black Hole Mergers in the First Advanced LIGO Observing Run"
Jan. 13, 2107	J. Ziprick	"Quantum gravitational collapse of a thin shell"

3.3 WITP Summer Student Symposium

On August 19, 2021, WITP held its annual Summer Student Symposium online using Zoom software. The participants viewed talks on topics including condensed matter physics and high energy theory. Eleven WITP graduate and undergraduate students gave talks, and one graduate student submitted a poster. Detailed information is available on the WITP website at `http://www2.physics.umanitoba.ca/u/witp/summer/symposium21.html` . There was no cost due to the online format.

3.4 Conferences and National Event Support

- The WITP has provided support in recent years for several national and international conferences in theoretical physics, mathematics, and astrophysics:
  - Applications of Quantum Information in QFT and Cosmology 2021, held online by University of Lethbridge. WITP supported fee-free registration for the online conference ($500).
  - Women in Physics Canada 2022, to be held at the University of Manitoba. WITP will fund two theory speakers for a total amount of $2500. WITP made this funding commitment in early 2020 because the conference was originally planned for summer 2020 and postponed due to the pandemic.
  - Canadian Association of Physicists Congress 2019, held at Simon Fraser University (BC) in June 2019 ($300). WITP funds supported the plenary lecture by Professor Cora Dvorkin of Harvard University.
  - Theory Canada 14 held in May-June 2019 at the University of British Columbia and TRIUMF ($500) in support of student attendance. Theory Canada is the leading national conference for theoretical physics.
  - Theory Canada 13 held in June 2018 at St. Francis Xavier University ($500).
- In 2014, the WITP agreed to co-sponsor a prize with the Canadian Association of Physicists Division of Theoretical Physics for the best Ph.D. thesis in theoretical physics each year ($250/yr). The prize is now known as the DTP/WITP P. R. Wallace Thesis Prize, and the WITP Director or Past Director sits on the award committee. The recent prize winners are
  - 2021 — Jens Boos (PhD University of Alberta) "Effects of Non-locality in Gravity and Quantum Theory."
  - 2020 — Job Feldbrugge (PhD University of Waterloo) "Path Integrals in the Sky - Classical and Quantum Problems with Minimal Assumptions."
  - 2019 — jointly awarded to Evan McDonough (PhD McGill University, 2017) "High energy physics and the early universe" and Robie Hennigar (PhD University of Waterloo) "Explorations in black hole chemistry and higher curvature gravity." WITP made an additional $300 commitment to support the joint prize this year.
  - 2018 — Philippe Landry (PhD University of Guelph, 2016), "Tidal Response of a Rotating Neutron Star in General Relativity."
  - 2017 — no prize awarded
- In 2020, the WITP agreed to contribute $500 per year through the 2022-23 fiscal year for Canadian national dues paid to the Asia-Pacific Centre for Theoretical Physics. APCTP is a centre based in South Korea that organizes and sponsors large international workshops and conferences in theoretical physics. Canada is the only national member from the Americas (out of close to 20 member nations), and

APCTP has provided significant sponsorship for events in Canada and held jointly with Canadian organizations in the last several years.

3.5 Graduate Degrees Supervised

Dates listed are defense dates.

1. Cameron Lawlor-Forsythe (2020), "Environments of Active Galactic Nuclei in the Close Active Galactic Nuclei Reference Survey," M.Sc. thesis (O'Dea).

2. Gavin MacAuley (2020), "Skating on Spin Ice," Ph.D. thesis (University of Glasgow) (Stamps).

3. Mohammad Shirazi (2020), "Faber and Grunsky operators on Riemann surfaces of arbitrary genus and the Schiffer isomorphism," Ph.D. thesis (Schippers).

4. Hermie Monterde (2021), "Quantum State Transfer Between Twins in Graphs," M.Sc. thesis (Plosker with S. Kirkland, UManitoba).

5. Oluwatobi Ruth Ojo (2021), "Universality of Weyl Unitaries," M.Sc. thesis (University of Regina) (Plosker with D. Farenick, University of Regina).

3.6 Publications of Permanent Members

M.E. Alexander

1. Hagit Peretz-Soroka, Reuven Tirosh, Jolly Hipolito, Erwin Huebner, Murray Alexander, Jason Fiege, and Francis Lin. "A bioenergetic mechanism for amoeboid-like cell motility profiles tested in a microfluidic electrotaxis assay" Integrative Biology **9**(11): 839-896, 2017.

2. Ke Yang, Jiandong Wu, Guoqing Xu, Hagit Peretz-Soroka, Susy Santos, Murray Alexander, Ling Zhu, Michael Zhang, Yong Liu, Francis Lin. "A dual-docking microfluidic cell migration assay (D2-Chip) for testing neutrophil chemotaxis and the memory effect". Integrative Biology, **9**, 303-312, 2017.

3. S. Rathee, Nilam, M.E. Alexander. "Dynamics and control of glucose-insulin regulatory system in diabetics using vitamin D." Mathematics in Computer Science, (in press) Jul. 2017.

P.G. Blunden

No update provided for this report

M. E. Carrington

1. "*Collective modes in anisotropic plasmas,*" M. E. Carrington, B. M. Forster and S. Makar, arXiv:2107.08229 [hep-ph], accepted for publication in Phys. Rev. C.

2. "*The energy-momentum tensor at the earliest stage of relativistic heavy ion collisions,*" M. E. Carrington, A. Czajka and St. Mrówczyński, arXiv:2012.03042 [hep-ph], accepted for publication in Nucl. Phys. A.

3. "*Effect of anisotropy on phase transitions in graphene,*" M. E. Carrington, A. R. Frey and B. A. Meggison, Phys. Rev. B **102**, 125427 (2020).

4. "*Heavy Quarks Embedded in Glasma,*" M. E. Carrington, A. Czajka and St. Mrówczyński, Nucl. Phys. A **1001**, 121914 (2020).

5. "*The HTL Lagrangian at NLO: the photon case,*" S. Carignano, M. E. Carrington and J. Soto, Phys. Lett. B **801**, 135193 (2020).

6. "*The effect of a Chern-Simons term on dynamical gap generation in graphene,*" M.E. Carrington, Phys Rev **B99**, 115432 (2019).

7. "*A Non-Equilibrium approach To holographic superconductors using gradient flow,*" P. Milkula, M.E. Carrington, and G. Kunstatter, Phys. Rev. **D100**, 046004 (2019).

8. "*Renormalization of the 4PI effective action using the functional renormalization group,*" M.E. Carrington, S.A. Friesen, C.D. Phillips and D. Pickering, Phys. Rev. **D99**, 074002 (2019).

9. "*Effective Coupling Constant of Plasmons,*" M.E. Carrington and St. Mrówczyński, Phys. Rev. **D100**, 056020 (2019).

10. "*Four loop scalar phi4 theory using the functional renormalization group,*" M.E. Carrington and C.D. Phillips, Universe 5, 9 (2019).

11. "*Smooth and sharp creation of a spherical shell for a (3+1) dimensional quantum field,*" M.E. Carrington, G. Kunstatter, J. Louko and L.J. Zhou, Phys. Rev. **D98**, 024035 (2018).

12. "*The 2PI effective theory at next-to-leading order using the functional renormalization group,*" M.E. Carrington, S.A. Friesen, B.A. Meggison, C.D. Phillips, D. Pickering and K. Sohrabi, Phys. Rev. **D97**, 036005 (2018).

13. "*The role of frequency dependence in dynamical gap generation in graphene,*" M.E. Carrington, C.S. Fischer, L. von Smekal and M.H. Thoma, Phys. Rev. **97**, 115411 (2018).

14. "*Momentum broadening in unstable quark-gluon plasma,*" M.E. Carrington, St. Mrówczyński, B. Schenke, Phys. Rev. **C95**, 024906 (2017).

15. "*Smooth and sharp creation of a pointlike source for a* $(3+1)$*-dimensional quantum field,*" L.J. Zhou, Margaret E. Carrington, Gabor Kunstatter, Jorma Louko, Phys. Rev. **D95**, 085007 (2017).

J. Fiege

No update provided for this report

A. R. Frey

Preprints

A. R. Frey, R. Mahanta and A. Maharana, "Dark Radiation and the Hagedorn Phase," [arXiv:2108.03317 [hep-th]].

Refereed Publications

A. R. Frey, M. P. Grehan and M. Srivastava, "Complexity of scalar collapse in anti-de Sitter spacetime," JHEP **12**, 135 (2021) doi:10.1007/JHEP12(2021)135 [arXiv:2110.09630 [hep-th]].

M. E. Carrington, A. R. Frey, and B. A. Meggison, "Effect of anisotropy on phase transitions in graphene," Phys. Rev. B **102**, no.12, 125427 (2020) doi:10.1103/PhysRevB.102.125427 [arXiv:2006.04790 [cond-mat.mes-hall]].

A. R. Frey, "Dirac branes for Dirichlet branes: Supergravity actions," Phys. Rev. D **102**, no.4, 046017 (2020) doi:10.1103/PhysRevD.102.046017 [arXiv:1907.12755 [hep-th]].

B. Cownden, N. Deppe and A. R. Frey, "Phase diagram of stability for massive scalars in anti–de Sitter spacetime," Phys. Rev. D **102**, no.2, 026015 (2020) [arXiv:1711.00454 [hep-th]].

1. B. Cownden and A. R. Frey, "Variations on the Dirac string," Phys. Rev. D **98**, no. 10, 105013 (2018) [arXiv:1807.07401 [hep-th]].

Media Appearances

1. Comments on the Nobel Prize in Physics 2019, National Post article, Oct 8, 2019.
2. Comments on the Nobel Prize in Physics 2019, Canadian Press article (syndicated throughout Canada), Oct 8, 2019.

Talks

1. "Dark Radiation vs Hagedorn Strings," McGill University, 2022.
2. "Holographic Complexity in Gravitational Collapse," Canadian Association of Physicists Congress online, invited speaker, 2021.
3. "Quantum Information for Quantum Gravity for Undergraduates," *Prairie University Physics Seminar Series*, University of Lethbridge & University of Saskatchewan, 2021.
4. "Dirac Branes for Dirichlet Branes," McGill University, 2020

5. "The Winnipeger's Guide to the 2019 Nobel Prize in Physics," public lecture at Fred Douglas Place, Winnipeg, and University of Winnipeg, 2019, Millenium Library, Winnipeg, 2020.

6. "Disentangling Brane & Flux Degrees of Freedom," Perimeter Institute, 2019.

7. "Black Holes: The Ultimate Quantum Computers?" Millenium Library, Winnipeg, 2019.

8. "To BH or Not To BH: Gravitational Stability of AdS and What That Means," University of Winnipeg, 2018.

9. "A New Interpretation for the Dirac String," McGill University & Perimeter Institute, 2018.

10. "Phases of Gravitational Collapse in AdS," McGill University & Perimeter Institute, 2018.

11. "Question and Answer" at the performance of *How the Heavens Go* at Prairie Theatre Exchange, Winnipeg, 2018.

12. "Gravitational Collapse in AdS," WITP Workshop at UManitoba, 2017.

T. D. Fugleberg

No update provided for this report

D. Krepski

No update provided for this report
Publications

1. (with J. Vaughan) Multiplicative vector fields on bundle gerbes, 35 pages. arXiv:2003.12874 (Submitted)

2. Basic equivariant gerbes on non-simply connected compact simple Lie groups. Journal of Geometry and Physics, 133 (2018), pp. 30-41.

3. (with J. Watts) Differential cocycles and Dixmier-Douady bundles. Journal of Geometry and Physics, 130 (2018), pp. 168–183.

4. Groupoid equivariant prequantization, Communications in Mathematical Physics, 360 (2018), no. 1, pp. 169–195.

G. Kunstatter

No update provided for this report
Refereed Journal Articles:

- Ramin G. Daghigh, Michael D. Green, Jodin C. Morey, Gabor Kunstatter, "Perturbations of a Single-Horizon Regular Black Hole", Phys. Rev. D 102, 104040 2020 [arXiv:2009.02367]

- J. Ziprick and G. Kunstatter, "Escape from the Quantum Pigeon Conundrum", Physics Letters **A 384** Issue 27, 28 September 2020, 126686 [arXiv:2002.01876].

- P. Mikula, M.E. Carrington, G. Kunstatter, "Nonequilibrium approach to holographic superconductors using gradient flow", Phys. Rev. D 100, 046004 (2019) .

- P. Mikula, M.E. Carrington, G. Kunstatter, "Gradient Flow in the Ginzburg-Landau Model of Superconductivity", Phys. Rev. D 100, 046004 (2019) 1. [arXiv:1902.08669]

- R. Daghigh, M. Green and G. Kunstatter, "Quantum mechanics of the interior of the Russo-Susskind-Thorlacius black hole", Phys. Rev. D 98, 124017 (2018) [arXiv:1807.02461].

- M. Carrington, G. Kunstatter, J. Louko and L.J. Zhou, "Smooth and sharp creation of a spherical shell for a (3+1)-dimensional quantum field", Phys. Rev. D 98, 024035 (2018) [arXiv:1805.08361] .

- Hideki Maeda and Gabor Kunstatter, "Exact time-dependent states for throat quantized toroidal AdS black holes", Phys. Rev. **D 96**, 106004 (2017) [arXiv:1706.01906]

- L.J. Zhou, Margaret E. Carrington, G. Kunstatter, J. Louko, "Smooth and sharp creation of a pointlike source for a (3+1)-dimensional quantum field", Phys. Rev. **D95**, 085007 (2017) [arXiv:1610.08455].

- P. Mikula, M.E. Carrington, G. Kunstatter, "Gradient Flow in the Ginzburg-Landau Model of Superconductivity". Phys. Rev. B 94, 184501 (2017) [arXiv:1511.03714]

Books Published:

- S. Das and G. Kunstatter, *Symmetry, Special Relativity and Quantum Mechanics: The Foundations of Physics*, 385 pages + 150 page solution manual, (Springer, 2020); ISBN 978-3-030-55420-0.

Invited talks at meetings:

- G. Kunstatter, " Lost Horizons: Regular Black Hole Formation and Evaporation", **Invited**, CAP Congress, SFU June, 2019.

- G. Kunstatter, "Lost Horizons: the formation and evaporation of regular black holes" **Invited, plenary**, JCAP-CGRRA, University of Alberta, June, 2018.

INVITED LECTURES:

- "2020 Nobel Prize in physics: how black holes benefit humankind", University of Winnipeg, November 2020.
- "Lost horizons: formation and evaporation of regular black holes", Bishops University, November 2020.
- "Escape from the quantum pigeon conundrum", University of Mississippi, October, 2020.
- "What can quantum gravity tells us about beginning and end of time?", University of Winnipeg, September, 2019.
- "Lost Horizons: Regular Black Hole Formation and Evaporation", SFU January, 2019.
- "Gradient flow in holographic superconductors",
  - University of Victoria, January 26, 2018.
  - Simon Fraser University, January 31, 2018.

P.D. Loly

1. Peter Loly, "Integer Square Matrices - The Science," submission to *Notebook Archive*, Wolfram Foundation, `https://www.notebookarchive.org/imfinal30jan2021-nb--2021-02-0j6p1q1/`.
2. Peter D. Loly and Ian D. Cameron, "Frierson's 1907 Parameterization of Compound Magic Squares Extended to Orders 3^l, $l = 1, 2, 3, ...$, with Information Entropy," arXiv:2008.11020 (2020).
3. Peter Loly, Ian Cameron & Adam Rogers, "Powers of doubly-affine integer square matrices with one non-zero eigenvalue", arXiv:1712.03393[math.HO] (2017).
4. Adam Rogers, Ian Cameron and Peter Loly, "Compounding Doubly Affine Matrices", arXiv:1711.11084 (2017).

   Talks

5. Peter Loly (speaker) "Perspectives in Physics: Eigenspectra from magnons to magic" 4 April 2018.

E. McDonough

Publications 2016-2021. 27 published papers, 31 papers including preprints.

2021:

31. E. McDonough, M. X. Lin, J. C. Hill, W. Hu and S. Zhou, *The Early Dark Sector, the Hubble Tension, and the Swampland*, Preprint available at [arXiv:2112.09128].

30. S. Alexander, C. Capanelli, E. G. M. Ferreira, and E. McDonough *Cosmic Filament Spin from Dark Matter Vortices*, Preprint available at [arXiv:2111.03061].

29. K. Inomata, E. McDonough and W. Hu, *Amplification of Primordial Perturbations from the Rise or Fall of the Inflaton*, Preprint available at [arXiv:2110.14641].

28. K. Inomata, E. McDonough, and W. Hu, *Primordial Black Holes Arise When The Inflaton Falls*. Phys.Rev.D 104 (2021) 12, 123553. [arXiv:2104.03972].

27. E. W. Kolb, A. J. Long and E. Mcdonough, *The Gravitino Swampland Conjecture*. Phys. Rev. Lett. 127 (2021) 13, 131603 [arXiv:2103.10437]

26. E. W. Kolb, A. J. Long, and E. McDonough, *Catastrophic Production of Slow Gravitinos*.
Phys. Rev. D 104 (2021) 7 [arXiv:2102.10113].

2020:

30. S. Alexander, E. McDonough, and David N. Spergel, *Strongly-Interacting Ultralight Millicharged Particles*. Phys. Lett. B, 822, 2021, 136653. [arXiv:2011.06589].

29. S. Alexander, L. Jenks and E. McDonough, *Higher Spin Dark Matter*. Phys. Lett. B 819, 2021,136436. [arXiv:2010.15125].

28. E. McDonough, A. H. Guth, D. I. Kaiser, *Nonminimal Couplings and the Forgotten Field of Axion Inflation*. Preprint available at [arXiv:2010.04179].

27. M. M. Ivanov, E. McDonough, J. C. Hill, M. Simonović, M. W. Toomey, S. Alexander, and M. Zaldarriaga, *Constraining Early Dark Energy with Large-Scale Structure*. Phys. Rev. D 102 (2020) 103502 . [arXiv:2006.11235].

26. J. C. Hill, E. McDonough, M. W. Toomey and S. Alexander, *Early Dark Energy Does Not Restore Cosmological Concordance*. Editors suggestion, Phys. Rev. D 102 (2020) 4, 043507 . [arXiv:2003.07355].

25. S. Alexander, G. Herczeg, J. Liu and E. McDonough, *Chiral Symmetry and the Cosmological Constant*. Phys. Rev. D 102 (2020) 8, 083526. [arXiv:2003.08416].

24. E. McDonough, *The Cosmological Heavy Ion Collider: Fast Thermalization after Cosmic Inflation*. Phys. Lett. B 809 (2020) 135755. [arXiv:2001.03633].

2019:

23. S. Alexander, E. McDonough, A. Pullen and B. Shapiro, *Physics Beyond The Standard Model with Circular Polarization in the CMB and CMB-21cm Cross-Correlation*. JCAP **2001**, no. 01, 032 (2020) [arXiv:1911.01418].

22. S. Alexander, S. Gleyzer, E. McDonough, M. W. Toomey and E. Usai, *Deep Learning the Morphology of Dark Matter Substructure*. Ap. J. 15 **893** (2020) [arXiv:1909.07346].

21. S. Alexander, S. J. Gates Jr. , L. Jenks, K. Koutrolikos, and E. McDonough, *Higher Spin Supersymmetry at the Cosmological Collider: Sculpting SUSY Rilles in the CMB*. JHEP **1910**, 156 (2019) [arXiv:1907.05829].

20. S. Alexander and E. McDonough, *Axion-Dilaton Destabilization and the Hubble Tension*. Phys. Lett. B797 (2019) [arXiv:1904.08912].

19. R. Kallosh, A. Linde, E. McDonough, and M. Scalisi, *dS vacua and the Swampland*. JHEP 1903 (2019) 134 [arXiv:1901.02022].

18. S. Alexander, J. Bramburger, and E. McDonough, *Dark Disk Substructure and Superfluid Dark Matter*. Phys. Lett. B797 (2019) [arXiv:1901.03694].

2018:

17. S. Alexander and E. McDonough, *Primordial Circular Polarization in the Cosmic Microwave Background*. Phys. Lett. B 0370 (2018) 2693 [arXiv:1811.05953].

16. R. Kallosh, A. Linde, E. McDonough and M. Scalisi, *4d models of dS uplift in KKLT*. Phys.Rev. D99 (2019) no.4, 046006 [arXiv:1809.09018].

15. S. Alexander, E. McDonough, R. Sims and N. Yunes, *Hidden-Sector Modifications to Gravitational Waves From Binary Inspirals*, Class. Quant. Grav. 35, no. 23, 235012 (2018) [arXiv:1808.05286]

14. R. Kallosh, A. Linde, E. McDonough and M. Scalisi, *de Sitter Vacua with a Nilpotent Superfield*. Fortschr. Phys. 2018, 1800068 [arXiv:1808.09428].

13. K. Dasgupta, M. Emelin, E. McDonough, and R. Tatar, *Quantum Corrections and the de Sitter Swampland Conjecture*. JHEP **1901**, 145 (2019) [arXiv:1808.07498].

12. S. Alexander and E. McDonough, *Observable Chiral Gravitational Waves from Inflation in String Theory*. JCAP 1811, no. 11, 030 (2018) [arXiv:1806.05684].

11. S. Alexander, E. McDonough, and D. N. Spergel, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, JCAP 1805, no. 05, 003 (2018) [arXiv:1801.07255].

2016:

10. H. Bazrafshan Moghaddam, E. McDonough, R. Namba, and R. H. Brandenberger, *Inflationary magneto-(non)genesis, increasing kinetic couplings, and the strong coupling problem*, Class. Quant. Grav. 35, no. 10, 105015 (2018) [arXiv:1707.05820].

9. S. Alexander, E. McDonough, and R. Sims, *V-mode Polarization in Axion Inflation and Preheating*, Phys. Rev. D 96, no. 6, 063506 (2017) [arXiv:1704.00838].

8. E. McDonough and M. Scalisi, *Inflation from Nilpotent Kähler Corrections*, JCAP 1611, no. 11, 028 (2016) [arXiv:1609.00364].

7. K. Dasgupta, M. Emelin, and E. McDonough, *Fermions on the Anti-Brane: Higher Order Interactions and Spontaneously Broken Supersymmetry,* Phys. Rev. D 95, 026003 [arXiv:1601.03409].

6. E. McDonough, H. B. Moghaddam, and R. H. Brandenberger, *Preheating and Entropy Perturbations in Axion Monodromy Inflation,* JCAP 1605 (2016) 012 [arXiv:1601.07749].

Talks

42. Invited talk at CITA National Jamboree, *Strongly Interacting Millicharged Particles*, October 8th, 2021.

41. Invited talk at Peebles Symposium, Canadian Association of Physicists Congress 2021, *New Directions for Dark Matter*, June 8th, 2021.

40. Invited talk at Stanford, *Catastrophic Production of Slow Gravitinos.* May 14, 2021.

39. Invited talk at CERN, *Catastrophic Production of Slow Gravitinos.* May 12, 2021.

38. Invited talk at Ben Gurion University, *Catastrophic Production of Slow Gravitinos.* May 10, 2021.

37. Invited talk at McGill University, *The Gravitino Swampland Conjecture.* Apr. 26, 2021.

36. Invited talk at University of Illinois at Urbana-Champagne, *Catastrophic Production of Slow Gravitinos.* Apr. 23, 2021.

35. Invited talk at String Pheno Webinar, *The Gravitino Swampland Conjecture.* Apr. 13, 2021.

34. Invited talk at the University of Chicago, Kadanoff Center for Theoretical Physics, *The Gravitino Swampland Conjecture.* Apr. 7, 2021.

33. Invited talk at Queen's University, *Constraining Early Dark Energy with Large Scale Structure.* Mar. 16, 2021.

32. Invited talk at Higher Spin Gravity Webinar, *Higher Spin Dark Matter.* Mar. 2, 2021.

31. Invited talk at the Perimeter Institute for Theoretical Physics, *Constraining Early Dark Energy with Large Scale Structure.* Feb. 16, 2021.

30. Invited talk at the University of New Brunswick, *Higher Spin Dark Matter.* Feb. 9, 2021.

29. Invited talk at Newton 1665 seminar, *STUMP Dark Matter.* Jan. 26, 2021.

28. Invited talk at the Massachusetts Institute of Technology, Joint MIT/Tufts cosmology seminar, *Constraining Early Dark Energy with Large Scale Structure*. Oct. 20, 2020.

27. Invited talk at MPA Garching, *Constraining Early Dark Energy with Large Scale Structure*. Oct. 20, 2020.

26. Invited talk at PACMAN (Particle Astro/Cosmo Meeting Around NYC) seminar, *Ultra-light Fermionic Dark Matter: Halo Cores as Dark Neutron Stars*. Oct. 13, 2020.

25. Invited talk at Copernicus Webinar Series, *Constraining Early Dark Energy with Large Scale Structure*. July 23, 2020.

24. Invited talk at the Theoretical Cosmology, Gravity and Fields Workshop, Dartmouth College. *Constraining Early Dark Energy with Large Scale Structure*. July 21, 2020.

23. Invited talk at University of Illinois Urbana-Champaign, *Gravitational Lamp Posts for Dark Matter Physics*. Dec. 6, 2019.

22. Invited talk at Northeastern University, *The Chirality of Primordial Gravitational Waves*. Sept. 30, 2019.

21. Invited talk at Theory Canada 14, *New (Old) Gravitational Probes of Dark Matter*. May 31, 2019.

20. Invited Lecture at Atlantic General Relativity 2019, *Primordial Cosmology and High Energy Physics*. May 27, 2019.

19. Seminar at the Flatiron Institute, Center for Computational Astrophysics, *Strong Gravity Probes of Dark Matter*. May 1, 2019

18. Seminar at the ETH Zurich, *The Chirality of Primordial Gravitational Waves*. March 22, 2019

17. Seminar at the Max Planck Institute for Astrophysics (MPA) Garching, *The Chirality of Primordial Gravitational Waves*. March 19, 2019

16. Seminar at the Syracuse University, *The Chirality of Primordial Gravitational Waves*, Dec 11, 2018.

15. Seminar at the Massachusetts Institute of Technology, *The Chirality of Primordial Gravitational Waves*, Dec 11, 2018.

14. Invited Speaker at Canadian Association of Physicists (CAP) Congress 2018, June 11-15, 2018. Dalhousie University, Halifax, Nova Scotia.

13. Session Chair and contributed talk at the Theory Canada 13, June 7-9, 2018. St. Francis Xiavier University, Antigonish, Nova Scotia.

12. Invited speaker at conference New England Cosmology Workshop, October 13-14, 2018. Massachusetts Institute of Technology.

11. Seminar at the Dartmouth College, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, May 2, 2018.

10. Seminar at the University of Pennsylvania, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, April 26, 2018.

9. Seminar at the New York University, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, April 17, 2018.

8. Seminar at the Institute for Advance Study, Princeton, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, March 12, 2018.

7. Seminar at Harvard University, Dvorkin-Finkbeiner-Kovacs journal club, *Chiral Gravitational Waves and Baryon Superfluid Dark Matter*, February 20, 2018.

6. Seminar at Tufts University, *Anti-Brane Induced Inflation*, November 14, 2017.

5. Invited speaker at conference String Theory and Cosmology: Cosmic Origin and Cosmic Fate, From Big Bang to Dark Energy May 27-28, 2017, Italy.

4. Seminar at Brown University, *Primordial Black Holes and Preheating in Axion Inflation*, April 26, 2016.

3. Contributed talk, *Fermions on the Antibrane*, at the workshop Northeast Gravity Workshop, April 22-24, 2016, hosted by UMass Amherst.

2. Seminar at the Massachusetts Institute of Technology, *Preheating in Axion Inflation Models*, April 12, 2016.

1. Seminar at the University of California at Berkeley, *Fermions on the Anti-Brane: Higher Order Interactions and Spontaneously Broken Supersymmetry*, March 1, 2016.

C. O'Dea

Refereed Articles

1. B. Balmaverde, A. Capetti, A. Marconi, G. Venturi, M. Chiaberge, R.D. Baldi, S. Baum, R. Gilli, P. Grandi, Eileen T. Meyer, G. Miley, C. O'Dea, W. Sparks, E. Torresi, G. Tremblay, "The MURALES survey. III. Completing the MUSE observations of 37 3C low-z radio galaxies," *Astronomy & Astrophysics*, 645, A12-30 (2021)

2. A. Jimenez-Gallardo, F. Massaro, A. Paggi, R. D'Abrusco, M. A. Prieto, H. A. Peña-Herazo, V. Berta, F. Ricci, C. Stuardi, B. J. Wilkes, C. P. O'Dea, S. A. Baum, R. P. Kraft, W. R. Forman, C. Jones, B. Mingo, E. Liuzzo, B. Balmaverde, A. Capetti, V. Missaglia, M. J. Hardcastle, R. D. Baldi, L. K. Morabito, "Extended X-Ray Emission around FR II Radio Galaxies: Hot Spots, Lobes, and Galaxy Clusters," *The Astrophysical Jounral Supplements*, 252, 31-54 (2021)

3. A. N. Vantyghem, B. R. McNamara, C. P. O'Dea, S. A. Baum, F. Combes, A. C. Edge, A. C. Fabian, M. McDonald, P. E. J. Nulsen, H. R. Russell, P. Salome, "A Massive, Clumpy Molecular Gas Distribution and Displaced AGN in Zw 3146," *The Astrophysical Journal*, 910, 53-66 (2021)

4. A. Gill, M. M. Boyce, C. P. O'Dea, S. A. Baum, P. Kharb, N. Campbell, G. R. Tremblay, S. Kundu, "Extended X-Ray Emission Associated with the Radio Lobes and the Environments of 60 Radio Galaxies," *The Astrophysical Journal*, 912, 88-107 (2021)

5. A. Jimenez-Gallardo, F. Massaro, B. Balmaverde, A. Paggi, A. Capetti, W. R. Forman, R. P. Kraft, R. D. Baldi, V. H. Mahatma, C. Mazzucchelli, V. Missaglia, F. Ricci, G. Venturi, S. A. Bam, E. Liuzzo, C. P. O'Dea, M. A. Prieto, H. J. A. Röttgering, E. Sani, W. B. Sparks, G. R. Tremblay, R. J. van Weeren, B. J. Wilkes, J. J. Harwood, P. Mazzotta, J. Kuraszkiewicz "Raining in MKW 3 s: A Chandra-MUSE Analysis of X-Ray Cold Filaments around 3CR 318.1," *The Astrophysical Journal Letters*, 912, L25-32 (2021)

6. V. Missaglia, F. Massaro, E. Liuzzo, A. Paggi, R. P. Kraft, W. R. Forman, A. Jimenez-Gallardo, J. P. Madrid, F. Ricci, C. Stuardi, B. J. Wilkes, S. A. Baum, C. P. O'Dea, J. Kuraszkiewicz, G. R. Tremblay, A. Maselli, A. Capetti, E. Sani, B. Balmaverde, and D. E. Harris, "Hidden Treasures in the Unknown 3CR Extragalactic Radio Sky: A Multiwavelength Approach," *The Astrophysical Jounral Supplements*, 255, 18-38 (2021)

7. Y. A. Gordon, M. M. Boyce, C. P. O'Dea, L. Rudnick, H. Andernach, A. N. Vantyghem, S. A. Baum, J.-P. Bui, M. Dionyssiou, S. Safi-Harb, I. Sander "A Quick Look at the 3 GHz Radio Sky. I. Source Statistics from the Very Large Array Sky Survey," *The Astrophysical Jounral Supplements*, 255, 30-47 (2021)

8. G. Speranza, B. Balmaverde, A. Capetti, F. Massaro, G. Tremblay, A. Marconi, G. Venturi, M. Chiaberge, R.D. Baldi, S. Baum, P. Grandi, E. T. Meyer, C. 0'Dea, W. Sparks, B.A. Terrazas, E. Torresi, "The MURALES survey. IV. Searching for nuclear outflows in 3C radio galaxies at $z < 0.3$ with MUSE observations," *Astronomy & Astrophysics*, 653, 150-180 (2021)

9. M. Singha, C. P. O'Dea, Y. A. Gordon, C. Lawlor-Forsyth, S. A. Baum "Ionized Gas Outflows in Low-excitation Radio Galaxies Are Radiation Driven," *The Astrophysical Journal*, 918, 65-81 (2021)

10. S. Silpa, P. Kharb, C. P. O'Dea, S. A. Baum, B. Sebastian, D. Mukherjee, C. M. Harrison, "AGN jets and winds in polarized light: the case of Mrk 231," *Monthly Notices of the Royal Astronomical Society*, 507, 2550-2561 (2021)

11. C. P. O'Dea & D. J. Saikia, "Compact steep-spectrum and peaked-spectrum radio sources," *The Astronomy and Astrophysics Review*, 29, 3- (2021)

12. C. Reynolds, B. Punsly, G. Miniutti, C. P. O'Dea, N. Hurley-Walker, "Estimating the Jet Power of Mrk 231 during the 2017-2018 Flare," The Astrophysical Journal, 891, 59-83 (2020)

13. M. Lacy et al. "The Karl G. Jansky Very Large Array Sky Survey (VLASS): science case and survey design," Publications of the Astronomical Society of the Pacific, 132, 035001-035035 (2020)

14. T. Rose, A. C. Edge, F. Combes, S. Hamer, B. R. McNamara, H. Russell, M. Gaspari, P. Salomé, C. Sarazin, G. R. Tremblay, S. A. Baum, M. N. Bremer, M. Donahue, A. C. Fabian, G. Ferland, N. Nesvadba, C. O'Dea, J. B. R. Oonk, A. B. Peck, "A molecular absorption line survey towards the AGN of Hydra-A," Monthly Notices of the Royal Astronomical Society, 496, 364-380 (2020).

15. B. Sebastian, P. Kharb, C. O'Dea, J. F. Gallimore, S. A. Baum, "A radio polarimetric study to disentangle AGN activity and star formation in Seyfert galaxies," Monthly Notices of the Royal Astronomical Society, 499, 334-354 (2020).

16. A. Jimenez-Gallardo, F. Massaro, M. A. Prieto, V. Missaglia, C. Stuardi, A. Paggi, F. Ricci, R. P. Kraft, E. Liuzzo, G. R. Tremblay, S. A. Baum, C. P. O'Dea, B. J. Wilkes, J. Kuraszkiewicz, W. R. Forman, D. E. Harris, "The Chandra 3CR extragalactic survey at high redshift," The Astrophysical Jounral Supplements, 250, 1-7 (2020)

17. D. A. Sales, A. Robinson, R. A. Riffel, T. Storchi-Bergmann, J. F. Gallimore, P. Kharb, S. Baum, C. O'Dea, C. Hekatelyne, F. Ferrari, "Gemini IFU, VLA, and HST observations of the OH Megamaser Galaxy IRAS17526 + 3253," Monthly Notices of the Royal Astronomical Society, 486, 3350-3367 (2019)

18. B. Husemann, J. Scharwachter, T. A. Davis, M. Perez-Torres, I. Smirnova-Pinchukova, G. R. Tremblay, M. Krumpe, F. Combes, S. A. Baum, G. Busch, T. Connor, S. M. Croom, M. Gaspari, R. P. Kraft, C. P. O'Dea, M. Powell, M. Singha, T. Urrutia, "The Close AGN Reference Survey (CARS). A massive multi-phase outflow impacting the edge-on galaxy HE 1353-1917," Astronomy & Astrophysics, 627, 53-81 (2019)

19. Y. A. Gordon, K. A. Pimbblet, S. Kaviraj, M. S. Owers, C. P. O'Dea, M. Walmsley, S. A. Baum, J. P. Crossett, A. Fraser-McKelvie, C. J. Lintott, J. C.S. Pierce, "The Effect of Minor and Major Mergers on the Evolution of Low-excitation Radio Galaxies," The Astrophysical Journal, 878, 88-101 (2019)

20. I. Smirnova-Pinchukova, B. Husemann, G. Busch, P. Appleton, M. Bethermin, F. Combes, S. Croom, T. A. Davis, C. Fischer, M. Gaspari, B. Groves, R. Klein, C. P. O'Dea, M. Perez-Torres, J. Scharwachter, M. Singha, G. R. Tremblay, and T. Urrutia, "The Close AGN Reference Survey (CARS). Discovery of a global [C II] 158 μm line excess in AGN HE 1353-1917," Astronomy & Astrophysics, 626, L3-10 (2019)

21. T. Rose, A. C. Edge, F. Combes, M. Gaspari, S. Hamer, N. Nesvadba, H. Russell, G. R. Tremblay, S. A. Baum, C. O'Dea, A. B. Peck, C. Sarazin, A. Vantyghem, M. Bremer, M. Donahue, A. C. Fabian, G. Ferland, B. R. McNamara, R. Mittal, J. B. R. Oonk, P. Salomé, A. M. Swinbank, M. Voit, "Deep and narrow CO absorption revealing molecular clouds in the Hydra-A brightest cluster galaxy," Monthly Notices of the Royal Astronomical Society, 485, 229-238 (2019)

22. M. S. Calzadilla, H. R. Russell, M. McDonald, A. C. Fabian, S. A. Baum, F. Combes, M. Donahue, A. C. Edge, B. R. McNamara, P. E. J. Nulsen, C. P. O'Dea, J. B. Raymond Oonk, G. R. Tremblay, A. N. Vantyghem, "Revealing a Highly-Dynamic Cluster Core in Abell 1664 with Chandra," Astrophysical Journal, 875, 65-78 (2019)

23. S. Vaddi, P. Kharb, R.A. Daly, C.P. O'Dea, S.A. Baum, D.K. Deo, T.C. Barbusca, C. Murali, "A VLA-GMRT look at 11 powerful FR II quasars," Monthly Notices of the Royal Astronomical Society, 484, 385-408 (2019)

24. F. Massaro, V. Missaglia, C. Stuardi, D. E. Harris, R. P. Kraft, A. Paggi, E. Liuzzo, G. R. Tremblay, S. A. Baum, C. P. O'Dea, B. J. Wilkes, J. Kuraszkiewicz, W. R. Forman, "The 3CR Chandra snapshot survey: extragalactic radio sources with $0.5 < z < 1.0$," Astrophysical Journal Supplements, 234, 7 - 32 (2018)

25. C. Hekatelyne, R. A. Riffel, D. Sales, A. Robinson, J. Gallimore, T. Storchi-Bergmann, P. Kharb, C. O'Dea, S. Baum, "Gemini IFU, VLA and HST observations of the OH Megamaser galaxy IRASF23199+0123: the hidden monster and its outflow," Monthly Notices of the Royal Astronomical Society, 474, 5319-5329 (2018)

26. K. Cooke, K. Fogarty, J. S. Kartaltepe, J. Moustakas, C. P. O'Dea, M. Postman "Stellar Mass and 3.4 m M/L Ratio Evolution of Brightest Cluster Galaxies in COSMOS since z$\sim$ 1.0," Astrophysical Journal, 857, 122 - 136 (2018)

27. C. Stuardi, V. Missaglia, F. Massaro, F. Ricci, E. Liuzzo, A. Paggi, R. P. Kraft, G. R. Tremblay, S. A. Baum, C. P. O'Dea, B. J. Wilkes, J. Kuraszkiewicz, W. R. Forman, D. E. Harris, "The 3CR Chandra extragalactic survey at $1.0 < z < 1.5$," Astrophysical Journal Supplements, 235, 32 - 52 (2018)

28. G. R. Tremblay, F. Combes, J. B. Raymond Oonk, H. R. Russell, M. A. McDonald, M. Gaspari, B. Husemann, P. E. J. Nulsen, B. R. McNamara, S. L. Hamer, C. P. O'Dea, S. A. Baum, T. A. Davis, M. Donahue, G. M. Voit, A. C. Edge, E. L. Blanton, M. N. Bremer, E. Bulbul, T. E. Clarke, L. P. David, L. O. V. Edwards, D. A. Eggerman, A. C. Fabian, W. R. Forman, C. Jones, N. Kerman, R. P. Kraft, Y. Li, M. C. Powell, S. W. Randall, P. Salomé, A. Simionescu, Y. Su, M. Sun, C. M. Urry, A. N. Vantyghem, B. J. Wilkes, J. A. ZuHone "A Galaxy-Scale Fountain of Cold Molecular Gas Pumped by a Black Hole," Astrophysical Journal, 865, 13 - 37 (2018)

29. C. Hekatelyne, R. A. Riffel, D. Sales, A. Robinson, T. Storchi-Bergmann, P. Kharb, J. Gallimore, S. Baum, C. O'Dea, "Star formation and gas inflows in the OH Mega-

maser galaxy IRAS03056+2034," Monthly Notices of the Royal Astronomical Society, 479, 3966 - 3977 (2018)

30. M. C. Powell, B. Husemann, G. R. Tremblay, M. Krumpe, T. Urrutia, S. A. Baum, G. Busch, F. Combes, S. M. Croom, T. A. Davis, A. Eckart, C. P. O'Dea, M. Perez-Torres, J. Scharwachter, I. Smirnova-Pinchukova, C. M. Urry, "The Close AGN Reference Survey (CARS): No evidence of galaxy-scale hot outflows in two nearby AGN," Astronomy & Astrophysics, 618, A27-37 (2018)

31. G. Busch, B. Husemann, I. Smirnova-Pinchukova, A. Eckart, S.A. Baum, F. Combes, S.M. Croom, T.A. Davis, N. Fazeli, C. Fischer, M. Gaspari, R. Klein, M. Krumpe, R. McElroy, C.P. O'Dea, M.A. Perez-Torres, M.C. Powell, A. Sanchez-Monge, J. Scharwachter, G.R. Tremblay, T. Urrutia, "The Close AGN Reference Survey (CARS): SOFIA detects spatially-resolved [CII] emission in the luminous AGN HE0433-1028," Astrophysical Journal Letters, 866, L9-15 (2018)

32. B. Balmaverde, A. Capetti, A. Marconi, G. Venturi, M. Chiaberge, R.D. Baldi, S. Baum, R. Gilli, P. Grandi, E. Meyer, G. Miley, C. O'Dea, W. Sparks, E. Torresi, G. Tremblay, "The MURALES survey. I. A dual AGN in the radio galaxy 3C459?" Astronomy & Astrophysics, 619, A83-89 (2018)

33. F. Ricci, L. Lovisari, R. P. Kraft, F. Massaro, A. Paggi, E. Liuzzo, G. Tremblay, W. R. Forman, S. Baum, **C. O'Dea**, B. Wilkes, "Stormy weather in 3C 196.1: nuclear outbursts and merger events shape the environment of the hybrid radio galaxy 3C 196.1," Astrophysical Journal, 867, 35 - 47 (2018)

34. C. P. O'Dea, D. M. Worrall, G. R. Tremblay, T. E. Clarke, B. Rothberg, S. A. Baum, K. P. Christiansen, C. A. Mullarkey, J. Noel-Storr, R. Mittal, "Testing for Shock-Heated X-ray Gas Around Compact Steep Spectrum Radio Galaxies," Astrophysical Journal, 851, 87-99 (2017)

35. J. E. Coleman, L. J. King, M. Oguri, H. R. Russell, R. E. A. Canning, A. Leonard, R. Santana, J. A. White, S. A. Baum, D. I. Clowe, A. Edge, A. C. Fabian, B. R. McNamara and C. P. O'Dea, The mass distribution of the unusual merging cluster Abell 2146 from strong lensing, Monthly Notices of the Royal Astronomical Society, 464, 2469-2480 (2017)

36. C. Reynolds, B. Punsly, G. Miniutti, C. P. O'Dea, N. Hurley-Walker, The Relativistic Jet-Accretion Flow-Wind Connection in Mrk 231," Astrophysical Journal, 836, 155-176 (2017)

37. M. Chiaberge, J. C. Ely, E. T. Meyer, M. Georganopoulos, A. Marinucci, S. Bianchi, G. R. Tremblay, B. Hilbert, J. P. Kotyla, A. Capetti, S. A. Baum, F. D. Macchetto, G. Miley, C. P. O'Dea, E. S. Perlman, W. B. Sparks, C. Norman, The puzzling radio-loud QSO 3C 186: a gravitational wave recoiling black hole in a young radio source?" Astronomy & Astrophysics, 600, 57-72 (2017)

38. L. Gu, J. Mao, C. P. O'Dea, S. A. Baum, M. Mehdipour, J. Kaastra, Charge exchange in the ultraviolet: implication for interacting clouds in the core of NGC 1275, Astronomy & Astrophysics, 601, 45-53 (2017)

39. **C. P. O'Dea**, "The infrared properties of the GPS and CSS radio sources," *Astronomische Nachrichten*, 337, 141-147 (2016)

40. **C. P. O'Dea** & A. Siemiginowska, "Summary," *Astronomische Nachrichten*, 337, 205-208 (2016)

41. S. Vaddi, **C. P. O'Dea**, S. A. Baum, S. Whitmore, R. Ahmed, K. Pierce, S. Leary, "Constraints on Feedback in the Local Universe: The Relation between Star Formation and AGN Activity in Early-type Galaxies," *Astrophysical Journal*, 818, 182-200 (2016)

42. H. R. Russell, B. R. McNamara, A. C. Fabian, P. E. J. Nulsen, A. C. Edge, F. Combes, N. W. Murray, I. J. Parrish, P. Salomé, J. S. Sanders, S. A. Baum, M. Donahue, R. A. Main, R. W. O'Connell, **C. P. O'Dea**, J. B. R. Oonk, G. Tremblay, A. N. Vantyghem, G. M. Voit, "ALMA observations of cold molecular gas filaments trailing rising radio bubbles in PKS 0745-191," *Monthly Notices of the Royal Astronomical Society*, 458, 3134-3149 (2016)

43. G. R. Tremblay, J. B.R. Oonk, F. Combes, P. Salomé, **C. P. O'Dea**, S. A. Baum, G. M. Voit, M. Donahue, B. R. McNamara, T. A. Davis, M. A. McDonald, A. C. Edge, T. E. Clarke, R. Galván-Madrid, M. Maury, H. R. Russell, A. C. Quillen, C. M. Urry, J. S. Sanders, M. W. Wise, "Cold, clumpy accretion onto an active supermassive black hole," *Nature*, 534, 218-221 (2016)

44. J. P. Kotayla, M. Chiaberge, S. A. Baum, A. Capetti, B. Hilbert, F. D. Macchetto, G. K. Miley, **C. P. O'Dea**, E. S. Perlman, W. B. Sparks, G. R. Tremblay, "The Environment of $z > 1$ 3CR Radio Galaxies and QSOs: From Proto-Clusters to Clusters of Galaxies?" *Astrophysical Journal*, 826, 46-58 (2016)

45. B. Hilbert, M. Chiaberge, J. P. Kotayla, G. R. Tremblay, C. Stanghellini, W. B. Sparks, S. A. Baum, A. Capetti, F. D. Macchetto, G. K. Miley, **C. P. O'Dea**, E. S. Perlman, A. C. Quillen, "Powerful Activity in the Bright Ages. I. A Visible/IR Survey of High Redshift 3C Radio Galaxies and Quasars," *Astrophysical Journal Supplements*, 225, 12-28 (2016)

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47. A. Maselli, F. Massaro, G. Cusumano, V. La Parola, D. E. Harris, A. Paggi, E. Liuzzo, G. R. Tremblay, S. A. Baum, **C. P. O'Dea**, "Swift observations of unidentified radio sources in the revised Third Cambridge Catalogue," *Monthly Notices of the Royal Astronomical Society*, 460, 3829-3837 (2016)

48. J. F. Gallimore, M. Elitzur, R. Maiolino, A. Marconi, **C P. O'Dea**, D. Lutz, S. A. Baum, R. Nikutta, C. M. V. Impellizzeri, R. Davies, Amy E. Kimball, and E. Sani "High-velocity Bipolar Molecular Emission from an AGN Torus," *Astrophysical Journal Letters*, 829, 7-12 (2016)

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S. Plosker

Peer-Reviewed Journal Articles

1. D. Farenick, O. Ojo*, and S. Plosker, *Universality of Weyl Unitaries*, Linear Algebra and its Applications, **634**, pp. 57–76, 2022.

2. D. Farenick, F. Huntinghawk*, A. Masanika*, and S. Plosker, *Complete order equivalence of spin unitaries*, Linear Algebra and its Applications, **610**, pp. 1-28, 2020.

3. A. Chan, S. Fallat, J.C.-H. Lin, S. Kirkland, S. Nasserasr, and S. Plosker. *Complex Hadamard diagonalisable graphs*, Linear Algebra and its Applications, **605**, pp. 158-179, 2020.

4. P. Ganesan, L. Gao, S. Pandey, and S. Plosker, *Quantum majorization on semifinite von Neumann algebras*, Journal of Functional Analysis, 108650, 2020.

5. L. Cao, D. McLaren*, and S. Plosker, *Centrosymmetric stochastic matrices*, Linear and Multilinear Algebra, pp. 1-16, 2020.

6. D. McLaren*, S. Plosker, and C. Ramsey*. *On operator valued measures*, Houston Journal of Mathematics, **46**(1), pp. 201-226, 2020.

7. M. Adm, S. Fallat, K. Meagher, S. Nasserasr, S. Plosker, and B. Yang. *Achievable multiplicity partitions in the inverse eigenvalue problem of a graph*, Special Matrices (special issue dedicated to Charlie Johnson), **7**, pp. 276-290, 2019. Received *Editor's Choice* recognition.

8. S. Kirkland, S. Plosker, and X. Zhang*. *Switching and partially switching the hypercube while maintaining perfect state transfer*, Quantum Information and Computation, **19**, no. 7& 8, pp. 0541-0554, 2019.

9. S. Moein*, R. Pereira, and S. Plosker. *A simplified and unified generalization of some majorization results*, Journal of Mathematical Analysis and Applications, **478**, pp. 1049-1058, 2019.

10. S. Plosker and C. Ramsey*. *An operator-valued Lyapunov theorem*, Journal of Mathematical Analysis and Applications, **469**, pp. 117–125, 2019.

11. S.J. Harris, R.H. Levene, V.I. Paulsen, S. Plosker, M. Rahaman. *Schur multipliers and mixed unitary maps*, Journal of Mathematical Physics, **59**, 112201 (2018).

12. S. Kirkland, D. Mclaren*, R. Pereira, S. Plosker, and X. Zhang*. *Perfect quantum state transfer in weighted paths with potentials (loops) using orthogonal polynomials*, Linear and Multilinear Algebra, pp. 1-19, 2018.

13. N. Johnston, C.-K. Li, S. Plosker, Y.T. Poon., and B. Regula. *Evaluating the robustness of k-coherence and k-entanglement*, Physical Review A, **98**, 022328, 2018

14. N. Johnston, C.-K. Li, and S. Plosker. *The modified trace distance of coherence is constant on most pure states*, Journal of Physics A: Mathematical and Theoretical, **51**, 414010, 2018.

15. N. Johnston, S. Kirkland, S. Plosker, R. Storey*, and X. Zhang*. *Perfect quantum state transfer using Hadamard diagonalizable weighted graphs.* Linear Algebra and its Applications, **531**, pp. 375–398, 2017.

Peer-Reviewed Conference Proceedings

16. S. Plosker, and G. Srivastava. *Cybersecurity Education in Rural Indigenous Canada*, Institute of Electrical and Electronics Engineers Canadian Conference of Electrical and Computer Engineering (IEEE CCECE) 2021

17. F. Huntinghawk*, C. Richard*, S. Plosker, and G. Srivastava. *Expanding Cybersecurity Knowledge Through an Indigenous Lens: A First Look*, Institute of Electrical and Electronics Engineers Canadian Conference of Electrical and Computer Engineering (IEEE CCECE) 2020.

18. B. Kacsmar*, S. Plosker, and R. Henry *Computing Low-Weight Discrete Logarithms*, the 24th Annual Conference on Selected Areas in Cryptography (SAC) Ottawa, ON, 2017

Invited Lectures

19. *Operator Algebras and Quantum Information Theory*, Culminating Workshop presentation, Groundwork for Operator Algebras Lecture Series (GOALS); GOALS aims to increase participation and retention in the field by persons from traditionally underrepresented groups, July 25, 2021.

20. *Operator-valued functions that are integrable against a positive, operator-valued measure*, Operator Algebras and Applications Session, *Quantum theoretic aspects of spin unitary matrices*, Quantum Information Theory Session, CMS Summer Meeting (virtual), June 7-14, 2021

21. *Bistochastic operators and quantum random variables*, The 49th Canadian Operator Symposium (COSy) (virtual), May 31-June 4, 2021.

22. *Centrosymmetric Stochastic Matrices*, SIAM Conference on Applied Linear Algebra (virtual), May 17-21, 2021.

23. *Centrosymmetric Stochastic Matrices*, Waterloo Algebraic Graph Theory Seminar Series (virtual), Mar. 22, 2021.

24. *Centrosymmetric Stochastic Matrices*, Matrix Seminar Series, University of Nevada, Reno (virtual), Mar. 1, 2021.

25. *Indigenous beadwork in a mathematics classroom*, Geometry: Education, Art, and Research (GEAR), Banff International Research Station, (virtual), Feb. 19-21, 2021.

26. *Complete order equivalence of spin unitaries*, special session on Advances in Operator Algebras, Joint Mathematics Meetings (JMM), Washington, D.C. (virtual), Jan. 6-9, 2021.

27. Six invited talks at national and international conferences cancelled due to COVID-19, Summer 2020.

28. *Quantum information on complex Hadamard diagonalizable graphs*, Quantum Information on Graphs Session, *Beadwork as a method of teaching linear algebra*, The Art of Mathematics Session, CMS Summer Meeting, Toronto, ON, Dec. 6-9, 2019.

29. *How superpositioned is my quantum state?*, Science Seminar Series, Brandon University, Oct. 31, 2019.

30. *The robustness of* $\mathbf{k}$*-coherence and* $\mathbf{k}$*-entanglement*, Algebraic and Statistical ways into Quantum Resource Theories Workshop, Banff International Research Station for Mathematical Innovation and Discovery (BIRS), Banff, AB, July 21-26, 2019.

31. *Schur multipliers and mixed unitary maps*, Invited Minisymposium: Linear Algebra and Quantum Information Science, International Linear Algebra Society (ILAS) Meeting Rio, Brazil, July 8-12, 2019.

32. *The robustness of* k*-coherence*, The Mathematics behind Quantum Information Science Session, CMS Summer Meeting, Regina, SK, June 7-10, 2019.

33. *Quantum majorization via operator space duality*, 47th Canadian Operator Symposium, University of Regina, Regina, SK, June 3-7, 2019.

34. *Finding the "closest" diagonal state to an arbitrary quantum state*, Special Session on Combinatorial Matrix Theory, American Mathematical Society Sectional Meeting, Auburn University, Auburn, AL, Mar. 15-17, 2019.

35. *On operator-valued measures*, Math dept. research seminar, Texas A&M University, Feb. 2, 2019.

36. *Switching the hypercube while maintaining perfect state transfer*, Optimization Techniques in Quantum Information Theory Session, CMS Summer Meeting, Fredericton, NB, Jun. 1-4, 2018.

37. *Hadamard diagonalizable graphs, cubelike graphs, and perfect state transfer*, Algebraic Graph Theory and Quantum Walks Workshop, Waterloo, ON, Apr. 23–27, 2018.

38. *Perfect quantum state transfer on weighted paths*, Mathematical Aspects of Quantum Information Session, CMS Winter Meeting, Waterloo, ON, Dec. 8–11, 2017.

39. *Achieving perfect state transfer using Hadamard diagonalizable graphs*, Matrix Analysis and its Applications Special Session, 3rd Pacific Rim Mathematical Association (PRIMA2017) Congress, Oaxaca, Mexico, Aug. 14–18, 2017.

40. *Clean quantum measurements via operator systems*, Workshop on Operator Systems in Quantum Information, Guelph, ON, Aug. 14–17, 2017

41. *Quantum state transfer via Hadamard diagonalizable graphs*, Invited Minisymposium: Linear Algebra and Quantum Information Science, 21st Meeting of the International Linear Algebra Society (ILAS) Ames, IA, USA, July 24–28, 2017

42. *Hadamard diagonalizability and cubelike graphs*, Special Western Canada Linear Algebra Meeting, Banff International Research Station for Mathematical Innovation and Discovery (BIRS), Banff, AB, July 7–9, 2017

43. *Hadamard diagonalizable graphs with perfect state transfer*, Prairie Discrete Math Workshop, Lumsden, SK, June 2–5, 2017.

44. *Optimal bounds on fidelity of quantum state transfer with respect to errors*, Optimization Techniques in Quantum Information Theory Session, CMS Winter Meeting, Niagara Falls, ON, Dec. 2–5, 2016.

Contributed Talks

1. *Universality of Weyl Unitaries*, Great Plains Operator Theory Symposium (GPOTS) (virtual), May 10-14, 2021

2. *Operator-valued Lyapunov theorem*, Canadian Operator Symposium, University of Manitoba, Winnipeg, MB, June 4–8, 2018

A. Prymak

1. A. Arman, A. Bondarenko, A. Prymak, D. Radchenko, *Upper bounds on chromatic number of $\mathbb{E}^n$ in low dimensions*, pre-print.
`http://arxiv.org/abs/2112.13438`

2. A. Prymak, *Every 3-dimensional convex body can be covered by 14 smaller homothetic copies*, pre-print.
`http://arxiv.org/abs/2112.10698`

3. A. Bondarenko, A. Prymak, D. Radchenko, *Spherical coverings and X-raying convex bodies of constant width*, Canad. Math. Bull., 2021, 1–7, doi:10.4153/S0008439521001016.
`http://arxiv.org/abs/2011.06398`

4. F. Dai, A. Prymak, *L^p-Bernstein inequalities on C^2-domains*, Trans. Amer. Math. Soc., accepted on Aug. 23 2021.
`http://arxiv.org/abs/2010.06728`

5. A. Prymak, *Geometric computation of Christoffel functions on planar convex domains*, Journal of Approximation Theory, **268** (2021), 105603.
`http://arxiv.org/abs/2003.12833`

6. F. Dai, A. Prymak, A. Shadrin, V. Temlyakov, S. Tikhonov, *Entropy numbers and Marcinkiewicz-type discretization theorem*, Journal of Functional Analysis, **281** (2021), 109090, doi:10.1016/j.jfa.2021.109090.
http://arxiv.org/abs/2001.10636

7. F. Dai, A. Prymak, *On directional Whitney inequality*, Canadian Journal of Mathematics, 2021, 1–25, doi:10.4153/S0008414X21000110.
http://arxiv.org/abs/2010.08374

8. F. Dai, A. Prymak, A. Shadrin, V. Temlyakov, S. Tikhonov, *Sampling discretization of integral norms*, Constructive Approximation, **54** (2021), 455–471.
http://arxiv.org/abs/2001.09320

9. A. Prymak, V. Shepelska, *On the Hadwiger covering problem in low dimensions*, J. Geom. **111**:42 (2020), 1-11.
http://arxiv.org/abs/1811.08962

10. F. Dai, A. Prymak, V.N. Temlyakov, S. Tikhonov, *Integral norm discretization and related problems*, *Russ. Math. Surv.*, **74** (2019), 579–630. Translation from *Uspek hi Mat. Nauk*, **74**, Is. 4 (448) (2019), 3–58 [Russian].
http://arxiv.org/abs/1807.01353

11. A. Prymak, O. Usoltseva, *Pointwise behavior of Christoffel function on planar convex domains*, in: Topics in Classical and Modern Analysis, In Memory of Yingkang Hu, Birkhäuser, 2019, 293–302.
http://arxiv.org/abs/1709.10509

12. A. Prymak, O. Usoltseva, *Christoffel function on planar domains with piecewise smooth boundary*, Acta Math. Hungar., **158** (2019), no. 1, 216–234.
http://arxiv.org/abs/1809.09205

13. S. Brodiuk, N. Palko, A. Prymak, *On Banach-Mazur distance between planar convex bodies*, *Aequationes Math.*, **92** (2018), 993–1000.
http://arxiv.org/abs/1707.04830

14. A. V. Bondarenko, A. Mellit, A. Prymak, D. Radchenko, M. Viazovska, *There is no strongly regular graph with parameters (460,153,32,60)*, "Contemporary Computational Mathematics - a celebration of the 80th birthday of Ian Sloan" (J. Dick, F. Y. Kuo, H. Woźniakowski, eds.), Springer-Verlag (2018), 131–134.
http://arxiv.org/abs/1509.06286

15. A. Prymak, *Upper estimates of Christoffel function on convex domains*, *J. Math. Anal. Appl.*, **455** (2017), 1984–2000.
http://arxiv.org/abs/1704.03025

16. A. Bondarenko, A. Prymak, D. Radchenko, *Non-existence of (76,30,8,14) strongly regular graph*, *Linear Algebra and its Applications*, **527** (2017) 53–72.
http://arxiv.org/abs/1410.6748

S. Safi-Harb

Refereed Journal Papers

1. Arghajit, J., Hsiang-Kuang, C., Chatterjee, A., Naik, S., Safi-Harb, S., Monthly Notices of the Royal Astronomical Society, submitted

2. Filipovic, M. et al. (50 co-authors including Safi-Harb, S.), Monthly Notices of the Royal Astronomical Society, under revision

3. Ferrand, G., Tanikawa, A., Warren, D,, Nagatakai, S., Safi-Harb, S and Decourchelle, A. The Astrophysical Journal, under revision

4. Burgess, D. A., Mori, K., Gelfand, J. D., Hailey, C. J., Tokayer, Y. M., Woo, J., An, H., Malone, K., Reynolds, S. P., Safi-Harb, S. and Temim, T., The Astrophysical Journal, under revision

5. Boyce, M. M., Hopkins, A. M., Riggi, S., Rudnick, L., Ramsay, M., Hale, C. L., Marvil, J., Whiting, M., Venkataraman, P., O?Dea, C. P., Baum, S. A., Gordon, A., Vantyghem, A. N., Dionyssiou, M., Andernach, H., Collier, J. D., English, J., Koribalski, B. S., Leahy, D., Micha?owski, M. J., Safi-Harb, S., Vaccari, M., PASA, under revision

6. Gordon, Y. A., Boyce, M. M., O'Dea, C. P., Rudnick, L., Andernach, H., Vantyghem, A. N., Baum, S. A., Bui, J.-P., Dionyssiou, M., Safi-Harb, S., Sander, I. 2021, The Astrophysical Journal (Supplement Series), 255, 30

7. Blumer, H., Safi-Harb, S., Borghese, A., Martín, J., McLaughlin, M. A., Torres, D. F., Younes, G. 2021, The Astrophysical Journal, 917, 56

8. Blumer, H., Safi-Harb, S., McLaughlin, M. A., Fiore, W. 2021, The Astrophysical Journal (Letters), 911, L6

9. Gotthelf, E. V.; Safi-Harb, S.; Straal, S. M.; Gelfand, J. D. 2021, The Astrophysical Journal, 908, 212

10. Blumer, H., Safi-Harb, S. 2020, The Astrophysical Journal (Letters), 904, L19

11. Guest, B., Safi-Harb, S. 2020, Monthly Notices of the Royal Astronomical Society, 498, 821

12. Guest, B., Safi-Harb, S., MacMaster, A., Kothes, R., Olmi, B., Amato, E., Bucciantini, N. & Arzoumanian, Z. 2020, MNRAS, 491, 3013

13. Kothes, R., Reich, W., Safi-Harb, S., Guest, B., Reich, P., Fürst, E. 2020, Monthly Notices of the Royal Astronomical Society, 496, 723

14. Vieira, N., Ruan, J., Haggard, D., Drout, M., Nynka, M., Boyce, H., Spekkens, K., Safi-Harb, S., Carlberg, R. G., Fernandez, R., Piro, A., Afsariardchi, N., Moon, D. 2020, The Astrophysical Journal, 895, 96

15. M. Chernyakova, et al. (including Safi-Harb, S.) 2019, Astronomy & Astrophysics (A&A), 631, 177

16. Braun, C., Safi-Harb, S. & Fryer, C. 2019, MNRAS, 489, 4444

17. Zhou, P., Vink, J., Safi-Harb, S. & Miceli, M. 2019, A&A, 629, 51

18. Jones, S, Moller, H., Fryer, C., Fontes, C, Trappitsch, R., Even, W.; Couture, A., Mumpower, M. & Safi-Harb, S. 2019, MNRAS, 485, 4287

19. Blumer, H., Safi-Harb, S., Kothes, R., Rogers, A. & Gotthelf, E.V. 2019, MNRAS, 487, 5019

20. Safi-Harb, S., Doerksen, N., Rogers, A. & Fryer, C. 2019, JRASC, Feb. 2019 issue; arXiv:1812.11320

21. Guest, B., Safi-Harb, S., Tang, X. 2019, MNRAS, 482, 1031

22. Simionescu, A. et al. (including Safi-Harb, S.) 2018, MNRAS, 483, 1701

23. Hitomi Collaboration (including Safi-Harb) 2018, Publications of the Astronomical Society of Japan, 70, 113

24. Hitomi Collaboration (including Safi-Harb, S., Guest, B.) 2018, Publications of the Astronomical Society of Japan, 70, 38

25. MAGIC and HESS Collaboration (including Safi-Harb, S.) 2018, Astronomy & Astrophysics, 612, 14

26. H.E.S.S. Collaboration (including Safi-Harb, S.) 2018, Astronomy & Astrophysics, 612, 3

27. H. E. S. S. Collaboration (including Safi-Harb, S.) 2018, Astronomy & Astrophysics, 612, 1

28. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 17

29. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 16

30. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 15

31. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 14

32. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 13

33. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 12

34. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 11

35. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 10

36. Hitomi Collaboration (including Safi-Harb, S.) 2018, Publications of the Astronomical Society of Japan, 70, 9

37. Fryer, C. L., Andrews, S., Even, W., Heger, A., Safi-Harb, S. 2018, Astrophysical Journal, 856, 63

38. Hitomi Collaboration, including Safi-Harb 2017, *Nature*, 551, 478

39. Blumer, H., Safi-Harb, S., & McLaughlin, M. A. 2017, The Astrophysical Journal Letters, 850, L18

40. West, J. L., Jaffe, T., Ferrand, G., Safi-Harb, S.,& Gaensler, B. M. 2017, The Astrophysical Journal Letters, 849, L22

41. Hitomi Collaboration (including Safi-Harb, S.) 2017, The Astrophysical Journal Letters, 837, L15

42. Rogers, A. & Safi-Harb, S. 2017, MNRAS, 465, 383

43. West, J. L., Safi-Harb, S. & Ferrand, G. 2017, Astronomy & Astrophysics, 597, 121

44. Acero, F. et al. (including Safi-Harb, S.) 2017, The Astrophysical Journal, 840, 74

45. Hitomi Collaboration, including Safi-Harb, S. 2017, the Astrophysical Journal Letters, 837, L15

46. Rogers, A. 2017, MNRAS, 465, 2151

47. Miceli, M., Bamba, A., Orlando, S., Zhou, P., Safi-Harb, S., Chen, Y. & Bocchino, F. 2017, Astronomy & Astrophysics, 599, 45

48. Zhou, Ping, Chen, Yang, Safi-Harb, Samar, Zhou, Xin, Sun, Ming, Zhang, Zhi-Yu & Zhang, Gao-Yuan 2016, The Astrophysical Journal, 831, 192

49. Hitomi Collaboration, including Safi-Harb, S. 2016, *Nature*, 535, 117

50. Zhou, Ping, Chen, Yang, Zhang, Zhi-Yu, Li, Xiang-Dong, Safi-Harb, Samar, Zhou, Xin & Zhang, Xiao 2016, The Astrophysical Journal, 826, 34

51. Matheson, H., Safi-Harb, S. & Kothes, R. 2016, The Astrophysical Journal, 825, 134

52. Rogers, A. & Safi-Harb, S. 2016, MNRAS, 457, 1180

53. West, J. L., Safi-Harb, S., Jaffe, T., Kothes, R., Landecker, T. L., Foster, T. 2016, Astronomy & Astrophysics, 587, 148

54. Coti Zelati, F., Rea, N., Campana, S., De Martino, D., Papitto, A., Safi-Harb, S., Torres, D. F. 2016, MNRAS, 456, 1913

55. Bamba, Aya, Terada, Yukikatsu, Hewitt, John, Petre, Robert, Angelini, Lorella, Safi-Harb, Samar, Zhou, Ping, Bocchino, Fabrizio & Sawada, Makoto 2016, The Astrophysical Journal, 818, 63

Proceedings Papers and Circulars

56. Mori, K., An, H., Brugess, D., Capasso, M., Dingus, B., Gelfand, J., Hailey, C., Humensky, B., Malone, K., Mukherjee, R., Park, N., Pope, I., Reynolds, S. P., Safi-Harb, S., Woo, J.; Galactic TeV Collaboration 2021, The 37th International Cosmic Ray Conference (ICRC 2021), arXiv:2108.00557

57. Gordon, Y. A. ; Boyce, M. M. ; O'Dea, C. P. ; Rudnick, L. ; Andernach, H. ; Vantyghem, A. N. ; Baum, S. A. ; Bui, J. -P. ; Dionyssiou, M. ; Safi-Harb, S. search by orcid ; Sander, I. 2021, VizieR On-line Data Catalog: J/ApJS/255/30. Originally published in: 2021ApJS..255...30G

58. Furuya, R., Pattle, K., Coude, S., Ching, T., Mairs, S., Sadavoy, S., Scicluna, P., Soam, A., Eswaraiah, C., Safi-Harb, S. 2020, 2019 EAO Submillimetre Futures Paper Series, arXiv:2001.05753

59. CTA collaboration including Safi-Harb, S. 2020, arXiv:2007.16129

60. J. Ruan et al. 2019, GCN Circular 25492: LIGO/Virgo S190814bv: Optical non-detection of radio source AT2019osy from CFHT

61. J. Ruan et al. 2019, GCN Circular 25443: LIGO/Virgo S190814bv: a potential faint optical counterpart in CFHT imaging

62. Moumen, I., Robert, C., Devost, D., Rousseau-Nepton, L., Patnaude, D., Safi-Harb, S., Martin, R. P., Drissen, L., Martin, T. O 2019, arXiv:1909.00766 (2019)

63. Takahashi, T. et al. (for the Hitomi collaboration, including Safi-Harb, S.) 2018, Journal of Astronomical Telescopes, Instruments, and Systems, Volume 4, id. 021402

64. H.E.S.S. Collaboration, including Safi-Harb, S. 2018, VizieR Online Data Catalog: HESS Galactic supernova remnants (Hess+, 2018); VizieR On-line Data Catalog

65. Safi-Harb, S. 2017 (Invited Refereed Review), Journal of Physics: Conference Series, Vol. 932, Issue 1, article id. 012005; arXiv:1712.06040

66. Cherenkov Telescope Array Consortium: Acharya, B. S., et al. including Safi-Harb 2017, arXiv:1709.07997 (Astrophysics - Instrumentation and Methods for Astrophysics, Astrophysics - High Energy Astrophysical Phenomena, High Energy Physics - Experiment)

67. Cherenkov Telescope Array Consortium: Acero, F., Acharya, B. S., Acín Portella, V., et al. including Safi-Harb 2017, arXiv:1709.03483 (Index of Cherenkov Telescope Array conference proceedings at the ICRC2017, Busan, Korea)

68. Katsuda, S., Yamaguchi, H., Sawada, M., et al. including Safi-Harb 2017, 7 years of MAXI: monitoring X-ray Transients, held 5-7 December 2016 at RIKEN.

    AIP Conference Proceedings, Volume 1792, Issue 1, id.020015; 6th International Symposium on High Energy Gamma-Ray Astronomy

White Papers

- *Equity, Diversity and Inclusion and the Canadian Astronomical Society in the next decade* by Spekkens, K. et al., Canadian Long Range Plan for Astronomy & Astronomy (LRP2020), submitted (2019.10.18)

- *Colibrì Instrument* by Hoffman, K. et al., LRP2020, submitted (2019.09.30)

- *Colibrì Science* by Caiazzo, I. et al., LRP2020, submitted (2019.09.30)

- *The cosmic origin and evolution of the elements* by Fernandez, R., LRP2020, submitted (2019.09.30)

- *Canada's Role in Multi-Messenger Gravitational-Wave Discoveries* in the 2020's by Ruan, J. et al., LRP2020, submitted (2019.09.30)

- *Canadian Investigations of the ISM* by Hill, A. et al., LRP2020, submitted (2019.09.30)

- *Cosmic Magnetism* by West, J. L., LRP2020, submitted (2019.09.30)

- *DRAO ST* by Landecker, T. , LRP2020, submitted (2019.09.30)

- *NGVLA White Paper for LRP2020* By J. diFrancesco et al., LRP2020, submitted (2019.09.30)

- *The Square Kilometer Array: Final report to the LRP panel* for LRP2020 by Spekkens, K. et al., submitted (2019.09.30)

- *Magnetic field studies in the next decade* by Furuya, R. et al., EAO Submillimetre futures paper series, 2019, submitted (2019.09.30)

- *Exploring the physics of neutron stars with high-resolution, high-throughput X-ray spectroscopy* by Heyl, J., Caiazzo, I., Safi-Harb, S. et al. (plus 21 co-authors), Colibrì Astro2020 (US Decadal Survey for Astronomy & Astrophysics) white paper, 2019BAAS...51c.491H

- *Testing general relativity with accretion onto compact objects* by Caiazzo, I. et al. (23 co-authors), Colibrì Astro2020 white paper, 2019BAAS...51c.516C

- *High-Resolution X-ray Imaging Studies of Neutron Stars, Pulsar Wind Nebulae and Supernova Remnants*; by Safi-Harb, S., Amato, E., Gotthelf, E.V., Katsuda, S., Sasaki, M., Uchiyama, Y., Tsuji, N. & Guest, B. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019); 2019arXiv190406600S

- *Future X-ray Studies of Supernova Remnants*; by Williams, B. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019); 2019arXiv190405857W

- *Supernova Remnants in High Definition*; by Lopez, L. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019); 2019arXiv190405857W

- *Multi-Messenger Astrophysics SAG: Thermonuclear Supernovae*; by Zingale, M. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019)

- *MeV Emission from Pulsar Wind Nebulae: Understanding Extreme Particle Acceleration in Highly Relativistic Outflows*; by Gelfand, J. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019)

- *Exploring the physics of neutron stars with high-resolution, high-throughput X-ray spectroscopy*; by Heyl, J. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019); 2019arXiv190405857W

- *Testing general relativity with accretion onto compact objects*; by Caiazzo, I. et al. A white paper for the NAS Astro2020 Decadal Survey, submitted 11 March (2019); 2019arXiv190306760C

- *The Advanced Imaging X-ray Satellite: AXIS* by R. Mushotzky et al.. A Probe-class mission study commissioned by NASA for the National Academy of Science (NAS) Astro2020 Decadal Survey, submitted 11 March (2019) 2019arXiv190306760C

- Report for the CSA CASTOR science study, entitled *Prospects for CASTOR Studies of Supernova Remnants, Pulsar Wind Nebulae and Neutron Stars* by S. Safi-Harb, submitted 21 Feb (2019)

- *CSA's Topical team in High-Energy Astrophysics*. Canadian Scientific Priorities for the CSA Space Exploration Strategy. S. Safi-Harb acted as Chair of the Diffuse Emission sub-committee. Report submitted to the Canadian Space Agency in June (2017).

Conference Presentations

- *Zooming in on highly magnetized neutron stars - lessons learnt from PSR J1119–6127 and its environment* by Safi-Harb, S., oral presentation at IAU Symposium 363, 29 Nov (2021)

- Five presentations by students (Janette Suherli, Chelsea Braun, Brydyn Mac Intyre, Cole Treyturik, and collaborator Ismael Moumen) at CASCA 2021, online, June (2021)

- *Pulsar Wind Nebulae at High Energies* by Safi-Harb, S., COSPAR ASSEMBLY Sydney, Australia (online due to COVID-19), Jan-Feb (2021)

- *Colibri's eyes on neutron stars* by Safi-Harb, S., Heyl, J. Gallagher, S. and the Colibri collaboration, COSPAR ASSEMBLY, Sydney, Australia (online due to COVID-19), Jan-Feb (2021)

- *Accretion Physics with Colibri* by Gallagher, S., Heyl, J. Safi-Harb, S. and the Colibri collaboration; COSPAR ASSEMBLY to take place in Sydney, Australia (online due to COVID-19), Jan-Feb (2021)

- *The Colibri X-ray Telescope* by Heyl, J., Gallagher, S., Safi-Harb S. and the Colibri collaboration; COSPAR ASSEMBLY to take place in Sydney, Australia (online due to COVID-19), Jan-Feb (2021)

- *Radio/X-ray Synergy to study PWNe* by Kothes, R., Reich, W. & Safi-Harb, S., COSPAR ASSEMBLY to take place in Sydney, Australia (online due to COVID-19), Jan-Feb (2021)

- *Colibri: Taking the pulse of black holes and neutron stars* by Heyl, J. and the Colibri collaboration, SPIE AstronomicalTelescopes+Instrumentation Symposium, Yokohama (Japan), online due to COVID-19, Dec. (2020)

- *A New Version of SNRcat: the High Energy Catalogue of Supernova Remnants* by Safi-Harb, S., Ramsay, M., Ferrand, G. and West, J., CASCA 2020 (online, York Univ.), May (2020)

- *A New View of the Supernova Remnant Puppis A with VLT?s MUSE* CASCA2020 by Suherli, J., (PhD candidate), Vogt, F. & Safi-Harb, S., CASCA 2020 (online, York Univ.), May (2020)

- *Discovery of Variability from Pulsar Wind Nebulae Using Spectral Index Maps* by Guest, B. (PhD candidate), and Safi-Harb, S. CASCA 2020 (online, York Univ.), May (2020)

- *A Global Progenitor Study of Supernova Remnants Hosting Central Compact Objects: RCW 103 Associated with the Peculiar Source 1E 16134–5055* by Braun, C. (PhD candidate), Safi-Harb, S. & Fryer, C., CASCA 2020 (online, York Univ.), May (2020)

- Five undergraduate students presentations for the Canadian Undergraduate Physics Conference (CUPC, Nov. 2019), the UofM's posters competition (Oct. 2019) and the Faculty of Science poster competition (Aug. 2019). ' HQP: Austin MacMaster (NSERC USRA on GW170817), Neil Doerksen (FoS USRA on GW170817), Michael Ramsay (FoS USRA on the new version of SNRcat).

- Two WITP presentations by undergraduate students: Michael Ramsay (on SNRcat) and Austin MacMaster+Neil Doerksen (on GW170817), WITP symposium, U. of Winnipeg. Aug. 28 (2019)

- *Spectral Index Maps of Pulsar Wind Nebulae* by Ben Guest (PhD candidate), A. MacMaster (undergraduate student) & S. Safi-Harb, SUPERNOVA REMNANTS II: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *An X-ray Imaging and Spectroscopic Study of the Supernova Remnant RCW 103 Using Chandra and XMM-Newton*, by Chelsea Braun (PhD candidate), S. Safi-Harb and C. Fryer, SUPERNOVA REMNANTS II: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *A New Version of SNRcat: the High Energy Catalogue of Supernova Remnants* by S. Safi-Harb, Michael Ramsay (undergraduate), G. Ferrand and Jennifer West, SUPERNOVA REMNANTS II: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *The X-ray Evolution of the PWN in the SNR Kes 75*, by S. Safi-Harb, Eric V. Gotthelf, Yosi Gelfand and Samayra Straal, SUPERNOVA REMNANTS II: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *G182.5-4.0: A new supernova remnant near the Crab Nebula*, by Jennifer West, Roland Kothes and S.. Safi-Harb, SUPERNOVA REMNANTS II: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *Radioactive Isotopes in Core-Collapse Remnants*, Chris Fryer, Aimee Hungerford, Oleg Korobkin, Sam Jones, S. Safi-Harb, SUPERNOVA REMNANTS: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *O CEASAR: The Optical Catalogue of ExtrAgalactic Supernova Remnants* by I. Moumen, C. Robert, D. Devost, R. P. Martin, L. Rousseau-Nepton, D. Patnaude, S. Safi-Harb, L. Drissen, T. Martin, SUPERNOVA REMNANTS: AN ODYSSEY IN SPACE AFTER STELLAR DEATH, Chania, Crete, Greece, June 2–8 (2019)

- *Piercing the Veil: Using X-rays to Study the Supernova Remnant 3C397* by Cole Treyturik (undergraduate) & Safi-Harb, S., UofM Undergraduate Poster Competition, 25 Oct. (2018)

- *Particle acceleration in SNRs: from 3D simulations to X-ray observations* by Brock Kleppenstein (undergraduate), S. Safi-Harb & G. Ferrand, UofM Undergraduate Poster Competition, 25 Oct. (2018)

- *The University of Manitoba's High-Energy Catalogue of Supernova Remnants: What's New?* by Michael Ramsay (computer science co-op), S. Safi-Harb, G. Ferrand & J. West; the UofM Undergraduate Poster Competition, 25 Oct. (2018)

- *Mapping the Unreachable: Pulsar Wind Nebula 3C58* by Austin MacMaster (undergraduate, NSERC USRA), S. Safi-Harb & B. Guest, UofM Undergraduate Poster Competition, 25 Oct. (2018)

- *From Darkness, Light: GW170817* by Neil Doerksen (undergraduate), S. Safi-Harb & Rogers, A., UofM Undergraduate Poster Competition, 25 Oct. (2018)

- Thirteen presentations in 2018: CASCA (Victoria, 2 graduate students presentations), UofM Undergraduate Posters competition (5 undergrad presentations), Ireland (2 invited talks at summer school), Washington, D.C. (2 Invited talks), Waterloo (invited talk), Italy (Invited talk)

- *Neutron Stars–Supernova Remnants associations* by S. Safi-Harb, Riken, Japan, Nov. 7 (2017)

- UofM Undergraduate Poster Competition by Austin MacMaster (NSERC USRA), winner of the 3rd prize in the Natural Sciences Category, Oct. 13 (2017)

- *High-Energy (synergy with radio)* by S. Safi-Harb, Future of Canadian Radio Astronomy, McGill, Montreal, Sep. 13–14 (2017)

- *Neutron Stars: Observational Diversity and Evolution*, PNS2017 conference, St Petersburg, Russia, July 10–14 (2017)

- *Hitomi's Glimpse at Supernova Remnants' by Safi-Harb*, S., CASCA, Edmonton, May 29–June 1 (2017)

Invited Talks

- Astrophysics colloquium, University of Minnesota and Minnesota Institute for Astrophysics (online), 01 Oct. (2021)

- Astronomy colloquium, University of Amsterdam (online), 15 Sep. (2021)

- *Transitioning to University Life in Pursuit of Science: Barriers and Pathways to Indigenous Achievement*, Canadian Mathematical Society, June (2021)

- *Overview of Pulsar Wind Nebulae at High Energies*, Invited talk for COSPAR (Committee on Space Research) event E1.2, Sydney, Australia (online), 28 Jan.–04 Feb (2021)–virtual due to covid19

- *Neutron Stars as Drivers for Interdisciplinary Research, new X-ray missions and Multi-Messenger Astrophysics*, Frontier of High-Energy Astrophysics Workshop, Kavli IPMU, Japan, 16–18 Oct. (2019)

- *Where do the heavy elements really come from?*, Royal Astronomical Society, Spruce Woods Party, in Glenboro, MB, 01 Sep. (2019)
- *Neutron Star Mergers as Cosmic Mines of Heavy Elements*, American University of Beirut, 17 July (2019)
- *My Journey into Astrophysics*, American University of Beirut, 18 July (2019)
- *Probing the Physics of the Extreme with Supernovae and their Remnants*, Physics Colloquium at the New York University Abu Dhabi, 19 Dec. (2018)
- *Pulsar Wind Nebulae*, in Particle acceleration and Transport: From the Sun to Extragalactic Sources, Universite.lla Calabria in Rende (Italy), 12-16 Nov. (2018)
- *High-Energy and Supernova Surveys*, Canadian Wide Field Astronomy, Perimetre Institute, Waterloo, Canada, 10-12 Oct. (2018)
- *SuperNova Remnants at the end of 2020's* at the AXIS summer workshop entitled 'X-Ray Skies with High-Res Eyes: Imaging the Cosmos with AXIS', Carnegie Institute for Science, Washington D.C., Aug. (2018)
- *Supernova Remnants*, High-Energy Astrophysics Summer School, Dublin, Ireland, June (2018)
- *Neutron Stars and Supernovae: The Most Exotic Astrophysical Objects That Keep Surprising Us*, George Washington Frances E. Walker Colloquium, Washington, D.C., April (2018)
- *Neutron Stars–Supernova Remnants associations*; Workshop on 'The Theories of Astrophysical Big Bangs', Riken, Japan, Nov. 6–10 (2017)
- *Neutron stars: Observational diversity and evolution*; Physics of Neutron Stars conference celebrating 50 years since the discovery of neutron stars, ST Petersburg, Russia, July 10–14 (2017)
- *Supernova Remnants and Neutron Stars: an Astrophysical Laboratory for Probing the Physics of the Extreme*, B.C Tour: U. Victoria and TRIUMF colloquia, March 15–16 (2017)

Media, Public and EDI Outreach and Press Releases

- Participant to the Faculty of Science's Science Promotion Youtube Video, Fall 2021 (to be released in 2022)
- Participant to Alliance Francaise du Manitoba, Science Exposed, Contributed images, Fall (2021)
- Interviewed for the Astronomy Magazine, Oct 2021 issue, article entitled: 'Neutron stars: A cosmic gold mine– These exotic stars may hold the key to solving some of physics' greatest mysteries.' (2021)

- 'ASTRONOMERS CATCH A PULSAR WIND POWERED BY MAGNETAR OUTBURSTS', University of Manitoba and Western Virginia press releases, 04 Oct (2021)
- Speaker for the Wawatay summer session, July (2021)
- WISDOM EDI Panel entitled: 'Diversity in Science: Unscripted', Panelist, 30 June (2021)
- 'UM astronomer and former graduate student take close look at powerful new 'baby magnetar' in Sagittarius', New Magnetar press release, appeared in several media releases including space.com and cosmoquest, 23 Nov (2020)
- Innovation News Network, Health Europa: Article following an interview highlighting my astrophysics research in the UK-based Research Media magazine, featured as an Innovation News Story, 04 Sep. (2020)
- Equity, Diversity and Inclusion (EDI): Interview for an article about 'Women in Physics', by Ashley Okuwosa (Columbia U., New York) for The Delacorte Review, 20 Apr. (2020)
- Media and press coverage for Dr. James Peebles (Winnipeg-born and UofM Alumnus) having won the 2019 Nobel Prize in Physics; interviews for CBC, Winnipeg Free Press and City News (TV), 08 Oct. (2019)
- Café Scientifique presentation on 'Nature's elements 150 years later: From a list of parts, we are seeing the future!'; MacNally Robinson Cafe, 28 Nov. (2019)
- Royal Astronomical Society Meeting Spruce Woods Star Party, Public Talk on 'Where did all the heavy elements really come from?', 01 Sep (2019)
- Mentorship talk entitled 'My Journey into Astrophysics: The Fun and the Challenges', American University of Beirut, 18 July (2019)
- Pint of Science (POS) talk on gravitational waves astrophysics and the formation of the elements, Winnipeg, 20 May (2019)
- Girls in Science, roundtable discussion, UofM, 01 May (2019)
- School Visit; Reading about Space and a Space Activity for KG and Grade 2 kids; Whyte Ridge Elementary School, Winnipeg, 22 Feb (2019)
- *A kilonova in our neighbourhood: Not 'super', but still pretty good*: UofM news article about the gravitational wave event GW170817, Feb (2019)
- Interview with Science News, *Astronomers may have spotted the birth of a pulsar*, Sep. (2018)
- Diversity Panel at the Canadian Conference for Undergraduate Women in Physics, CCUWiP, Ottawa, 19–20 Jan. (2019)

- Several media interviews (CBC radio, CJOB, CJNU (Winnipeg), National Post Media (Toronto), Women of Influence, etc.) following the 2017 WXN Canada's Most Powerful Women Top 100 award (2017–2018)
- Discover your Future in Science Presentations, UofM, 08 Feb (2017) and 08 Feb (2018).
- How do Sun-like stars explode? Hitomi Mission Glimpses Cosmic Recipe for Nearby Universe, UofM/NASA/JAXA press releases, Nov (2017)
- Une recette cosmique pour un univers pres du notre, RCI Radio Canada, Nov. 18 (2017)
- Presentation for the CFI event attended by Minister of Science Kristy Duncan, UofM downtown campus, Oct 12 (2017)

Conference Organization

- Organizing committee member and Sloan conference proposal Co-I, Turtle Island Indigenous Science Conference to be hosted at the U. of Manitoba in 2022
- Chair, Women in Physics Canada Conference (WIPC), to be held at UofM, postponed due to COVID-19
- Scientific Organizing Committee, Gamma2020 postponed to 2022, International Symposium on gamma-ray astronomy to be held in Spain June (2022)
- Scientific Organizing Committee, IAU Symposium: Neutron Star Astrophysics at the Crossroads: Magnetars and the Multi-messenger revolution, virtual, Nov 29–Dec 3 (2021)
- Scientific Organizing Committee, The Future of Canadian Radio Astronomy, NRC's Herzberg, Penticton, B.C. (2019)
- Scientific Organizing Committee, High Energy Phenomena in Relativistic Outflows, Barcelona (Spain) 9–12 July (2019)
- Scientific Organizing Committee, Astrophysics of hot plasma in extended X-ray sources, Madrid (Spain) 12–14 June (2019)
- Scientific Organizing Committee member and session chair. Supernova Remnants: An Odyssey in Space after Stellar Death II, Crete, (Greece), June (2019)
- Scientific Organizing Committee, 'Future of Canadian Radio Astronomy', McGill, Montreal, Sep. (2017)
- Scientific Organizing Committee, International Astronomical Union (IAU) Symposium 331 on 'SN1987A, 30 years later', Reunion Island (France), Feb. (2017)

Astrophysics Missions science working groups

- Neutron Stars Science working group Lead for the Colibrì mission concept study, Canada's Flagship X-ray mission (2018–present)
- Science Working Group Member for NASA's AXIS Probe X-ray mission (2018–present)
- Science working group member for the proposed ESA's Athena X-ray mission (2015–present)
- Member of the Cherenkov Telescope Array (CTA) future gamma-ray mission (2014–present)
- Associate member of the H.E.S.S. gamma-ray collaboration (2011–present)
- Member of the Thirty Meter Telescope (TMT) International Science Development Team (2017–present)
- Member of the ASTRO-H/Hitomi X-ray mission; lead of SNR and Magnetars science (2011–2018)

Selected professional service activities

- NSERC Discovery Grants Physics Evaluation Group (2019–2022; 2021-2022: Group Chair)
- Canadian Astronomical Society's Vice-President (2020–2021)
- In 2021, refereed for the Astrophysical Journal, MNRAS, NSERC CRC, NASA ADAP program
- European Space Agency's Time Allocation Committee for the XMM-Newton Satellite (2020)
- Equity, Diversity and Community Lead for the Faculty of Science (2019–2021)
- NASA Senior Review for the Chandra X-ray Observatory (2018)
- CASCA Board of Directors (2018–2019)
- NRC's Covington Fellowship Search Committee (2018–2019)
- NRC's Gemini Assessment Point Committee (2018)
- Chair (2018) and member (multiple times), NASA/Chandra Peer Review Panel
- Chair (2018) and member (2015–2018), NRC Canadian Time Allocation Committee Galactic Panel
- Chair of the Canadian Space Agency's high-energy astrophysics Diffuse Emission Subcommittee (2015–2017)
- Member of NASA's Chandra Users Committee (2014–2017)

Recent recognition

Tier 1 Canada Research Chair in Extreme Astrophysics

E. Schippers

Publications

1. Schippers, E; and Staubach, W. *Scattering theory of harmonic one-forms on Riemann surfaces.* Submitted. arXiv:2112.00835

2. Schippers, E; and Staubach, W. *Analysis on quasidisks: a unified approach through transmission and jump problems.* To appear in European Mathematical Society Surveys in Mathematical Sciences. https://arxiv.org/abs/2009.01954

3. Schippers, E; Shirazi, M; and Staubach, W. *Schiffer operators and approximations on Riemann surfaces bordered by quasicircles.* J. Geom. Anal. **31** (2021), no. 6, 5877—5908.

4. Radnell, D; Schippers, E; Shirazi, M.; and Staubach, W. *Schiffer operators and computation of a determinant line in conformal field theory.* New York J. Math. **27** (2021), 253—271.

5. Schippers, E.; and Staubach, W. "Transmission of harmonic functions through quasicircles on compact Riemann surfaces". Annales Academiae Scientiarum Fennicae **45** (2020), 1111–1134

6. Schippers, E.; and Staubach, W.. "Plemelj-Sokhotski isomorphism for quasicircles in Riemann surfaces and the Schiffer operators". Mathematische Annalen **378** (2020), 1613–1653.

7. Radnell, D; Schippers, E; and Staubach, W. *Dirichlet spaces of domains bounded by quasicrcles.* Communications in Contemporary Mathematics **22** (2020), no. 3.

8. Radnell, D.; Schippers, E.; and Staubach, W. "A Model of the Teichmüller space of genus-zero bordered surfaces by period maps". Conformal Geometry and Dynamics **23** (2019), 32-51 arXiv:1710.06960

9. Schippers, E. "Conformal invariants associated with quadratic differentials". Israel J. of Math. **223** (2018), no. 1, 449–491.

10. Schippers, E.; Staubach, W. "Harmonic reflection in quasicircles and well-posedness of a Riemann-Hilbert problem on quasidisks.", Journal of Mathematical Analysis and Applications **448** (2) (2017), 864–884.

11. Schippers, E.; Staubach, W. "Well-posedness of a Riemann-Hilbert problem on d-regular quasidisks.", Annales Academiae Scientiarum Fennicae **42** (2017), 141–147.

12. Schippers, E.; Staubach, W. "Riemann boundary value problem on quasidisks, Faber isomorphism and Grunsky operator.", Complex Anal. Oper. Theory **12** (2018), no. 2, 325–354.

13. Radnell, D.; Schippers, E.; and Staubach, W. "Convergence of the Weil-Petersson metric on the Teichmueller space of bordered Riemann surfaces", Communications in Contemporary Mathematics **19**, No. 01, 1650025 (2017).

14. Radnell, D.; Schippers, E.; and Staubach, W. "Quasiconformal maps of bordered Riemann surfaces with L^2 Beltrami differentials." Jounal d'Analyse Mathematique **132** (1) (June 2017) 229–245.

Book Chapter

15. Schippers, E.; and Staubach, W. "Comparison moduli spaces of Riemann surfaces" New Trends and Open Problems in Complex Analysis and Dynamical Systems, 231–271, Trends Math., Birkhäuser/Springer, Cham, 2018.

Refereed Conference Proceedings

16. Radnell, D.; Schippers, E; Staubach, W. "Quasiconformal Teichmuller theory as an analytic foundation for two-dimensional conformal field theory." In 'Lie algebras, Vertex Operator Algebras and Related Topics'. eds Katrina Barron, Elizabeth Jurisich, Antun Milas, Kailash Misra. Contemporary Mathematics **695**, Amer. Math. Soc. (2017).

Research Presentations

17. Reading seminar on geometric quantization, Liouville, and related topics (online), Hausdorff Center for Mathematics Bonn University, July 2021.

18. Canadian Mathematical Society Summer Meeting (online), Session on Recent Advances in Complex Analysis and Applications, Ottawa, June 2021.

19. Analysis Seminar, Uppsala University, Uppsala, Sweden, May 2019.

20. American Mathematical Society Session on Complex Analysis and its Applications, Portland, Oregon, April 2018.

21. Uppsala University Mathematics Colloquium, May 2018.

22. Lie Groups/Quantum Mathematics Seminar, Rutgers University, February 2018.

23. University of Western Ontario analysis seminar, April 2017.

A. Shalchi

1. Shalchi, A., Perpendicular Diffusion of Energetic Particles: A Complete Analytical Theory, The Astrophysical Journal **923**, 209 (2021)

2. Shalchi, A., Field Line Random Walk in Magnetic Turbulence, Physics of Plasmas **28**, 120501 (2021)

3. Shalchi, A., Landau Damping of LangmuirWaves: An Alternative Derivation, Physics **3**, 940-954 (2021)

4. Shalchi, A., Subspace Approximation to the Cosmic Ray Fokker-Planck Equation with Perpendicular Diffusion, Astrophysics and Space Science **366**, 69 (2021)

5. Abdalla, H., . . . , Shalchi, A., et al., Sensitivity of the Cherenkov Telescope Array for probing cosmology and fundamental physics with gamma-ray propagation, Journal of Cosmology and Astroparticle Physics **2**, 48 (2021)

6. Acharyya, A., . . . , Shalchi, A., et al., Sensitivity of the Cherenkov Telescope Array to a dark matter signal from the Galactic centre, Journal of Cosmology and Astroparticle Physics **1**, 57 (2021)

7. Arendt, V. & Shalchi, A., Detailed Test-Particle Simulations of Energetic Particles Interacting with Magnetized Plasmas, I. Two-Component Turbulence, Advances of Space Research **66**, 2001-2023 (2020)

8. Shalchi, A., Heuristic Description of Perpendicular Particle Transport in Turbulence with Super-Diffusive Magnetic Field Lines, The Astrophysical Journal **898**, 2 (2020)

9. Shalchi, A. & Arendt, V., Distribution Functions of Energetic Particles Experiencing Compound Sub-Diffusion, The Astrophysical Journal **890**, 147 (2020)

10. Shalchi, A., Perpendicular Transport of Energetic Particles in Magnetic Turbulence, Space Science Reviews **216**, 23 (2020)

11. Shalchi, A., Heuristic Description of Perpendicular Transport, From the Sun's Atmosphere to the Edge of the Galaxy: A Story of Connections. 19th IGPP International Astrophysics Conference. American Institute of Physics Conference Proceedings **1620**, 012018 (2020)

12. Shalchi, A., Field Line Random Walk, Field Line Separation, and Particle Transport in Turbulence with Weak Transverse Complexity, Advances of Space Research **64**, 2426 (2019)

13. Shalchi, A., Heuristic Description of Perpendicular Diffusion of Energetic Particles in Astrophysical Plasmas, The Astrophysical Journal Letters **881**, L27 (2019)

14. Lasuik, J. & Shalchi, A., Subspace Approximations to the Cosmic Ray Fokker-Planck equation, Monthly Notices of the Royal Astronomical Society **485**, 1635 (2019)

15. Gammon, M., Heusen, M., & Shalchi, A., Comparison between test-particle simulations and test-particle theories for cosmic ray transport: III. Dynamical turbulence, Journal of Physics: Communications **3**, 015016 (2019)

16. Acharyya, A., . . . , Shalchi, A., et al., Monte Carlo studies for the optimisation of the Cherenkov Telescope Array layout, Astroparticle Physics **111**, 35 (2019)

17. Shalchi, A. & Gammon, M., Perturbation Theory Based Solution of the Pitch-Angle Dependent Cosmic Ray Diffusion Equation, Advances in Space Research **63**, 653 (2019)

18. Shalchi, A., Analytical forms of the cosmic ray perpendicular diffusion coefficient with implicit contribution of slab modes, Advances in Space Research **62**, 2817 (2018)

19. Shalchi, A., Analytical Description of the Time-dependent Perpendicular Transport of Energetic Particles, The Astrophysical Journal **864**, 155 (2018)

20. Arendt, V. & Shalchi, A., Time-dependent transport of energetic particles in magnetic turbulence: computer simulations versus analytical theory, Advances in Space Research **363**, 116 (2018)

21. Lasuik, J. & Shalchi, A., The influence of non-Gaussian distribution functions on the time-dependent perpendicular transport of energetic particles, Advances in Space Research **61**, 2827 (2018)

22. Shalchi, A., Analytical Forms of the First 14 Moments of the Cosmic Ray Fokker-Planck Equation, Journal of Plasma Physics **83**, 905830603 (2017)

23. Negrea, M., Petrisor, I., & Shalchi, A., Stochastic field-line wandering in magnetic turbulence with shear. II. Decorrelation trajectory method, Physics of Plasmas **24**, 112303 (2017)

24. Gammon, M. & Shalchi, A., Simple Analytical Forms of the Perpendicular Diffusion Coefficient for Two-Component Turbulence, III. Damping Model of Dynamical Turbulence, The Astrophysical Journal **847**, 118 (2017)

25. Lasuik, J. & Shalchi, A., Time-Dependent Perpendicular Transport of Energetic Particles for Different Turbulence Configurations and Parallel Transport Models, The Astrophysical Journal **847**, 9 (2017)

26. Lasuik, J. & Shalchi, A., Solutions of the Cosmic Ray Velocity Diffusion Equation, Advances in Space Research **60**, 1532 (2017)

27. Shalchi, A., Time-dependent perpendicular transport of energetic particles in magnetic turbulence with transverse complexity, Physics of Plasmas Letters **24**, 050702 (2017)

28. Heusen, M. & Shalchi, A., Numerical Test of Analytical Theories for Perpendicular Diffusion in Small Kubo Number Turbulence, The Astrophysical Journal **839**, 2 (2017)

29. Acero, F., . . . , Shalchi, A., et al., Prospects for Cherenkov Telescope Array Observations of the young supernova remnant RX J1713.7-3946, The Astrophysical Journal **840**, 74 (2017)

30. Lasuik, J., Fiege, J. D., & Shalchi, A., Numerical Analysis of the Fokker-Planck Equation with Adiabatic Focusing: Realistic Pitch-Angle Scattering, Advances in Space Research **59**, 722 (2017)

Khodr M. Shamseddine

Refereed Journal Publications

- On non-Archimedean valued fields: a survey of algebraic, topological and metric structures, analysis and applications, *Khodr Shamseddine and Angel Barria Comicheo*, Advances in Non-Archimedean Analysis and Applications - The p-adic Methodology, a special volume in **STEAM-H: Science, Technology, Engineering, Agriculture, Mathematics & Health**, 2021, pp. 207–252.

- Taylor's theorem, the inverse function theorem and the implicit function theorem for weakly locally uniformly differentiable functions on non-Archimedean spaces, *Khodr Shamseddine*, ***p*-Adic Numbers, Ultrametric Analysis, and Applications**, Volume 13 # 2, 2021, pp. 148–165.

- On computational applications of the Levi-Civita field, *Darren Flynn and Khodr Shamseddine*, **Journal of Computational and Applied Mathematics**, Volume 382, 2021.

- On the topological structure of the Hahn field and convergence of power series, *Darren Flynn and Khodr Shamseddine*, **Indagationes Mathematicae**, Volume 30 # 5, 2019, pp. 773-795.

- On Integrable Delta Functions on the Levi-Civita Field, *Darren Flynn and Khodr Shamseddine*, ***p*-Adic Numbers, Ultrametric Analysis, and Applications**, Volume 10 # 1, 2018, pp. 32-56.

- Positive operators on a free Banach space over the Levi-Civita field, *Jose Aguayo, Miguel Nova and Khodr Shamseddine*, ***p*-Adic Numbers, Ultrametric Analysis, and Applications**, Volume 9 # 2, 2017, pp. 122-137.

- A local mean value theorem for functions on non-Archimedean field extensions of the real numbers, *Khodr Shamseddine and Gidon Bookatz*, ***p*-Adic Numbers, Ultrametric Analysis, and Applications**, Volume 8 # 2, 2016, pp. 160-175.

Edited Proceedings

- Advances in Ultrametric Analysis, Proceedings of the Fourteenth International Conference on p-Adic Functional Analysis, *Alain Escassut, Cristina Perez-Garcia and Khodr Shamseddine, editors*, **Contemporary Mathematics, American Mathematical Society**, Volume 704, 2018, ISBN: 978-1-4704-3491-5.

Refereed Conference Proceedings

- On an operator theory on a Banach space of countable type over a Hahn field, *Khodr Shamseddine and Changying Ding*, Proceedings of the 11th ISAAC Congress (Växjö, Sweden, August 2017), **Analysis, Probability, Applications, and Computation**, 2019, pp. 267–282.

- Summary on non-Archimedean valued fields, *Angel Barria Comicheo and Khodr Shamseddine*, **Contemporary Mathematics, American Mathematical Society**, Volume 704 (Advances in Ultrametric Analysis), 2018, pp. 1-36.

- Calculus on a non-Archimedean field extension of the real numbers: inverse function theorem, intermediate value theorem and mean value theorem, *Gidon Bookatz and Khodr Shamseddine*, **Contemporary Mathematics, American Mathematical Society**, Volume 704 (Advances in Ultrametric Analysis), 2018, pp. 49-67.

- Measure theory and Lebesgue-like integration in two and three dimensions over the Levi-Civita field, *Khodr Shamseddine and Darren Flynn*, **Contemporary Mathematics, American Mathematical Society**, Volume 665 (Advances in Non-Archimedean Analysis), 2016, pp. 289- 325.

Invited Talks at Conferences

- On non-Archimedean valued fields: a survey of algebraic, topological and metric structures, analysis and applications, Eighth International Conference on p-adic Mathematical Physics and its Applications, an online conference, May 17-28, 2021.

- Calculus theorems for locally uniformly differentiable functions on a non-Archimedean ordered field extension of the real numbers, Seventh International Conference on p-adic Mathematical Physics and its Applications, Covilha, Portugal, September 30-October 4, 2019.

- One-variable and Multi-variable Integral Calculus over the Levi-Civita Field and Applications, Sixth International Conference on p-adic Mathematical Physics and its Applications, Mexico City, Mexico, October 23-27, 2017.

- On the Levi-Civita Fields: Introduction and Summary of Selected Recent Research, 11th Congress of the International Society for Analysis, its Applications and Computations (ISAAC), Växjö, Sweden, August 14-18, 2017.

Contributed Talks at Conferences

- Elements of an operator theory on the space c_0 over a non-Archimedean valued field, 46th Canadian Operator Symposium, University of Manitoba, June 4-8, 2018.

Seminars and Colloquia at Universities

- Department of Physics and Engineering Physics, University of Saskatchewan, March 9, 2021.

- Department of Physics and Astronomy and Winnipeg Institute for Theoretical Physics (joint colloquium), University of Manitoba, March 8, 2019.

- Department of Mathematics, Universidad de Concepcion, Concepcion, Chile, March 23, 2018.

- Department of Mathematics, American University of Beirut, Beirut, Lebanon, August 31, 2017.

Conference and Workshop Organization

- Member of the International Organizing Committee, Eighth International Conference on p-adic Mathematical Physics and its Applications, Online Conference (May 17-28, 2021)
- Member of the International Scientific Committee, 15th International Conference on p- Adic Functional Analysis, Poland (July 2020). This conference was postponed due to COVID-19.
- Member of the International Advisory Committee, Seventh International Conference on p-adic Mathematical Physics and its Applications, Portugal (September 2019)
- Member of the International Scientific Committee, NUMTA2019: Numerical Computations: Theory and Algorithms, Italy (June 2019)
- Co-Organizer, Winnipeg Institute of Theoretical Physics Summer Symposium, U of Manitoba (July 31-August 1, 2017)

J. Sirker

No update provided for this report

1. J. Sirker,
   "Physics at the nanoscale (Preface of special issue in Physica E",
   Editor: J. Sirker,
   Physica E **110** (2019).
2. J. Sirker,
   "Transport in one-dimensional integrable quantum systems",
   arXiv:1910.12155 (2019) [SciPost].
3. Y. Zhao, J. Sirker,
   "Logarithmic entanglement growth in two-dimensional disordered fermionic systems",
   Phys. Rev. B **100**, 014203 (2019).
4. F. Göhmann, K. K. Kozlowski, J. Sirker, J. Suzuki,
   "The equilibrium dynamics of the XX chain revisited", Phys. Rev. B **100**, 155428 (2019).
5. A. Naseri, S. Peng, W. Luo, J. Sirker,
   "Spin Vortices and Skyrmions of a Single Electron in Inhomogeneous Magnetic Fields",
   arXiv:1901.07149 (2019).
6. A. Urichuk, Y. Oez, A. Klümper, J. Sirker,
   "The spin Drude weight of the XXZ chain and generalized hydrodynamics",
   SciPost Phys. **6**, 005 (2019).

7. J. Sirker,
"Does a distinct quasi many-body localized phase exist? A numerical study of a translationally invariant system in the thermodynamic limit",
Phys. Rev. B **99**, 075162 (2019).

8. W. Luo, A. Naseri, J. Sirker, T. Chakraborty,
"Unique Spin Vortices in Quantum Dots with Spin-orbit Couplings",
Sci. Rep. **9**, 672 (2019).

9. N. Sedlmayr, P. Jaeger, M. Maiti, J. Sirker,
"A bulk-boundary correspondence for dynamical phase transitions in one-dimensional topological insulators and superconductors",
Phys. Rev. B **97**, 064304 (2018).

10. N. Sedlmayr, M. Fleischhauer, J. Sirker,
"The fate of dynamical phase transitions at finite temperatures and in open systems",
Phys. Rev. B **97**, 045147 (2018).

11. M. Kiefer-Emmanouilidis, J. Sirker,
"Current reversals and metastable states in the infinite Bose-Hubbard chain with local particle loss",
Phys. Rev. A **96**, 063625 (2017).

12. Y. Zhao, S. Ahmed, J. Sirker, "Localization of fermions in coupled chains with identical disorder", Phys. Rev. B **95**, 235152 (2017).

13. T. Enss, F. Andraschko, J. Sirker, "Many-body localization in infinite chains", Phys. Rev. B **95**, 045121 (2017).

Talks

14. 'Entanglement spreading in disordered low-dimensional quantum systems',
Theory Colloquium, University Kaiserslautern, November 2019

15. 'The Drude weight of the XXZ spin chain',
International Conference: 'Correlation days',
Max-Planck Institute Dresden, Germany, September 2019

16. 'The Drude weight of the XXZ spin chain',
XIth International Symposium: 'Quantum Theory and Symmetries (QTS)',
Centre de Recherches Mathematiques (CRM), Montreal, July 2019

17. 'Does a well-defined quasi many-body localized phase exist?',
American Physical Society: 'Annual meeting of the division of atomic, molecular and optical physics (DAMOP)',
Milwaukee, May 2019

18. 'Ergodicity and Thermalization in closed quantum systems',
Colloquium Dep. Of Physics & Astronomy,
UM, Winnipeg, December 2018

19. "Many-body localization in infinite chains",
SSPCM, Rzeszow, Poland, September 2018

20. "Transport from Integrability",
Les Houches Summer School, Lectures, September 2018

21. "The fate of dynamical phase transitions at finite temperatures and in open systems",
International Conference, Natal, Brazil, July 2018

22. "Many-body localization in infinite chains",
Theory seminar, NPU, Xi'an, June 2018

23. "Transport in integrable lattice models",
International workshop in honor of Ian Affleck, UBC, April 2018

24. "Low temperature dynamics of nonlinear Luttinger liquids",
Theory seminar, UBC, Vancouver, August 2017

25. "Many-body localization in infinite chains", Conference: Correlation days 2017, Dresden, Germany, September 2017.

26. "Low temperature dynamics of nonlinear Luttinger liquids", Theory seminar, UBC, July 2017.

27. "Low temperature dynamics of nonlinear Luttinger liquids", Theory seminar, Wuppertal University, May 2017.

28. "Low temperature dynamics of nonlinear Luttinger liquids", Theory seminar, FU Berlin, June 2017.

29. "Low temperature dynamics of nonlinear Luttinger liquids", Theory seminar, Marburg University, June 2017.

R.L. Stamps

Refereed Publications

1. R. Stamps. Probing a Mesoscopic Elephant. NATURE MATERIALS, 20(2):127–128, February 2021.

2. I. Proskurin and R. L. Stamps. Symmetry Approach to Chiral Optomagnonics in Antiferromagnetic Insulators. In Kamenetskii, E, editor, CHIRALITY, MAGNETISM AND MAGNETOELECTRICITY: SEPARATE PHENOMENA AND JOINT EFFECTS IN METAMATERIAL STRUCTURES, volume 138 of Topics in Applied Physics, pages 207–240. 2021.

3. I. Proskurin and R. L. Stamps. Level attraction and exceptional points in a resonant spin-orbit torque system. PHYSICAL REVIEW B, 103(19), MAY 7 2021.

4. V. M. Parakkat, G. M. Macauley, R. L. Stamps, and K. M. Krishnan. Configurable Artificial Spin Ice with Site-Specific Local Magnetic Fields. PHYSICAL REVIEW LETTERS, 126(1), JAN 7 2021.

5. R. Macedo, R. C. Holland, P. G. Baity, L. J. McLellan, K. L. Livesey, R. L. Stamps, M. P. Weides, and D. A. Bozhko. Electromagnetic Approach to Cavity Spintronics. PHYSICAL REVIEW APPLIED, 15(2), FEB 25 2021.

6. J. O. Iyaro, I. Proskurin, and R. L. Stamps. Collective dynamics of domain walls: An antiferromagnetic spin texture in an optical cavity. PHYSICAL REVIEW B, 104(18), NOV 15 2021.

7. S. H. Skjaervo, C. H. Marrows, R. L. Stamps, and L. J. Heyderman. Advances in artificial spin ice (vol 2, pg 13, 2020). NATURE REVIEWS PHYSICS, 2(2):117, FEB 2020.

8. R. Macedo and R. L. Stamps. Electromagnetic waves in canted magnets. Compendium On Electromag- netic Analysis-From Electrostatics To Photonics: Fundamentals And Applications For Physicists And Engineers (In 5 Volumes), page 231, 2020.

9. G. M. Macauley, G. W. Paterson, Y. Li, R. Macedo, S. McVitie, and R. L. Stamps. Tuning magnetic order with geometry: Thermalization and defects in two-dimensional artificial spin ices. PHYSICAL REVIEW B, 101(14), APR 2 2020.

10. G. Gubbiotti, M. Madami, F. Montoncello, Y. Li, and R. L. Stamps. Magnetic normal modes of nanopatterned magnets investigated by both wavevector-and space-resolved brillouin light scattering spectroscopy. Compendium On Electromagnetic Analysis-From Electrostatics To Photonics: Funda- mentals And Applications For Physicists And Engineers (In 5 Volumes), page 263, 2020.

11. L. Desplat, C. Vogler, J.-V. Kim, R. L. Stamps, and D. Suess. Path sampling for lifetimes of metastable magnetic skyrmions and direct comparison with kramers' method. Phys. Rev. B, 101:060403, Feb 2020.

12. B. W. Zingsem, M. Farle, R. L. Stamps, and R. E. Camley. Unusual nature of confined modes in a chiral system: Directional transport in standing waves. PHYSICAL REVIEW B, 99(21), JUN 20 2019.

13. M. Wyss, S. Gliga, D. Vasyukov, L. Ceccarelli, G. Romagnoli, J. Cui, A. Kleibert, R. L. Stamps, and M. Poggio. Stray-field imaging of a chiral artificial spin ice during magnetization reversal. ACS nano, 2019.

14. S. H. Skjærvø, C. H. Marrows, R. L. Stamps, and L. J. Heyderman. Advances in artificial spin ice. Nature Reviews Physics, pages 1–16, 2019.

15. I. Proskurin, R. Macedo, and R. L. Stamps. Microscopic origin of level attraction for a coupled magnon- photon system in a microwave cavity. NEW JOURNAL OF PHYSICS, 21, SEP 10 2019.

16. J. M. Porro, S. A. Morley, D. A. Venero, R. Macêdo, M. C. Rosamond, E. H. Linfield, R. L. Stamps, C. H. Marrows, and S. Langridge. Magnetization dynamics of weakly interacting sub-100 nm square artificial spin ices. Scientific reports, 9(1):1–11, 2019.

17. G. W. Paterson, G. M. Macauley, Y. Li, R. Macêdo, C. Ferguson, S. A. Morley, M. C. Rosamond, E. H. Linfield, C. H. Marrows, R. L. Stamps, et al. Heisenberg pseudo-exchange and emergent anisotropies in field-driven pinwheel artificial spin ice. Physical Review B, 100(17):174410, 2019.

18. Y. Li, G. W. Paterson, G. M. Macauley, F. S. Nascimento, C. Ferguson, S. A. Morley, M. C. Rosamond, E. H. Linfield, D. A. MacLaren, R. Macedo, C. H. Marrows, S. McVitie, and R. L. Stamps. Superferro- magnetism and Domain-Wall Topologies in Artificial "Pinwheel" Spin Ice. ACS NANO, 13(2):2213–2222, FEB 2019.

19. L. Desplat, J. Kim, V, and R. L. Stamps. Paths to annihilation of first- and second-order (anti)skyrmions via (anti)meron nucleation on the frustrated square lattice. PHYSICAL REVIEW B, 99(17), MAY 13 2019.

20. I. Proskurin, A. S. Ovchinnikov, J.-i. Kishine, and R. L. Stamps. Excitation of magnon spin photocurrents in antiferromagnetic insulators. PHYSICAL REVIEW B, 98, 2018.

21. I. Proskurin, A. S. Ovchinnikov, J.-i. Kishine, and R. L. Stamps. Cavity optomechanics of topological spin textures in magnetic insulators. PHYSICAL REVIEW B, 98, 2018.

22. R. Macedo, G. M. Macauley, F. S. Nascimento, and R. L. Stamps. Apparent ferromagnetism in the pinwheel artificial spin ice. PHYSICAL REVIEW B, 98, 2018.

23. R. Macedo, T. Dumelow, R. E. Camley, and R. L. Stamps. Oriented Asymmetric Wave Propagation and Refraction Bending in Hyperbolic Media. ACS PHOTONICS, 5:5086–5094, 2018.

24. M. Harder, Y. Yang, B. M. Yao, C. H. Yu, J. W. Rao, Y. S. Gui, R. L. Stamps, and C. M. Hu. Level Attraction Due to Dissipative Magnon-Photon Coupling. PHYSICAL REVIEW LETTERS, 121, 2018.

25. L. Desplat, D. Suess, J.-V. Kim, and R. L. Stamps. Thermal stability of metastable magnetic skyrmions: Entropic narrowing and significance of internal eigenmodes. PHYSICAL REVIEW B, 98, 2018.

26. J. P. Azpizau, S. Morley, D. A. Venero, R. Macedo, M. Rosamond, R. L. Stamps, C. H. Marrows, and S. Langridge. Magnetization dynamics of weakly interacting sub-100 nm square artificial spin ices. In 2018 IEEE INTERNATIONAL MAGNETIC CONFERENCE (INTERMAG), 2018.

27. M. C. Wheeler, F. Al Ma'Mari, M. Rogers, F. J. Goncalves, T. Moorsom, A. Brataas, R. Stamps, M. Ali, G. Burnell, B. J. Hickey, and O. Cespedes. Optical conversion of pure spin currents in hybrid molecular devices. Nature Communications, 8:926, 2017.

28. I. Proskurin, R. L. Stamps, A. S. Ovchinnikov, and J. Kishine. Spin-wave chirality and its manifestations in antiferromagnets. Physical Review Letters, 119:177202, 2017.

29. S. Morley, D. Alba Venero, J. Porro, S. Riley, A. Stein, P. Steadman, R. Stamps, S. Langridge, and C. Marrows. Vogel-fulcher-tammann freezing of a thermally fluctuating artificial spin ice probed by x-ray photon correlation spectroscopy. Physical Review B - Condensed Matter and Materials Physics, 95(10), 2017.

30. Y. Masaki and R. Stamps. Magnetic anisotropy and conical phase transition in monoaxial chiral magnets. Physical Review B - Condensed Matter and Materials Physics, 95(2), 2017.

31. Y. Li, G. Gubbiotti, F. Casoli, S. Morley, F. Gon?alves, M. Rosamond, E. Linfield, C. Marrows, S. McVi- tie, and R. Stamps. Thickness dependence of spin wave excitations in an artificial square spin ice-like geometry. Journal of Applied Physics, 121(10), 2017.

32. Y. Li, G. Gubbiotti, F. Casoli, F. Goncalves, S. Morley, M. Rosamond, E. Linfield, C. Marrows, S. McVi- tie, and R. Stamps. Brillouin light scattering study of magnetic-element normal modes in a square artificial spin ice geometry. Journal of Physics D: Applied Physics, 50:015003, 2017.

33. D. Laroze, P. Diaz, and R. L. Stamps. Scaling laws of dipolar magnetic systems at finite temperature. Physical Review B - Condensed Matter and Materials Physics, 95:104438, 2017.

34. F. Goncalves, T. Sogo, Y. Shimamoto, Y. Kousaka, J. Akimitsu, S. Nishihara, K. Inoue, D. Yoshizawa, M. Hagiwara, M. Mito, R. Stamps, I. Bostrem, V. Sinitsyn, A. Ovchinnikov, J. Kishine, and Y. Togawa. Collective resonant dynamics of the chiral spin soliton lattice in a monoaxial chiral magnetic crystal. Physical Review B - Condensed Matter and Materials Physics, 95(10), 2017.

35. F. Goncalves, G. Paterson, D. McGrouther, Y. Togawa, D. S. Schmool, and R. L. Stamps. Probing microwave fields and enabling in-situ experiments in a transmission electron microscope. Scientific Reports, 7:11064, 2017.

36. S. Gliga, G. Hrkac, C. Donnelly, J. Buchi, A. Kleibert, J. Cui, A. Farhan, E. Kirk, R. V. Chopdekar, Y. Masaki, N. S. Bingham, A. Scholl, R. L. Stamps, and L. J. Heyderman. Emergent dynamic chirality in a thermally driven artificial spin ratchet. Nature Materials, 16:1106, 2017.

37. A. Baker, M. Beg, G. Ashton, M. Albert, D. Chernyshenko, W. Wang, S. Zhang, M.-A. Bisotti, M. Franchin, C. Hu, R. Stamps, T. Hesjedal, and H. Fangohr. Proposal of a micromagnetic stan- dard problem for ferromagnetic resonance simulations. Journal of Magnetism and Magnetic Materials, 421:428–439, 2017.

B.W. Southern

Refereed Publications

1. A. Zelenskiy, T. L. Monchesky, M. L. Plumer, and B. W. Southern. "Anisotropic magnetic interactions in hexagonal AB-stacked kagome lattice structures: Application to Mn3X (X=Ge,Sn,Ga) compounds". Physical Review B. 103: 144401 (2021).

2. M. D. LeBlanc, A. A. Aczel, G. E. Granroth, B. W. Southern, J.-Q. Yan, S. E. Nagler, J. P. Whitehead, and M. L. Plumer, "'Impact of further-range exchange and cubic anisotropy on magnetic excitations in the fcc kagome antiferromagnet IrMn3"', Physical Review B. 104: 014427 (2021).

3. B. Alkadour, B.W. Southern, J.P. Whitehead and J. van Lierop. "Triangular array of gamma-Fe2O3 nanoparticles: A simulation study of intraparticle and interparticle magnetism", Physical Review B **100**, 094416 (2019)

4. A.R. Way, K.P.W. Hall, I. Saika-Voivod, M.L. Plumer and B.W. Southern, "Continuous degeneracy of the fcc lattice with magnetic dipolar interactions", Physical Review B **98**, 214417 (2018).

5. Bassel Alkadour, J.L. Mercer, J.P. Whitehead, B.W. Southern, and J. van Lierop, "Dipolar ferromagnetism in three-dimensional superlattices of nanoparticles", Physical Review B **95**, 214407 (2017).

6. Emrul Hasan and B.W. Southern, "Monte Carlo Study of a Geometrically Frustrated Rare Earth Compound: $SrGd_2O_4$", Physical Review B. **96**, 094407 (2017).

Conference Contributions

7. A.R. Way, K.P.M. Hall, M. Plumer, I. Saika-Voivodi and B.W Southern. "Continuous Degeneracy in Dipolar Magnets". Magnetic North, Gimli, Canada (2019).

8. Bassel Alkadour, B.W. Southern, J.P. Whitehead and J. van Lierop. "Triangular array of gamma- Fe2O3 nanoparticles: A simulation study of intra- and inter-particle magnetism". Magnetic North, Gimli, Canada (2019).

9. B. Alkadour, B.W. Southern, J.P. Whitehead and J. van Lierop. "Triangular array of gamma-Fe2O3 nanoparticles: A simulation study of intra- and inter-particle magnetism". Manitoba Institute of Materials Conference, Winnipeg, Canada (2019).

10. B. Alkadour, B.W. Southern, J.P. Whitehead and J. van Lierop. "Triangular array of gamma-Fe2O3 nanoparticles: A simulation study of intra- and inter-particle magnetism". Winnipeg Institute for Theoretical Physics Symposium, Winnipeg, Canada (2019).

11. Bassel Alkadour, Jason Mercer, Byron Southern, John Whitehead, Johan van Lierop, "Dipolar ferromagnetism in three dimensional superlattices of nanaoparticles: a micromagnetic simulation study of $\gamma - Fe_2O_3$ nanoparticles", Manitoba Institute of Materials, Winnipeg MB, Canada (2017).

12. Kyle Hall, Martin Plumer, Ivan Saika-Voivod, Byron Southern, "The 3D diploar Kagome lattice", Atlantic Universities Physics and Astronomy Conference, St. John's Nfld, Canada (2017).

13. Daniel Maciel and Byron Southern, "H-T Phase Diagram of the 3D Kagome Lattice", Manitoba Institute of Materials Conference, Winnipeg MB, Canada (2017).

14. Emrul Hasan and Byron Southern, "Monte Carlo Study of SrGd2O4", Manitoba Institute of Materials Conference, Winnipeg MB, Canada (2017).

J.P. Svenne

No update provided for this report

No Current Refereed Publications

G.C. Tabisz

No update provided for this report

No Current Refereed Publications

J.M. Vail

No update provided for this report

Last Refereed Publications

1. Vail, J. M., Hernandez, O.J., Si, M. and Wang, Z., "Graphene electronic structure in charge density waves", Journal of Materials Research, vol. 32, pp. 3294 - 3506 (2017).

M. Whitmore

No update provided for this report

J.G. Williams

1. T.A. Harriott and J.G. Williams, "Three-parameter solution for the null-surface formulation in 2+1 dimensions," in Proceedings of the 16th Marcel Grossmann Meeting on General Relativity, edited by M. Bianchi, R.T. Jantzen and R. Ruffini (World Scientific, Singapore), to appear (2022).

2. T.A. Harriott and J.G. Williams, "Petrov type-N solution for the null-surface formulation in 2+1 dimensions," General Relativity and Gravitation, **51**, 98 (2019).

3. T.A. Harriott and J.G. Williams, "Petrov type-N solution for the null-surface formulation of general relativity in 2+1 dimensions," 22nd International Conference on General Relativity and Gravitation. Valencia, Spain, 7–12 July 2019

4. T.A. Harriott and J.G. Williams, "Three-variable solution in the (2+1)-dimensional null-surface formulation," General Relativity and Gravitation, **50**, 39 (2018).

5. T.A. Harriott and J.G. Williams, "Solutions for the null-surface formulation of general relativity," in Proceedings of the 14th Marcel Grossmann Meeting on General Relativity, edited by M. Bianchi, R.T. Jantzen and R. Ruffini (World Scientific, Singapore), pp. 2525–2528 (2017).

4 Financial

4.1 Statement of Income and Expenditures

Income

Income Source	Amount
UWinnipeg Dean of Science & VP Research	$2000.00
UManitoba Dean of Science	$3000.00
Total Income	$5000.00

Expenditures

Activity	Amount Spent
DTP/WITP PhD Thesis Prize	$250
Quantum Information conference commitment	$500
Total Expenditures	$750

The income listed above represents commitments to WITP funding from the three major universities in Manitoba from which the WITP draws its members. For the five-year period 2018-19 to 2022-23, the University of Winnipeg has commited $2000 per annum and the University of Manitoba has committed $3000 per annum. Brandon University contributed $1000 in 2018-19.

In addition to the supporting funds indicated above, it should be pointed out that the members of the Institute use their individual NSERC discovery grants to subsidize Institute activities. As of 2016-17, the members from the three universities drew upon more than $700,000 per year of individual NSERC Research Grants. These funds have a significant fortifying effect on the level of activities in which we are able to engage.

The Institute has neither endowment nor trust fund support. The Institute has no significant space requirements. The occasional long term visitor requires a desk, but these needs have been accommodated by the space available to the physics departments at the member Universities. The host departments also supply occasional secretarial support such as that required for the preparation of seminar notices and research papers.

The WITP does not incur or depend on any fixed annual cost. Further, the purpose and the activities of the Institute are designed to ensure that virtually all funds go directly towards research, in the form of visitors, seminars, summer schools, etc. Since the WITP is a collection of theorists, we have no expensive equipment to maintain or technicians to employ, and there are virtually no no direct infrastructure costs. This allows the WITP to tailor its operations to match the level of funding it receives. However, in order for the WITP to create visibility for the theoretical physics community in Manitoba and in order to provide adequate training for our HQP, a certain minimum funding level is required as outlined below.

The following represents an estimated budget for WITP activities in the five-year period from 2018-19 to 2022-23. It is important to note that the most costly WITP activity, the visitor program, is primarily funded by Member research grants, and those funds are not included in the proposed budget. The following expenditures are for activities that fall outside the usual purview of a research grant and which are more properly and efficiently organized as a collective. In addition, a small fraction of WITP funding will be

used to supplement the visitor program by providing partial funding to extend the stay of some visitors or to make it possible for Members to extend an invitation.

An estimated annual budget for the current five-year period follows:

- Conference support: $1500

  Advertises theoretical physics in Manitoba throughout Canada, promotes research collaborations and dissemination of results, provides opportunity to recruit graduate students

  - Theory Canada conferences: $500
    Main annual conference for Canadian theoretical physics
  - National & international conferences held in Manitoba and surrounding region: $1000
    Average annual amount

- Summer School and Summer Symposium for graduate and undergraduate student researchers: $2500

  One of the most important tasks of the WITP is to provide support in the adequate training of HQP. Contrary to other areas in physics such as nuclear physics, there are no large national labs or large research collaborations where students would be exposed to broader cutting-edge research outside of what is done in the group of their supervisor. Furthermore, the percentage of faculty members working in theoretical physics is—at least at UM—much smaller than at most other U15 universities and also much smaller than the international average. This leads to a relative lack of advanced courses in theoretical physics. The WITP plays an important role in filling this gap by bringing together students from all three Manitoban universities. The annual summer school/summer symposium, in particular, provides lectures by world-leading scientists and the opportunity for our students to present their research to a larger community.

- Visitor Support: $1750

  The WITP visitor program is primarily funded by Members; this funding is to allow visits that individual Members may not otherwise be able to afford or to increase the length of time that visitors can stay in Manitoba.

- DTP/WITP P. R. Wallace PhD Thesis Prize: $250

Total: $6000 per annum

4.2 Financial Stability and Growth

The Institute has no substantial fixed costs and for this reason it is intrinsically stable. It can operate in a productive fashion at a variety of funding levels. All of the funds that the Institute receives are transformed directly into its research enhancing activities. The funds allocated to the Institute by the three universities in Manitoba are fortified by the individual NSERC research grants of members. This is a strong commitment to

the Institute by the Institute members. In view of its overall research productivity, in terms of published papers and supervised graduate students, its capacity for running very successful conferences and workshops, and the demonstrated ability to attract excellent short-term and long-term visiting scientists, the Institute is achieving its goals.

The WITP membership includes all of the theoretical physicists in the province. Hence its growth relies upon the Associate and Student Members that it can attract (i.e. graduate students, post- doctoral fellows, and research associates), along with occasional new faculty hires. Another area of potential growth is identifying new Permanent Members at UM, UW, and Brandon University among current faculty members in related fields. For example, experimental physicists who work closely with theorists may be candidate members, as may mathematicians whose research is closely related to mathematical physics. The WITP has recently added members that fit these criteria; for example, three colleagues from the Department of Mathematics at U of M became permanent members of WITP in 2015.

The report guidelines suggest that some indication be given of the percentage of time that members spend on Institute research. Since the Institute's programs enhance the ongoing research interests of its members, there is no distinction between individual research and Institute research. The director has spent less than 5% of his time with the administrative aspects of the Institute.

1 Appendix: Research Interests of Members

M.E. Alexander

My principal research interests are:

Dynamics of exoplanet systems. (1) (Manuscript in preparation) Collaborating with with Dr. E. Budding (Carter O bservatory, Wellington, New Zealand), a theoretical model to explain anomalies i n photometric and spectroscopic measurements of exoplanet transits in several s ystems, using data primarily from the Kepler mission. The model has been develop ed to include interaction of the normal mode oscillations of a rotating host sta r with an orbiting exoplanet, without assuming alignment of the rotation and orb ital axes (as has been the case in the literature). Rotational-orbital motion in teraction causing resonance effects give rise to significant orbital precession and nutation. The effects, which occur mainly in exoplanetary systems hosted by early-type stars, are at the limit of detectability by the Kepler mission data, but may well be within reach of modern missions, such as TESS and Webb space tel escopes. These interactions have been shown to be dynamically complex: initial a nalyses and numerical experiments indicate the resonance-induced orbital precess ion effects are comparable to "classical" (rotation-distortion induced) preces sion. Observational data of systems with unaligned rotation and orbital axes are becoming more plentiful and accurate, and the predictions of this paper will s oon be within reach of modern exoplanet system measurements. This work is an ext ension of much earlier work, published in 2 papers in Monthly Notices of the Roy al Astronomical Society (1987-1988).

(2) **Effects of stellar winds on orbital period changes in sdOB-type binary systems**. In collaboration with Dr. D. Kilkenny (Univ. Western Cape, South Africa) and Dr. A.E. Lynas-Gray (Univ. College London, UK), we are developing a model for stellar winds in subdwarf B-type binary systems, in order to explain observational data on orbital period changes in these systems. This work is and a continuation of a project on the effects of stellar winds arising from the late-type secondary in these systems caused by irradiation by the hot subdwarf primary component. We are attempting to model the interaction of the wind with the magnetic field of the secondary, to try to explain the observed period changes in these systems, several of which cannot be explained by other mechanisms (e.g., Applegate mechanism, exoplanets, gravitational radiation). A simple model has previously been derived, but a more comprehensive one is under investigation.

P.G. Blunden

The objective underlying my research program is understanding the fundamental properties of nucleons and nuclei through electromagnetic and electroweak interactions.

In the electromagnetic sector, calculations of two-photon exchange (TPE) radiative corrections have been instrumental in resolving the discrepancy between measurements of electron-nucleon scattering form factors using Rosenbluth and polarization-transfer techniques. Pioneering calculations by our group have focussed on a hadronic approach

to evaluating the model-dependent TPE amplitudes, including the contribution of nucleon resonances.

Precision low-energy experiments in atomic parity-violation and in parity-violating electron-proton scattering are a vital complement to direct tests of the Standard Model. They also give information about the structure of the proton, such as its weak charge and strangeness content. These low-energy measurements have the potential to give constraints on new physics, provided that the critical radiative corrections involving hadronic contributions are understood.

A major component of my research is aimed at unravelling these hadronic contributions and their associated uncertainties. Complementary to the TPE program, electroweak radiative corrections from two-boson exchange involve physics on both low-energy hadronic (resonance region) and high-energy (deep inelastic and Regge region) scales. A significant advance by our group in recent years is to reduce the uncertainties associated with the model-dependence of these contributions by using dispersion relations based on structure function data. In addition to atomic parity-violation and the weak charge of the proton, this work is significant for a new generation of upcoming precision experiments utilizing parity- violating electron scattering.

M.E. Carrington

My main area of interest is field theory. There are standard techniques for doing field theoretic calculations in systems that are weakly coupled and equilibrated, but these methods are not applicable to many physically interesting situations. I am particlularly interested in the study of quark-gluon plasmas, and strongly coupled condensed matter systems like graphene.

Non-perturbative field theoretic approaches are technically difficult to implement, and often involve issues with renormalizability and gauge invariance. One approach is the use of nPI effective actions which, in principle, can be used arbitrarily far from equilibrium. One of the main thrusts of my research is developing methods to renormalize nPI effective actions. I am also working to understand the gauge dependence of the method in lower dimensional theories.

Systems that are close to equilibrium can be studied using transport theory, which uses a linear response approximation to study the transport of conserved quantities over distances that are long compared to the microscopic relaxation scales of the system via long wavelength collective modes. The dynamics of quark-gluon plasmas is strongly influenced by imaginary modes, or plasma instabilities, which are not included in traditional formulations of transport theory. Another direction of my research is the development of methods to incorporate the role of plasma instabilities in transport theory.

I am also interested in the glasma phase of the matter produced in heavy ion collisions. This phase is the most difficult to study, and the least well understood of the phases of matter produced in a heavy ion collision. A good understanding of the glasma phase is crucial however, because the glasma provides the initial conditions for the long-lasting hydrodynamically evolving phase that follows. I am working to develop methods to apply the Colour Glass Condensate approach to study the temporal evolution of the glasma phase.

J.D. Fiege

My research program involves three areas of astrophysics, plus an interdisciplinary project in medical physics. The common thread of this research is the application of sophisticated optimization methods solve very large multi objective optimization problems or to mode data. The various components of this research program are enumerated below.

1. Gravitational lens modeling: Gravitational lens systems probe the structure of dark matter haloes, while also using these systems as natural telescopes to study distant extra galactic sources. My Ph.D. student Adam Rogers and I have developed new and very efficient methods to explore and reconstruct the lens density profile and background source in gravitational lens systems, leading to the largest lens reconstructions in the literature.

2. Polarization modeling: Submillimetre polarization mapping is the best observational technique to study magnetic fields in molecular cloud cores. My M.Sc. student Erica Franzmann and I have developed a modeling technique to simultaneously constrain the density structure and magnetic field geometry in cores and filaments. We are providing theoretical support to two international surveys (JCMT Gould's Belt survey and a CARMA polarization survey).

3. I develop a code called "GalAPAGOS" (Galaxy Parameter Aquisition by Genetic Optimization Software), which uses a genetic algorithm to constrain the kinematics of rotating neutral hydrogen (HI) disks in galaxies by modeling their HI data cubes.

4. I collaborate with Boyd McCurdy on the development of a code called PARETO, as part of unique interdisciplinary project in medical physics, which applies optimization methods to treatment planning in cancer radiotherapy. PARETO is the first software package to use a multi objective GA (Ferret) to simultaneously optimize radiation beam orientations and fluence patterns by solving a large scale, monolithic, multi objective optimization problem.

A. R. Frey

I have a wide range of interests in high-energy theoretical physics, encompassing topics from particle physics phenomenology to formal string theory.

One focus of my research is developing a deeper understanding of models of extra dimensions in string theory that have been discovered in the last 20 years. Specifically, I study the relationship of the full 10-dimensional theory to the effective 4-dimensional physics we would observe. I have carried out the first derivations of 4D quantities from the 10D theory for modern models of extra dimensions; in addition, I am interested in understanding the 10D origins of various contributions to the 4D potential energy that have mostly been considered from the perspective of the 4D effective theory only (specifically including curvature, brane tensions, and gaugino condensation). This is a particularly active area in the literature due to questions about whether de Sitter spacetimes — the basic model for the late-time behavior of our universe — exist in string theory (or any theory of quantum gravity).

A major thread of my research program concerns the AdS/CFT correspondence and its generalizations, which state that a gravitational system (such as string theory) on anti-de Sitter or similar spacetimes is equivalent to a quantum field theory without gravity on

the boundary of that spacetime. I currently have an active program understanding how the gravity side of the correspondence represents information theoretic quantities from the quantum field theory. I am especially interested in complexity, which, roughly speaking, measures the difficulty of creating the quantum field theory state, and how it maps to the full higher-dimensional description of AdS/CFT in string theory. I am further interested in developing connections to de Sitter spacetime and string compactifications.

In the recent past, I have also investigated when small amounts of matter in AdS collapse and form a black hole, which relates to non-equilibrium dynamics of strongly coupled gauge theories, and I am still working on related questions. I am interested in strongly coupled theories more generally and am also collaborating with Margaret Carrington on other nonperturbative approaches to these theories.

Finally, I maintain a long-standing interest in uncovering the nature of dark matter, yet-to-be-discovered particles known only by their influence on gravity, particularly phenomenological models to explain anomalies in astroparticle physics.

T.D. Fugleberg

My current research interests are in three main areas.

The first is the study of a novel form of superconductivity called colour superconductivity. This is the study of a new state of matter - the colour superconducting state - which may be present in neutron and/or quark stars with consequences detectable in astronomical observations. The colour superconducting state arises in the theory of the strong nuclear force, Quantum Chromodynamics, (QCD). I have looked at refining models used in this analysis to include the physical masses of the quarks and other degrees of freedom in as complete a way as possible in order to make definitive quantitative predictions for observation. This research involves free colour charge and is thus related to the main unsolved problem of QCD - colour confinement.

The second area is non-equilibrium and thermal field theory. Both of these topics have important applications in the physics of the early universe and in heavy ion collisions. I am developing techniques for simplifying calculations in the real time formalism of thermal field theory. Non-equilibrium field theory is still in its infancy but has important implications in the search for the quark gluon plasma and the evolution of the universe immediately following the big bang.

The third area of research is in the area of quantum computation. A computer designed to utilize quantum mechanical indeterminacy in the computation process will theoretically be capable of solving difficult problems much more rapidly than a classical computer. This has important implications since international monetary security depends on cryptographic systems based on the fact that certain problems are "too hard" to solve in a reasonable amount of time. Since very simple quantum computers have already been constructed, quantum computation is a very important field of research. In particular I have been studying a particular model of quantum computation - adiabatic quantum computation - with the goal of gaining insight into the fundamental physical quantity or quantities responsible for the power of a quantum computer.

D. Krepski

Research interests: symplectic geometry, algebraic topology, Lie groups and groupoids, Hamiltonian actions, momentum maps, geometric quantization, Verlinde algebra.

G. Kunstatter

In February of 2016, the LIGO (Light Interference Gravitational wave Observatory) Scientific Collaboration announced the detection of gravitational waves emitted by the merger of two massive black holes a billion years ago. This observation provided astounding confirmation of the validity of Einstein's theory of gravity in the strong field region as well as the first direct evidence for the existence of black holes.

According to Einstein's theory, at the center of every black hole there exists a "singularity", a region of infinite density and curvature, where the known laws of physics break down. Such singularities do not pose a threat as long as they are concealed beneath the event horizon of a black hole. In the mid 1970's Stephen Hawking showed that quantum processes near the event horizon allow energy to leak out in the form of thermal radiation. This radiation causes the black hole to shrink and eventually disappear without revealing any information about the matter that fell into the black hole. Consequently black holes appear to have the capacity to irreversibly destroy information, leading to the so-called "black hole information loss conundrum". It is commonly believed that the information loss conundrum can only be fully resolved once quantum mechanics is successfully unified with gravitation theory, something that has eluded theoretical physicists for many decades.

My research for the past few years has focussed on simple models of black formation and evaporation in which the singularity has been eliminated, ostensibly by quantum gravitational effects. Recently, collaborators and I constructed a new and powerful model well suited for this purpose. I am currently investigating in detail the implications of this model for the information loss conundrum. This research will move us closer to the resolution of a long standing, fundamental problem in theoretical physics.

P.D. Loly

A new project started in September 2016 has just been submitted to arXiv: 'Powers of doubly-affine square matrices with one non-zero eigenvalue' with Ian Cameron and Adam Rogers. While I identified 1EV magic squares more than a decade ago (see LAA2009), a colleague in Argentina drew my attention to this issue via a reference to a paper in the Fibonacci Quarterly. This arXiv will be followed shortly by another: 'Compounding Doubly Affine Matrices', by Rogers, Cameron and myself, which completes a study begun in 2004 for multiplying-up smaller Latin or magic squares to larger ones of multiplicative order. Combining results from the latter paper enables 'Powers' to generate 1EV square matrices to orders which are any multiples of orders 4,5 and 8. Next I plan to finish a project with Cameron on extending Frierson's algebraic compounding of the sole order 3 magic to orders 3^n, first presented in 2009 at Can. Math. Soc. in Windsor. These papers all make use of my 'singular value clan' concept given in 'Signatura of Magic and

Latin Integer Squares: Isentropic Clans and Indexing', by Cameron. Rogers and Loly, in Discussiones Mathamaticae : Probability and Statistics, 33 (2013) 121-149.

Website: `http://home.cc.umanitoba.ca/~loly/`

E. McDonough

My research develops the interface of cosmology and high energy physics. Taking input from quantum field theory, supergravity, and string theory, I strive to understand the relation between cosmological observables, such as the cosmic microwave background and large scale structure of the universe, and the underlying fundamental theory.

I have worked extensively on a proposal for the earliest moments of the universe, namely cosmic inflation, wherein the universe underwent a phase of exponential expansion. I am particularly interested in the implications for high energy of an observation or non-observations of primordial gravitational waves, encoded in the polarization of the cosmic microwave background. With Guth and Kaiser (2021) I demonstrated that the observable predictions of one of simplest models of inflation, namely axion inflation, can be significantly modified if the radial counterpart to the axion (itself the phase of a complex scalar) is evolving during inflation. In work with Scalisi (2016) I developed new models of inflation in supergravity, and in work with Kolb and Long (2021) studied the spontaneous emission of gravitinos (the partner to the graviton in supergravity) that occurs in the transition from inflation to standard cosmology. In work with Alexander (2018) we demonstrated that the primordial gravitational wave signal from inflation in string theory can be substantially larger than the naive single-field expectation.

I am very active in the study of dark matter, and in particular "ultra-light" dark matter candidates. These models are characterized by wave-like behavior on astrophysical scales, and phenomena usually associated with condensed matter physics, such as Bose-Einstein condensation, superfluidity, and superconductivity. In papers with Spergel and Alexander (2018 and 2021) we developed ultra-light dark matter as a composite state in non-Abelian gauge theory, and superconductivity in astrophysical environments. This broad class of models can be distinguished from more conventional particle dark matter models (such as WIMP models) in a variety of experimental arenas, ranging from particle colliders to astrophysical observations. In recent work with Cappanelli, Ferreira, and Alexander, we proposed dark matter vortices as an explanation for the coherent rotation of cosmic filaments, some of the largest structures in the universe. I am active in studying new models and new astrophysical phenomena of ultralight dark matter.

Finally, I am active in understanding the apparent disagreement between cosmological data sets that probe differing epochs in the evolution of the universe. The cosmic microwave background allows an inference of the present expansion rate of the universe, namely the Hubble constant, that relies almost exclusively on early universe physics. However the CMB inferred value is in significant disagreement with the measurement using the cosmic distance ladder (winner of the 2011 Nobel prize in physics for the discovery of the accelerated expansion of the universe) which relies solely on late universe physics. An open question is whether there exists an alternative cosmological model, wherein the CMB inferred value is changed, and brought into agreement with the cosmic distance ladder measurement. In several papers with collaborators I have performed statistical analyses

of cosmological data sets to constrain field theory models, and have developed new models motivated by string theory. I am interested in developing new models that take input from fundamental theory, and can explain additional phenomena, such as particle physics anomalies.

C. O'Dea

My research is centered on investigating how super massive Black Holes influence their host galaxies, and how the galaxies influence the properties of the Black Hole in turn. We now know that massive black holes form as part of the process of galaxy formation with about 0.1% of the mass of the galaxy going into the central black hole. Whenever gas in the galaxy is able to penetrate down to the vicinity of the black hole large amounts of energy are released. A bright disk of gas (accretion disk) can form if the amount of gas is sufficiently high. In addition, in some cases outflows (jets) of hot plasma and magnetic fields are ejected at velocities approaching the speed of light carrying large amounts of energy. These outflows emit at radio wavelengths - hence the name "radio source". Galaxies in which the black hole and accretion disk are generating radiation and/or a powerful outflow are called Active Galactic Nuclei. I investigate the process of providing gas to the black hole, the formation of the jets, the propagation of the radio source and the interaction of the radio source with the environment. The transfer of energy from the radio source to the environment turns out to provide the solution to a number of outstanding problems in galaxy formation and clusters of galaxies.

S. Plosker

My research interests fall under the general umbrella of operator theory and matrix analysis, with applications to quantum information theory. Quantum information theory is the study of quantum properties that can be used to store, transmit, and process information in an efficient, accurate, and secure way. My approach is to build up the mathematical foundations for physical realizations in quantum mechanics through operator theory and matrix algebra techniques with the end goal of advancing the mathematics behind quantum information theory. My current focus is on quantum coherence, positive operator valued measures (POVMs), quantum fidelity (probability of state transfer), and various generalizations of majorization as they pertain to entanglement transformations and other problems in quantum information theory.

A. Prymak

Research interests: Approximation theory and geometric methods in analysis, shape-preserving approximation, measures of smoothness and approximation, convexity, packing and covering in Euclidean spaces, computational and numerical methods, some problems in quantum information theory (perfect state transfer, mutually unbiased bases).

S. Safi-Harb

My research is focused on the study of supernova remnants (SNRs) and associated phenomena. These include neutron stars, pulsar wind nebulae, the interaction of these objects with the interstellar medium, and the acceleration of cosmic rays at supernova shocks. The science goals of my research program are targeted to understand the aftermath of a supernova explosion, the growing diversity of neutron stars (including magnetars), their relativistic outflows and magnetic field evolution, their evolution and interaction with their hosting supernova remnant shells, nucleosynthesis, and the acceleration of cosmic rays to extremely high energies. My program makes use of multi-wavelength observations from radio to very high-energies, with focus on X-ray data acquired with NASA's Chandra and NuSTAR and ESA's XMM-Newton satellites, combined with modelling. I played a leadership role on the international, JAXA-led, ASTRO-H (renamed to Hitomi) X-ray satellite, serve on the science team for the future ESA-led ATHENA X-ray mission, and currently lead the neutron stars' science working group for the first Canadian X-ray telescope (Colibri) concept study approved by CSA in Sep. 2018. In radio, I serve on the ACURA Advisory Committee for the Square Kilometre Array (SKA). In optical, I was selected for the TMT International Science Development Team for the Milky Way & Nearby Galaxies. At gamma-ray energies, I am an associate member of the currently operating H.E.S.S. mission and a member of the upcoming Cherenkov Telescope Facility (CTA). My team also includes numericists/theorists/computer scientists developing models to interpret and catalogue data, performing state-of-the-art numerical simulations to apply to data, and making use of a local CFI-funded computing cluster. Lastly, with the latest LIGO discovery of the Gravitational Wave Neutron Stars Merger event (aka kilonova), my research is branching out into this new direction.

E. Schippers

My research interests are in three areas of pure mathematics: complex analysis, Teichmuller theory, and conformal field theory. A unifying theme is the construction and investigation of conformal invariants. These appear in the three fields in very different forms. My work over the next few years will unify these different forms.

Conformal field theory: My work relates to a programme of finding a rigorous mathematical construction of two-dimensional conformal field theory. This programme has been active since the 80s and relates to many disparate branches of mathematics, including representation theory of Lie algebras and vertex operator algebras, so-called monstrous moonshine and modularity, moduli spaces of Riemann surfaces, and stochastic processes.

Friedan/Shenker and Vafa considered moduli spaces of Riemann surfaces with extra data, formulated either as boundary parametrizations or collections of non-overlapping mappings. With David Radnell, I showed that this moduli space is in fact the quasiconformal Teichmuller space. This allowed the resolution of certain analytic problems in the programme of construction of 2D conformal field theory: for example, we showed that the moduli space has a complex structure and the sewing operation is holomorphic. In further work with W. Staubach, we constructed a Teichmuller space modelled on square-integrable local deformations, which we conjecture to be the correct space for the existence

of a determinant line bundle of dbar operators with boundary data, which is central to the construction of CFT from moduli spaces of Riemann surfaces.

Future projects include the demonstration of the convergence of the determinant of the operators over the refined space, and drawing connections with classical objects of complex function theory. This will lead to new algebraic and geometric structure in function theory, as well as making function theoretic techniques newly available for the CFT programme.

Teichmuller theory: I also work on applying ideas of conformal field theory to Teichmuller theory.The problem of refinement of Teichmuller space to a smaller space appropriate for conformal field theory was decribed above. It also has implications for Teichmuller theory. Namely, this is precisely the space on which the so-called Weil-Petersson metric converges. The Weil-Petersson metric is a main tool in the investigation of Teichmuller spaces, but until recently has only been available for finite-dimensional Teichmuller spaces. Work of Takhtajan and Teo, as well as our work, considerably broadens its applications.

Another example is that the correspondence between the rigged moduli space of Friedan/Shenker and Vafa described above implies the existence of geometric and aglebraic structure on Teichmuller space. In particular, with D. Radnell I showed that Teichmuller space has a fiber structure. We also showed that the operation of sewing induces an algebraic operation on Teichmuller space. In the case of annuli, this is a group operation, which closely relates to the representation theory of certain function spaces by composition operators.

Future work involves construction of modular invariants on Teichmuller space, and relating them to conformal invariants and the determinant line bundle of dbar operators with boundary data.

Complex analysis: My work in complex analysis is mostly in geometric function theory, which studies the geometric properties of classes of complex analytic functions. It involves for example construction of new variational techniques; discovery of Lie-theoretic structure in semi-groups of complex analytic maps; construction of conformal invariants, from conformal metrics or potential theory; and general techniques for the solution of extremal problems.

In very recent work, I have constructed a complete set of conformal invariants for the case of complex analytic maps from one simply-connected domain into another. These invariants form an infinite-dimensional family, which is necessary to uniquely characterize elements of this space of maps.

In unpublished work I showed that these invariants can be seen as modular invariants on the Teichmuller space of annuli, and that these can be significantly generalized to arbitrary Riemann surfaces. In future work I plan to show that these generalize the so-called theta functions on Teichmuller space of compact Riemann surface to open Riemann surfaces; on these spaces, they are infinite dimensional. Furthermore, they will have applications to understanding so-called modularity phenomena in the conformal field theory setting, and to the investigation of connections on moduli spaces of Riemann surfaces.

A. Shalchi

A fundamental problem in astrophysics is the interaction between space plasmas and energetic particles. Space plasmas can be found in any astrophysical scenario. This could be the plasma of the solar wind or the interstellar medium. Examples for energetic particles are the so-called Solar Energetic Particles (SEPs) and Cosmic Rays. These particles experience strong scattering while they propagate through the interplanetary or interstellar space. Describing these scattering effects theoretically is important to understand the motion of Cosmic Rays through the Universe and the mechanism of diffusive shock acceleration. The latter mechanism is important for understanding the origin of cosmic radiation.

In recent years we have achieved a more complete understanding of the fundamental scattering mechanisms due to the development of computer simulations and nonlinear diffusion theories. Currently, our research team explores these scattering mechanisms to achieve further progress in the theory of charged particle transport by using numerical and analytical tools. The results are applied to different physical scenarios such as Cosmic Ray propagation and acceleration of particles at interplanetary shocks and supernova remnants.

Khodr M. Shamseddine

My research interests and activities include various areas of non-Archimedean Analysis: one-variable and multi-variable calculus, power series and analytic functions, measure theory and integration, optimization, existence and uniqueness of solutions of differential equations, complex analysis, and functional analysis over non-Archimedean valued fields. The focus of my research has been on the Levi-Civita fields which were first introduced by the Italian mathematician Tullio Levi-Civita at the end of the nineteenth century. Of those Levi-Civita fields, one (which we denote by $\mathcal{R}$) is of particular interest; it is shown to be the smallest non-Archimedean ordered field extension of the real numbers that is complete in the topology induced by the order and real closed. In fact, $\mathcal{R}$ is small enough so that the numbers of the field can be implemented on a computer; and this allows for many useful applications, one of which is the fast and accurate computation of the derivatives of real-valued functions up to high orders.

We have studied in my research group two topologies on $\mathcal{R}$: the valuation topology induced by the order on the field, and another weaker topology induced by a family of semi-norms, which we call weak topology. We showed that each of the two topologies results from a metric on $\mathcal{R}$, that the valuation topology is not a vector topology while the weak topology is, and that $\mathcal{R}$ is complete in the valuation topology while it is not in the weak topology. Then we studied the properties of both topologies in detail; in particular, we gave simple characterizations of open, closed, and compact sets in both topologies. Finally, we showed that the metric which induces the weak topology is translation invariant.

We studied convergence of sequences and series in both topologies mentioned above, which led to an exhaustive study of power series. A handful of people had investigated power series on the Levi-Civita fields before, but all the previous studies had been restricted to

the special case of power series with real coefficients. We dropped that restriction and showed that power series on the Levi-Civita fields have all the nice smoothness properties that real power series have. In particular, they satisfy the intermediate value theorem, the extreme value theorem, the mean value theorem and the inverse function theorem; they are infinitely often differentiable; and they are re-expandable around any point within their domain of convergence.

While it is a known fact that conventional continuity or differentiability are not sufficient to guarantee that a function on a closed interval of a non-Archimedean ordered field be bounded or satisfy any of the common theorems of real calculus, we have shown that under mild conditions, differentiability is sufficient for the function to assume all intermediate values and a differentiable inverse function. We also showed that conventional differentiability is not the right one to study optimization questions on non-Archimedean fields in general; and based on a stronger concept of differentiability, we studied finite-dimensional optimization both with and without constraints. In both cases, we derived necessary and sufficient conditions of first and second order for a function to have a local minimum at a point of its domain.

We developed a measure theory and integration on the Levi-Civita field $\mathcal{R}$. We introduced a measure that proved to be a natural generalization of the Lebesgue measure on the field of the real numbers and have similar properties. Then we introduced a family of simple functions from which we obtained a larger family of measurable functions and derived a simple characterization of such functions. We studied the properties of measurable functions, we showed how to integrate them over measurable sets, and we showed that the resulting integral satisfies similar properties to those of the Lebesgue integral of Real Analysis. We generalized the results to two and three dimensions. In particular, we defined a Lebesgue-like measure on $\mathcal{R}^2$ (resp. $\mathcal{R}^3$). Then we defined measurable functions on measurable sets using analytic functions in two (resp. three) variables and showed how to integrate those measurable functions using iterated integration. The resulting double (resp. triple) integral satisfies similar properties to those of the single integral as well as those properties satisfied by the double and triple integrals of real calculus.

Together with my collaborators Jose Aguayo and Miguel Nova from Concepcion (Chile), we developed an operator theory on the Banach space c_0 over $\mathcal{C} := \mathcal{R} + i\mathcal{R}$, where c_0 denotes the space of all null sequences of elements of $\mathcal{C}$. The natural inner product on c_0 induces the sup-norm of c_0. We showed that c_0 is not orthomodular; then we characterized those closed subspaces of c_0 with an orthonormal complement with respect to the inner product. Such a subspace, together with its orthonormal complement, defines a special kind of projection, the so-called normal projection. We presented a characterization of such normal projections as well as a characterization of other kinds of operators, the self-adjoint and compact operators on c_0. Then we worked on some B*-algebras of operators, including those mentioned above; we studied normal and Hilbert-Schmidt operators; and finally, we studied the properties of positive operators, which we then used to introduce a partial order on the B*-algebra of compact and self-adjoint operators on c_0 and studied the properties of that partial order.

While the Levi-Civita field $\mathcal{R}$ is interesting to study in detail for the reasons stated above, I have also expanded my research focus to include any non-Archimedean field extension of the real numbers that is real closed and complete in the topology induced by the order and whose Hahn group is Archimedean; such a field is denoted by F. For example, we studied the properties of weakly locally uniformly differentiable functions at a point or on an open subset of F or F^n and we proved local versions of the intermediate value theorem, the mean value theorem and Taylor's theorem for weakly locally uniformly differentiable functions on F. We also proved the inverse function theorem and implicit function theorem for weakly locally uniformly differentiable functions from F^n to F^n and from F^n to F^m $(m < n)$, respectively. Moreover, the work on the topological structure as well as on the integration theory and its applications on the Levi-Civita field $\mathcal{R}$ has recently been extended to the field F.

J. Sirker

Quantum mechanics predicts that electrons in a solid or atoms in a gas can loose there single particle properties completely and instead start behaving collectively. This often leads to the emergence of new states of matter which are a fascinating topic for fundamental research and offer the potential for technological advances. Important examples include high-temperature superconductivity in certain cuprates and iron pnictides, quantum wires such as carbon nanotubes, as well as the Bose-Einstein condensation in trapped atomic gases at ultracold temperatures.

More specifically, my research interests lie in the theoretical explanation of the physics of such strongly correlated quantum systems. Recent publications include work on:

- Quenches, thermalization, and many-body localization in quantum systems,
- transport in spin chains and quantum wires,
- multiferroic behavior in spin chains,
- domain walls in ferromagnetic Luttinger liquids,
- compounds with orbital degrees of freedom,
- quantum critical points in magnetic systems with frustration,
- field- or pressure-driven phase transitions in magnetic systems (Bose-Einstein condensation of magnons).

My research on these topics often combines field-theoretical methods (bosonization, conformal field theory, nonlinear sigma-models, renormalization group) with numerical methods, in particular, the density-matrix renormalization group (DMRG). Recently, we have developed in my group several new DMRG-type algorithms to study quantum dynamics both in equilibrium at finite temperatures and in non-equilibrium following a quantum quench.

B.W. Southern

Nanomagnetism

The study of magnetism in confined geometries has produced much new science and many technical applications in the past thirty years and will continue to be a rewarding area of research yielding applications in the foreseeable future. Confined systems that exhibit novel properties often consist of dissimilar materials that include at least one or more magnetic component (ferromagnetic, antiferromagnetic, etc.). A fundamental understanding of nanomagnetism will lead to the development of integrated systems with complex structures and architectures that possess new functionalities. Controlled release of drugs from nanostructured functional materials, especially nanoparticles, is attracting increasing attention because of the opportunities in cancer therapy and the treatment of other ailments. The potential of magnetic nanoparticles stems from the intrinsic properties of their magnetic cores combined with their drug loading capability and the biochemical properties that can be bestowed on them by means of a suitable coating. Magnetic properties at interfaces and surfaces, which make up a large fraction of nanostructured and confined materials, can be qualitatively different from those of bulk systems. Fundamental to understanding these differences is understanding the evolution of the magnetism as the structural scale descends from the bulk to the nanoscale. Due to reduced symmetry, the magnetic anisotropy at a surface or interface can be orders of magnitude larger than in the bulk. This result can lead to magnetic frustration and reorientation of the magnetization at the surface and interface. For example, when in contact with an antiferromagnet, the properties of a ferromagnet change dramatically; the coercive field is enhanced and, the magnetization curve can become asymmetric showing the exchange bias effect. My research is investigating the complex atomic spin structure of magnetic nanostructures using both analytic and computational approaches in order to gain a fundamental understanding of nanomagnetism.

R. L. Stamps

My interests cover a range of topics in condensed matter physics including linear and nonlinear dynamics of magnetic and ferroelectric nanostructures, frustrated spin systems and glasses, inelastic light scattering and ferromagnetic resonance, spin electronics, and spin dynamics in constrained geometries. Current work falls under three topics: complex networks, artificial magnetic 'spin ice', and cavity magnonics.

J. P. Svenne

Our current work involves work with a multi-channel algebraic system (MCAS) to study scattering of nucleons from light nuclei, and reactions initiated by such. This is a four-continent collaboration with Drs. L. Canton, G. Pisent (Padova University, Italy), S. Karataglidis (University of Johannesburg, S.A.) and K. Amos, Paul R. Fraser (now at Padova, It.) and D. van der Knijff (Melbourne University, Australia). The theory uses expansions in Sturmian functions of the channel-coupling interactions, leading to an algebraic solution of the coupled integral equations of the multichannel problem. This enables us to allow for the Pauli principle in the context of a collective model description of the

target nucleus, by the use of orthogonalizing pseudo-potentials. The algebraic solution provides us a method of locating all resonances, no matter how narrow, as well as all bound states of the compound system, without the use of an excessively fine energy step sizes. Satisfying the Pauli principle is an essential aspect of the theory, as it removes any spuriosity, in both bound states and resonances and thus provides a theoretical formulation of the scattering problem that has predictive power. The results of the calculations can also be used to give accurate interpretation of the nuclear structure of the target nucleus and the compound system. Our first work was on the well-studied, both theoretically and experimentally, nucleus ^{12}C, with scattering by both neutrons and protons, with inclusion of the Coulomb force. The results compare very well with experiment. We are now working on other light and medium mass nuclear systems including systems well away from the valley of stability. We use the method of mirror nuclei to reach proton-rich nuclei at or near the proton drip line. A "proof of concept" paper for the MCAS method [K. Amos, et al, Nuclear Physics **A728**, 65 (2003)] was our publication in 2006 [L. Canton *et al*,Phys. Rev. Letters, **96**, 072502 (2006)], where we predicted narrow states in the proton-unstable nucleus ^{15}F, whose existence were confirmed in 2009 [Mukha, *et al*, Phys. Rev. C **79**, 061301 (2009)]. Two new developments are our ability, now, to consider systems in which the target nuclei may have particle-unstable excited states, and the ability to apply MCAS to study hypernuclei. The first has been published in a Physical Review Letter and in the Mexican J. of Physics (see publication list, below). The work on hypernuclei has been published in the International Journal of Modern Physics.

G. Tabisz

My research interests involve the theoretical and experimental study of the interaction of light with molecules with the aim of obtaining information on intra- and inter- molecular dynamical processes. Current areas of special interest are nonlinear optical rotation effects in chiral molecules and the theory of collision-broadened spectral line shapes.

J.M. Vail

My principal research area has been in developing and applying methods to simulate the properties of solid materials. Reliable simulation is an important complement to experiment in studying material properties where subtle variations of chemical composition, crystal structure, electronic configuration, and disorder are crucial, or where time scales, and temperature and pressure regimes are experimentally inaccessible. In 1984, with collaborators, we made a major advance in the atomistic simulation of point defects in ionic materials by combining accurate electronic structure methods for the defect with total energy analysis of the crystal. The method includes physically consistent boundary conditions, the quantum-mechanical ion-size effect, and lattice distortion and polarization, and is embodied in an automated user-friendly program. The method has been applied to charge state and structural stability of defect complexes, optical and spin resonance properties of color centers and impurities, local modification of valence and conduction band edges by impurities, derivation of effective interatomic forces, hole trapping and electron loss by impurities in oxides, local phonon mode frequencies, and classical and

quantum diffusion. I maintain an interest in my recent publication, on the properties of anionic site defects in AlN, a wide band-gap insulator.

My most recent published research has been on Charge density waves having the electronic properties of graphene: stability conditions. It examines the physical limitations for stability of such CDWs, and the dependence of the total energy upon the parameter which defines the effective electron-electron interaction, including the phonon-mediated component.

D.W. Vincent

My general research interests lie in gravitation theory and early universe cosmology. I am currently involved with calculations on multidimensional cosmology solutions of Einstein's equations, which have relevance to the cosmological constant problem, the Anthropic Principle, and the Many-Worlds approach to quantum cosmology .

M. Whitmore

My research group does theoretical studies of soft condensed matter systems, in particular inhomogeneous copolymer systems and end-tethered polymers. These molecules have relatively high molecular weights, have chemically distinct sections, and are chain-like in structure. As a result, they can self-assemble to form complex nano-scale structures, and undergo subtle phase transitions. The end-tethered polymers can be used to stabilize colloids, control the properties of functional surfaces, and control transport properties inside microtubles. We use a variety of techniques including self-consistent feld theory and, with our collaborators, Monte Carlo and molecular dynamics simulations. Our recent work on copolymers has been on the analysis of cylinder-forming polymers, and the use of fluorescence decay measurements to extract detailed interfacial properties. Our work on end-tethered polymers has included identifying universal control parameters of polymers inside microtubles, and flow through these and other related systems. Most recently, we have combined a variety of computational and experimental results into an integrated picture of end-tethered polymers covering the full range of systems from the one limit of a single, isolated chain through to the other limit of high anchoring density. In addition to formulating this consistent picture, our results provide corrections to previous theories of the two limits, including those introduced by de Gennes and coworkers.

J.G. Williams

My research focusses on a new approach to general relativity due to Ted Newman and his group: the null surface formulation (NSF). In this approach, it is not the metric that plays the primary role but families of null surfaces. These surfaces are specified by a function Z, which depends upon the spacetime variables and an additional parameter that labels the family. If desired, the usual general relativistic metric can be derived to within a conformal factor. The field equations of the NSF are three in number and the dependent variable can be chosen to be Z itself or, more usually, a derivative of Z, thereby resulting in a reduction in the order of the main (partial) differential equation. This partial differential equation is called the main metricity condition and has proved

extremely difficult to solve. It has never been solved in 3+1 dimensions. In recent years, my colleague, Tina Harriott, and I have been able to find the only three currently known solutions of the main metricity condition in 2+1 dimensions. The (2+1)-dimensional NSF is closely related to the early work on differential equations due to Elie Cartan (1938), and so our solutions also represent the first known nontrivial solutions of Cartan's metricity condition. Future work by Tina Harriott and myself will be concerned with the (3+1)-dimensional NSF and also with developing methods to move seamlessly between the NSF and the traditional approaches to general relativity.