

Michal Zajaček

Curriculum Vitae

MPIfR Bonn
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Education

- September 17, 2014– October 12, 2017 **PhD degree, IMPRS scholar at University of Cologne, 1. Physikalisches Institut and MPIfR, Bonn, Germany, graduated as very good – sehr good with the grade 1.00.**
- December 15, 2014 **Rigorosum examination – RNDr. (Czech Title for the Doctor of natural sciences), Charles University in Prague, Czech Republic.**
- 2012–2014 **Master of Science (Astronomy & Astrophysics), Charles University in Prague, Czech Republic, graduated with honours.**
- 2009–2012 **Bachelor of Science (General Physics), Charles University in Prague, Czech Republic, graduated with honours.**
- 2004–2009 **Abitur (Maturita), Evangelical Lyceum in Bratislava, Slovakia, all grades excellent.**

PhD Thesis

- Title *Interaction between interstellar medium and black-hole environment*
- Supervisor Prof. Dr. Andreas Eckart
- Advisors PD Dr. Silke Britzen, Prof. Dr. Vladimír Karas, Dr. Mónica Valencia-S., Prof. Dr. J. Anton Zensus
- Description The thesis deals with the transition region where the complex interstellar medium in the Galactic Centre meets a rather simple object at the very centre – most probably a black hole of 4×10^6 Solar masses characterized by only three classical parameters: mass, spin, and electric charge. Recently, a NIR-excess object named DSO/G2 was detected that is moving on a highly eccentric orbit, with the pericentre reached in 2014 at ~ 2000 Schwarzschild radii. The monitoring, the analysis of NIR data, and the comparison with models have provided an unprecedented opportunity to constrain the properties of previously unexplored region around Sgr A* as well as to determine the nature of this enigmatic source. We explored the dynamics of different scenarios for DSO/G2, its interaction with the ambient medium close to the Galactic centre, and the radiative properties of its NIR continuum emission. Approaching the innermost region of the Galactic Centre, we explore the problem of an electric charge associated with Sgr A*, which is assumed to be zero in most studies. We found that a stable charge can be maintained by several mechanisms. One of the most promising ones is the charging due to the rotating black hole that is immersed in a uniform magnetic field. Realistic values of the charge that we calculated do not influence space-time metric, but can significantly influence the dynamics of plasma in the vicinity of the Galactic centre. Furthermore, we also propose a novel observational test for detecting the signature of the charge using a bremsstrahlung brightness distribution.

Master Thesis

- Title *Neutron stars near a galactic centre*
- Supervisors Prof. RNDr. Vladimír Karas, DrSc., Devaky Kunneriath, PhD.

Description The main results of the thesis include the study of the interaction modes of magnetized neutron stars that move through gaseous-dusty environment near the Galactic center. The population of neutron stars is unexplored and there are very few detections in the central regions of the Galaxy, more specifically only one magnetar in the innermost parsec. Therefore the distribution of interaction modes of neutron stars studied in the thesis will help to explain the “missing pulsar” paradox in the Galactic center. Furthermore, I have been modelling both analytically and numerically the passages of stars with envelopes near the supermassive black hole in the Galactic center.

Bachelor Thesis

Title *The Late Heavy Bombardment (LHB) at various places of the Solar System*

Supervisors Miroslav Brož, PhD.

Description The subject of the thesis was the period of LHB, which is a period in the history of the Solar system when an enhanced flux of impactors occurred. I used N-body orbital integrators and collisional codes to construct a particular model of this event and compare the results with the observed distribution of crater sizes. The model helped to constrain the size distribution of primordial comets located in the outer Solar System. Moreover, it reaffirmed the Nice model of the evolution of the Solar System.

Honors & Awards

September 17, 2014- October 12, 2017 International Max Planck Research School Scholarship

2014 Master degree with honours – Summa Cum Laude – the Charles University in Prague

2013-2014 Scholarship for excellent studying results - the Charles University in Prague

2013 MILSET Regards and Gratitude award (Abu Dhabi, United Arab Emirates)

2013-2014 Research grant (879113) awarded by the Charles University in Prague

2012 Bachelor degree with honours – Summa Cum Laude – the Charles University in Prague

2012 Second prize at the Czech-Slovak Physics Student conference for the bachelor thesis

2008 Third place at the nationwide astronomical competition “What do you know about stars?”

Publications

refereed

2018 **M. Zajaček**, G. Busch, M. Valencia-S., A. Eckart, S. Britzen, L. Fuhrmann, J. Schneeloch, N. Fazeli, K. C. Harrington, J. A. Zensus; *Radio-spectral index distribution of SDSS-FIRST sources across optical diagnostic diagrams*; A&A submitted (2018).

2018 **M. Zajaček**, A. Tursunov; *A stellar fly-by close to the Galactic centre: Can we detect stars on highly-relativistic orbits?*; Astronomical Notes submitted (2018).

2018 S. Britzen, C. Fendt, G. Witzel, S.-J. Qian, I.N. Pashchenko, O. Kurtanidze, **M. Zajaček**, G. Martinez, V. Karas, M. Aller, H. Aller, A. Eckart, K. Nilsson, P. Arévalo, J. Cuadra, A. Witzel; *OJ287: Deciphering the “Rosetta stone of blazars”*; MNRAS accepted (2018).

2018 **M. Zajaček**, A. Tursunov, A. Eckart, S. Britzen; *On the charge of the Galactic centre black hole*; MNRAS submitted (2017).

2017 **M. Zajaček**, S. Britzen, A. Eckart, B. Shahzamanian, G. Busch, V. Karas, M. Parsa, F. Peissker, M. Dovčiak, M. Subroweit, F. Dinnbier, J. Anton Zensus; *Nature of the Galactic centre NIR-excess sources. I. What can we learn from the continuum observations of the DSO/G2 source?*; A&A 602, A121 (2017).

- 2017 A. Eckart, A. Hüttemann, C. Kiefer, S. Britzen, **M. Zajaček**, C. Lämmerzahl, M. Stöckler, M. Valencia-S., V. Karas, M. García-Marín; *The Milky Way's Supermassive Black Hole: How Good a Case Is It?*; Foundations of Physics 47, Issue 5 (2017).
- 2016 B. Shahzamanian, A. Eckart, **M. Zajaček**, M. Valencia-S., N. Sabha, L. Moser, M. Parsa, F. Peissker, C. Straubmeier; *Polarized near-infrared light of the Dusty S-cluster Object (DSO/G2) at the Galactic Center*; A&A 593, A131 (2016).
- 2016 **M. Zajaček**, A. Eckart, V. Karas, D. Kunneriath, B. Shahzamanian, N. Sabha, K. Muzic, M. Valencia-S.; *Effect of an isotropic outflow from the Galactic Centre on the bow-shock evolution along the orbit*; MNRAS, Volume 455, Issue 2, p.1257-1274.
- 2015 **M. Zajaček**, A. Eckart, F. Peissker, G. D. Karssen, V. Karas; *Infrared-excess Source DSO/G2 Near the Galactic Center: Theory vs. Observations*; accepted by the proceedings of the Week of Doctoral Students organized by the Charles University in Prague, preprint available at arXiv:1507.00237.
- 2015 **M. Zajaček**, V. Karas, D. Kunneriath; *Galactic Center Minispiral: Interaction Modes of Neutron Stars*; Acta Polytechnica, Volume 55, No. 3, p. 203-214.
- 2015 B. Shahzamanian, A Eckart, M Valencia-S., G. Witzel, M. Zamaninasab, **M. Zajaček**, N. Sabha, M. García-Marín, V. Karas, F. Peissker, G. D. Karssen, M. Parsa, N. Grosso, E. Mossoux, D. Porquet, B. Jalali, M. Horrobin, R. Buchholz, M. Dovčiak, D. Kunneriath, M. Bursa, A. Zensus, R. Schödel, J. Moutaka, C. Straubmeier; *Variable and Polarised Near-infrared Emission from the Galactic Centre*; The Messenger, vol. 159, p. 41-45
- 2015 M. Valencia-S., A. Eckart, **M. Zajaček**, F. Peissker, M. Parsa, N. Grosso, E. Mossoux, D. Porquet, B. Jalali, V. Karas, S. Yazici, B. Shahzamanian, N. Sabha, R. Saalfeld, S. Smajic, R. Grellmann, L. Moser, M. Horrobin, A. Borkar, M. García-Marín, M. Dovčiak, D. Kunneriath, G. D. Karssen, M. Bursa, C. Straubmeier, H. Bushouse; *Monitoring the Dusty S-cluster Object (DSO/G2) on its Orbit toward the Galactic Center Black Hole*; The Astrophysical Journal, Volume 800, Issue 2, article id. 125, 21 pp.
- 2014 **M. Zajaček**, V. Karas, A. Eckart; *Dust-enshrouded star near supermassive black hole: predictions for high-eccentricity passages near low-luminosity galactic nuclei*; Astronomy & Astrophysics, Volume 565, id.A17, 15 pp.
- unrefereed (proceedings)
- 2017 V. Karas, O. Kopáček, D. Kunneriath, **M. Zajaček**, A. Araudo, A. Eckart, J. Kovář; *Plunging neutron stars as origin of organised magnetic field in galactic nuclei*; Contrib. Astron. Obs. Skalnaté Pleso 47, 124-132 (2017).
- 2017 B. Shahzamanian, **M. Zajaček**, M. Valencia-S., F. Peissker, A. Eckart, N. Sabha, M. Parsa; *Detection of polarized continuum emission of the Dusty S-cluster Object (DSO/G2)*; IAU Symposium 322 (2017).
- 2017 **M. Zajaček**, B. Shahzamanian, M. Valencia-S., F. Peissker, A. Eckart, N. Sabha, M. Parsa; *Nature of the Dusty S-cluster Object (DSO/G2): Pre-main-sequence star with non-spherical dusty envelope*; IAU Symposium 322 (2017).
- 2015 V. Karas, **M. Zajaček**, D. Kunneriath, M. Valencia-S., A. Eckart; *Monitoring the Dusty S-cluster object (DSO/G2) near the Galactic center black hole: model predictions for Br-gamma energy shift during the passage*; Proceedings of the conference held 8-10 June, 2015 in Madrid, Spain. Online at http://xmm.esac.esa.int/external/xmm_science/workshops/2015_science/
- 2015 **M. Zajaček**, V. Karas, L. Šubr, D. Kunneriath, A. Eckart; *Gaseous environment in LLAGN: modes of interaction with compact star nuclear population*; Galaxies in 3D across the Universe, Proceedings of the International Astronomical Union, IAU Symposium, Volume 309, pp. 353-353

- 2015 A. Eckart, M. Valencia-S., B. Shahzamanian, M. Garcia-Marin, F. Peissker, **M. Zajaček**, M. Parsa, B. Jalali, R. Saalfeld, N. Sabha, S. Yazici, G. D. Karssen, A. Borkar, K. Markakis, J. A. Zensus, C. Straubmeier; *The Center of the Milky Way from Radio to X-rays*; Published in PoS-SISSA Proceedings of the Frontier Research in Astrophysics Workshop 2014, edt. Franco Giovannelli held in Mondello (Palermo - Italy) 26 - 31 May 2014; eprint arXiv:1501.02164
- 2014 V. Karas, **M. Zajaček**, A. Eckart, D. Kunneriath, M. Valencia-S.; *Modelling Pericenter Passage near a Supermassive Black Hole*; American Astronomical Society, HEAD meeting # 14, id.# 118.03
- 2014 A. Eckart, M. Horrobin, S. Britzen, M. Zamaninasab, K. Mužić, N. Sabha, B. Shahzamanian, S. Yazici, L. Moser, M. García-Marín, M. Valencia-S., A. Borkar, M. Bursa, G. Karssen, V. Karas, **M. Zajaček**, L. Bronfman, R. Finger, B. Jalali, M. Vitale, C. Rauch, D. Kunneriath, J. Moultaqa, C. Straubmeier, Y. E. Rashed, K. Markakis, A. Zensus; *The infrared K-band identification of the DSO/G2 source from VLT and Keck data*; Proceedings of the International Astronomical Union, Volume 303, pp. 269-273

Presentations

- 04/2018 Talk at the IBWS 2018, Carlsbad, the Czech Republic
- 10/2017 Talk at the RAGtime meeting 2017, Silesian University in Opava
- 05/2017 Talk at the Cologne-Prague-Kiel meeting 2017, Castle Wahn, Cologne, Germany
- 12/2016 Talk at the Cologne-Prague-Kiel meeting 2016, Castle Wahn, Cologne, Germany
- 08/2016 Two talks at the Days of the Universe, Makarska Public Observatory, Croatia
- 07/2016 Poster presentation and pop-up talk at IAUS 322 in Cairns, Australia
- 06/2016 Talk at the Astronomy department, University of California, Los Angeles
- 06/2016 Talk at the 28th American Astronomical Society meeting in San Diego, California
- 06/2016 Talk at the 25th Week of doctoral students at the Charles University in Prague
- 04/2016 Talk at the StrongGravity consortium meeting, Warsaw, Poland
- 04/2016 Talk at the group seminar of Stellar population and Dynamics group (Prof. Dr. Pavel Kroupa), Bonn, Germany
- 03/2016 Talk at the Relativist seminar of the Institute for Theoretical physics, Charles University in Prague, Czech Republic
- 11/2015 Talk at the CPP15 - Cologne-Prague Meeting in Prague 2015: From supermassive black holes to star formation in galactic nuclei, Prague, Czech Republic
- 09/2015 Talk at the splinter meeting The Galactic Center and the Growth of Black Holes of the Annual meeting of the Astronomische Gesellschaft, Kiel, Germany
- 09/2015 Two posters at the 6th Zermatt ISM Symposium, Zermatt, Switzerland
- 07/2015 Talk at the workshop From the Dolomites to event horizon: Sledging down the Black Hole potential well (3rd ed.), Sesto-Sexten, Italy
- 06/2015 Talk at the European Week of Astronomy and Space Science EWASS, La Laguna, Tenerife, Canary Islands
- 06/2015 Talk at the Week of Doctoral Students, Charles University in Prague, Czech Republic
- 08/2014 Talk at the FER0–Finding Extremely Relativistic Objects–meeting, Krakow, Poland
- 07/2014 Poster at the IAU symposium: Galaxies in 3D, Vienna, Austria
- 07/2014 Poster at the European Week of Astronomy and Space Science EWASS, Geneva, Switzerland
- 05/2014 Talk at the conference 99 years of Black Holes – from Astronomy to Quantum Gravity, Potsdam, Germany

- 04/2014 Talk at the INTEGRAL/BART workshop, Karlovy Vary, Czech Republic
- 04/2014 Poster at the workshop Seven years in Chile: The Accomplishments and Goals of Czech Astronomers at ESO, Prague, Czech Republic
- 12/2013 Talk at the Joint Student Conference INAP 2013, Prague, Czech Republic
- 11/2013 Talk at the conference Galactic Center Black Hole Laboratory, Granada, Spain
- 09/2013 Talk at the Expo Sciences International, Abu Dhabi, United Arab Emirates
- 08/2013 Oral presentation at the Cologne-Prague meeting CPK13, Kiel, Germany
 - + talks at the local SFB956 student colloquium in Cologne
 - + regular talks (once a year) at the IMPRS Monday talk in Bonn
 - + regular talks in the local group seminar (Prof. Eckart) in Cologne
 - + regular talks in the local group seminar (Prof. Karas) in Prague

Working Experience

- October 13, 2017–present **Junior postdoctoral researcher**, MAX PLANCK INSTITUTE FOR RADIOASTRONOMY BONN, Germany.
I am working within SFB956 collaboration in the subgroup A2 “Conditions for Star Formation in Nearby AGN and QSO Hosts” (PIs PD Dr. Silke Britzen and Prof. Dr. Andreas Eckart). We study the impact of the star-formation in galaxies on their galaxy evolution, making use of their radio–optical properties. In addition, I continue studying the properties of young stellar objects in the Galactic centre region. Concerning the strong-gravity regime, we focus on the radiative properties of the compact radio source Sgr A* as well as extragalactic sources. Among them one of the most interesting ones is the blazar OJ287, which is one of the best candidates for hosting the supermassive black hole binary.
- 2014–2017 **Research Assistant–PhD candidate**, I. PHYSIKALISCHES INSTITUT, Cologne.
PhD student in the workgroup of Prof. Andreas Eckart. I am working on my research projects dealing with the physics of the Galactic center and active galactic nuclei. Besides research I am also involved in teaching activities. I have organized Advanced Astrophysics and Atomic Physics exercises and advised high-school, bachelor, and master students.
- 2012–present **External research assistant**, ASTRONOMICAL INSTITUTE OF THE ACADEMY OF SCIENCES, Czech Republic, Prague.
Involved in cooperation research projects dealing with strong gravity relativistic physics and the physics of galactic nuclei.
- 2008–present **Science popularization and projects for students**, ASSOCIATION FOR YOUTH, SCIENCE, AND TECHNOLOGY–AMAVET, Bratislava.
Project coordinator of various projects (LABAK, Science Cup, Curious scientists) intended for elementary and high-school students.

Observational Experience

- 2015–present **Radio continuum observations**, *Effelsberg radiotelescope, Germany*, Observations of radio galaxies, SDSS-FIRST sources, data reduction and statistical analysis.
- 07/2013 **Optical photometry**, *65-cm telescope at Ondrejov observatory, Czech Republic*, observations of asteroid, data reduction and analysis.
- 10/2012 **Optical spectroscopy of ϵ Aurigae**, *2-m telescope at Ondrejov observatory, Czech Republic*, observations of a variable star, basic analysis of stellar spectra, mainly H α line.
- 08/2012 **Polarimetric observations of Solar prominences**, *Coronagraph at the Lomnický peak, Slovakia*, observations of Solar prominences and corona, statistical analysis of the latitudinal distribution of Solar prominences.

Membership and Committees

- 2014–present Member of International Max Planck Research School
- 2015–present Member of StrongGravity consortium
- 2015–present Member of SFB956: Conditions for Star Formation in Nearby AGN and QSO Hosts
- 2015–present Student representative of IMPRS for the University of Cologne
 - 2015 Member of Organizing committee of Cologne-Prague meeting in Prague: From supermassive black holes to star-formation in galactic nuclei
 - 2013 Member of Local Organizing committee, MILSET Expo Sciences International, Abu Dhabi, United Arab Emirates
 - 2011 Member of Local Organizing committee, MILSET Expo Sciences International, Bratislava, Slovakia

Languages

- Slovak **Mother tongue**
- English **Fluent**
- Czech **Writing knowledge: Fluent, Speaking knowledge: Passive**
- German **intermediate level**
- French **basic knowledge**

Computer skills

- Operating System Linux (Ubuntu), MS Windows, MacOS
- Programming Language FORTRAN, PYTHON, C, PASCAL
- Miscellaneous \LaTeX , GNUplot, Office, gimp, Inkscape, CASA