

IAU Symposium

324

12–16 September 2016
Ljubljana, Slovenia

Proceedings of the International Astronomical Union

New Frontiers in Black Hole Astrophysics

Edited by

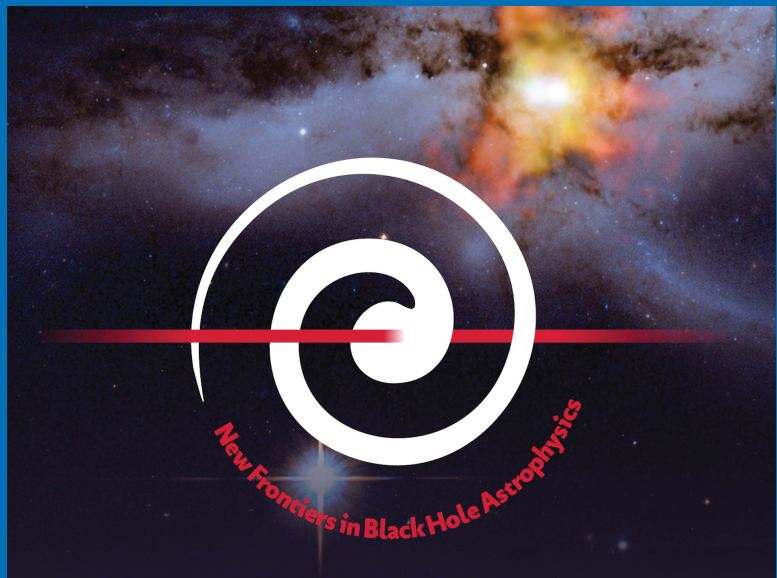
Andreja Gomboc

ISSN 1743-9213

International Astronomical Union



CAMBRIDGE
UNIVERSITY PRESS



NEW FRONTIERS IN BLACK HOLE ASTROPHYSICS
IAU SYMPOSIUM 324

COVER ILLUSTRATION:

Logo of the IAU Symposium 324 on the background of NGC 6240 (Logo Credit: Branko Žalar, Photo Credits: X-ray: NASA/CXC/MIT/C. Canizares, M. Nowak; Optical: NASA/STScI)

IAU SYMPOSIUM PROCEEDINGS SERIES

Chief Editor

PIERO BENVENUTI, IAU General Secretary

IAU-UAI Secretariat

98-bis Blvd Arago

F-75014 Paris

France

iau-general.secretary@iap.fr

Editor

MARIA TERESA LAGO, IAU Assistant General Secretary

Universidade do Porto

Centro de Astrofísica

Rua das Estrelas

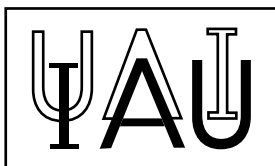
4150-762 Porto

Portugal

mtlago@astro.up.pt

INTERNATIONAL ASTRONOMICAL UNION
UNION ASTRONOMIQUE INTERNATIONALE

International Astronomical Union



NEW FRONTIERS IN BLACK HOLE ASTROPHYSICS

PROCEEDINGS OF THE 324th SYMPOSIUM
OF THE INTERNATIONAL ASTRONOMICAL
UNION HELD IN LJUBLJANA, SLOVENIA
SEPTEMBER 12–16, 2016

Edited by

ANDREJA GOMBOC

University of Nova Gorica, Slovenia



CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
University Printing House, Cambridge CB2 8BS, United Kingdom
1 Liberty Plaza, Floor 20, New York, NY 10006, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

© International Astronomical Union 2017

This book is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of the International Astronomical Union.

First published 2017

Printed in the UK by Bell & Bain, Glasgow, UK

Typeset in System L^AT_EX 2 ϵ

A catalogue record for this book is available from the British Library Library of Congress Cataloguing in Publication data

This journal issue has been printed on FSCTM-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see www.fsc.org for information.

ISBN 9781107169944 hardback
ISSN 1743-9213

Table of Contents

Preface	xi
Acknowledgements	xiii
Scientific Organizing Committee	xiv
Conference Photograph	xv
Participants	xx

Introduction

Old/Past/Ancient/Historic Frontiers in Black Hole Astrophysics	1
<i>V. Trimble</i>	

Topic 1. Similarity and Diversity of Black Hole Systems

Similarity and diversity of black holes - view from the Very High Energies	11
<i>E. Lindfors</i>	
Where is the electric current driven in the Blandford-Znajek process?	19
<i>K. Toma, F. Takahara</i>	
Transonic structure of slowly rotating accretion flows with shocks around black holes	23
<i>P. Suková, S. Charzyński & A. Janiuk</i>	
Stellar progenitors of black holes: insights from optical and infrared observations	27
<i>I. F. Mirabel</i>	
Investigating ultraluminous X-ray sources through their multiwavelength variability and broadband spectra	31
<i>L. Zampieri, E. Ambrosi & A. Nayerhoda</i>	
Black Hole Binaries in Quiescence	35
<i>C. D. Bailyn</i>	
The search for isolated BH candidates based on kinematics of pulsars - their former companions in disrupted binaries	39
<i>E. Chmyreva, G. Beskin, V. Dyachenko & S. Karpov</i>	
Prospects for the Discovery of Black Hole Binaries without Mass Accretion with Gaia	41
<i>N. Kawanaka, M. Yamaguchi, T. Piran & T. Bulik</i>	
Two optical emission components with different variability in V404 Cygni	43
<i>Y. Tachibana, T. Yoshii & N. Kawai</i>	
A pseudo-Newtonian description of any stationary space-time	45
<i>V. Witzany & C. Lämmerzahl</i>	

Topic 2: Gamma Ray Bursts

Gamma-ray Bursts Progress and Problems	49
<i>N. R. Tanvir</i>	

Gamma-Ray Bursts Polarization	54
<i>D. Götz & S. Covino</i>	
Generation and decay of the magnetic field in collisionless shocks	62
<i>M. Garasev & E. Derishev</i>	
Low- Γ jets from Compact Binary Mergers as Candidate Electromagnetic Counterparts to Gravitational Wave Sources	66
<i>G. P. Lamb & S. Kobayashi</i>	
Search for High Energy emission from GRBs with MAGIC	70
<i>A. Berti for the MAGIC GRB group</i>	
Extremely Bright GRB160625B with Short-Soft Precursor and long-hard extended emission: Hints for long-term evolution of the GRB Ejecta	74
<i>S.-Q. Zhong, J. Lü, H.-J. Lü, H.-M. Zhang, X.-L. Huang & E.-W. Liang</i>	
Lorentz Factor Evolution Patterns within Relativistic Jets of GRBs and AGNs	78
<i>H.-M. Zhang, D.-B. Lin, T.-T. Lin, B.-R. Liu, X.-L. Huang, S.-Q. Zhong, R.-J. Lu & E.-W. Liang</i>	
Doppler Boosting Effect on the Jet Radiation of Gamma-Ray Bursts and Active Galactic Nuclei	82
<i>X.-L. Huang, H.-M. Zhang, S.-Q. Zhong & E.-W. Liang</i>	
Untriggered search for rapid optical transients with Mini-MegaTORTORA wide-field monitoring system	85
<i>S. Karpov, G. Beskin, A. Biryukov, S. Bondar, E. Ivanov, E. Katkova, N. Orekhova, A. Perkov & V. Sasyuk</i>	
Synergetic Growth of the Rayleigh–Taylor and Richtmyer–Meshkov Instabilities in the Relativistic Jet	87
<i>J. Matsumoto & Y. Masada</i>	
Spatial Distribution of the Gamma-ray Bursts and the Cosmological Principle.	89
<i>A. Mészáros</i>	
Topic 3: Tidal Disruption Events	
Observational Progress in Identifying and Characterizing Tidal Disruption Flares	93
<i>S. B. Cenko</i>	
Relativistic loss cone dynamics: Infall and inspiral rates and branching ratios.	99
<i>T. Alexander</i>	
The role of electromagnetism in tidal disruption events	107
<i>A. Čadež</i>	
Star Formation Close to Sgr A* and Beyond the Nuclear Cluster	111
<i>F. Yusef-Zadeh & M. Wardle</i>	
What can Fermi LAT observation of the Galactic Centre tell us about its active past?	115
<i>G. Zaharijas, J. Petrović & P. Serpico</i>	

Swift J1644+5734: the EVN view	119
<i>Z. Paragi, J. Yang, S. Komossa, A. van der Horst, L. I. Gurvits, R. M. Campbell, D. Giannios & T. An</i>	
Tidal disruption events seen in the XMM-Newton slew survey	123
<i>R. Saxton, S. Komossa, A. Read, P. Lira, K. D. Alexander & I. Steele</i>	
Tidal Disruption Events and stellar-mass black holes in OGLE and Gaia surveys	127
<i>L. Wyrzykowski, A. Hamałowicz & K. A. Rybicki</i>	
Tidal disruption events from different kinds of astrophysical objects: a preliminary analysis	132
<i>A. Clerici & A. Gomboc</i>	
Accretion and wind dynamics in tidal disruption events	134
<i>T. Mageshwaran & A. Mangalam</i>	
Explosive nucleosynthesis in tidal disruption events of massive white dwarfs, and their debris	136
<i>A. Tanikawa, Y. Sato, K. Nomoto, K. Maeda, N. Nakasato & I. Hachisu</i>	
Topic 4: Active Galactic Nuclei	
The remarkable AGN jets	141
<i>S. Komissarov</i>	
Observational View of Magnetic Fields in Active Galactic Nuclei Jets	149
<i>T. Hovatta</i>	
Ultrafast VHE Gamma-Ray Flares of IC 310	157
<i>M. V. Barkov, F. Aharonian & D. V. Khangulyan</i>	
Monitoring of the radio galaxy M87 at Very High Energy with MAGIC during a low emission state between 2012 and 2015	164
<i>C. Arcaro, P. Bangale, M. Manganaro, D. Mazin, P. Colin, Ie. Vovk, K. Mannheim for the MAGIC Collaboration, K. Hada, H. E. Jermak, J. P. Madrid, F. Massaro, S. Richter, F. Spanier & R. C. Walker</i>	
The Extremes of AGN Variability	168
<i>S. Komossa, D. Grupe, N. Schartel, L. Gallo, J. L. Gomez, W. Kollatschny, G. Kriss, K. Leighly, A. L. Longinotti, M. Parker, M. Santos-Lleo, D. Wilkins & M. Zetzl</i>	
X-ray fluctuation timescale and Black Hole mass relation in AGN	172
<i>A. Wandel & M. Malkan</i>	
Periodic optical variability of AGN	176
<i>E. Bon, P. Marziani & N. Bon</i>	
Quasi-Periodicities at Year Time Scales in Blazars	180
<i>S. Covino, A. Sandrinelli & A. Treves</i>	
Radio and γ -ray loud narrow-line Seyfert 1 galaxies in the spotlight	184
<i>V. Karamanavis, E. Angelakis, S. Komossa, I. Myserlis, D. Blinov & J. A. Zensus</i>	

The jet detection in radio-loud narrow-line Seyfert 1 galaxies	188
<i>M. Gu</i>	
Elusive Accretion Discs in Low Luminosity AGN	192
<i>J.A. Fernández-Ontiveros, M.A. Prieto Escudero, S. Markoff, L. Reb, D. Espada & O. González-Martín</i>	
A thin disk model for the high efficiency jet in powerful lobe-dominated FR II radio galaxies	196
<i>S.-L. Li</i>	
Particle-in-cell Simulations of Global Relativistic Jets with Helical Magnetic Fields	199
<i>I. Duřan, K.-I. Nishikawa, Y. Mizuno, J. Niemiec, O. Kobzar, M. Pohl, J. L. Gómez, A. Pe'er, J. T. Frederiksen, Å. Nordlund, A. Meli, H. Sol, P. E. Hardee & D. H. Hartmann</i>	
Multi-wavelength flares and magnetic field in blazars: a case study of IBL S5 0716+714	203
<i>S. Chandra, K. P. Singh & K. S. Baliyan</i>	
Producing ultra high energy cosmic rays from AGN magnetic luminosity	207
<i>C. H. Coimbra-Araújo & R. C. Anjos</i>	
The Energetic Particle Population in Centaurus A	211
<i>P. Chadwick, A. M. Brown, C. Boehm, J. Graham, T. Lacroix & J. Silk</i>	
Space Telescope and Optical Reverberation Mapping Project: A Leap Forward in Reverberation Mapping	215
<i>B. M. Peterson</i>	
Studying the outskirts of reverberation mapped AGNs	219
<i>S. Kaspi</i>	
Searching for a pair of accreting supermassive black holes in J1425+3231	223
<i>K. É. Gabányi, S. Frey, Z. Paragi, T. An & S. Komossa</i>	
A Statistical Method for Detecting Gravitational Recoils of Supermassive Black Holes in Active Galactic Nuclei	227
<i>P. Raffai, B. Bécsy, Z. Haiman & Z. Frei</i>	
Simulation of AGN feedback and its impact on galaxies	231
<i>M. A. Bourne</i>	
MAGIC detection of sub-TeV emission from gravitationally lensed blazar QSO B0218+357	235
<i>D. Dominis Prester, J. Sitarek, J. Becerra, S. Buson, E. Lindfors, M. Manganaro, D. Mazin, M. Nieves Rosillo, K. Nilsson, A. Stamerra, F. Tavecchio, I. Vovk for the MAGIC Coll. and the Fermi-LAT Coll.</i>	
The effect of AGN feedback on Sunyaev-Zeldovich properties of simulated galaxy clusters	237
<i>D. Fabjan, S. Planelles, S. Borgani, G. Murante, E. Rasia, V. Biffi, N. Truong, C. Ragone-Figueroa, G. L. Granato, K. Dolag, E. Pierpaoli, A. M. Beck, L. K. Steinborn & M. Gaspari</i>	

Empirical multi-wavelength prediction method for Very High Energy Gamma-ray emitting BL Lacs	239
<i>V. Fallah Ramazani, E. Lindfors & K. Nilsson</i>	
Observations of possible jet formation in the binary blazar OJ287	241
<i>H. Jermak, I. A. Steele, G. P. Lamb, M. Valtonen & S. Zola</i>	
Optical variability patterns of radio-quiet and radio-loud quasars.	243
<i>P. Marziani, E. Bon, A. Grieco, N. Bon, D. Dultzin, A. Del Olmo & M. D'Onofrio</i>	
Highly accreting quasars: a tool for cosmology?	245
<i>P. Marziani, C. A. Negrete, D. Dultzin, M. L. Martinez-Aldama, A. Del Olmo, D. Esparza, J. W. Sulentic, M. D'Onofrio, G. M. Stirpe, E. Bon & N. Bon</i>	
Open our eyes to wider fields in VLBI surveys	247
<i>K. Rozgonyi & S. Frey</i>	
Ensemble quasar spectral variability from the XMM-Newton Serendipitous Source Catalogue	249
<i>R. Serafinelli, F. Vagnetti & R. Middei</i>	
Peculiar emission from the new VHE gamma-ray source H1722+119	251
<i>T. Terzić, A. Stamerra, the MAGIC Coll., F. D'Ammando (for the Fermi-LAT Coll.), C. M. Raiteri, M. Villata, F. Verrecchia & O. Kurtanidze</i>	
Influence of self-gravity on the equilibrium structures of magnetized tori.	253
<i>A. Trova, V. Karas, P. Slaný & J. Kovář</i>	
Topic 5: Tests of fundamental theories of physics using black hole systems	
Unveiling early black holes with <i>JWST</i>	257
<i>P. Natarajan</i>	
Black holes in Einstein-Gauß-Bonnet-dilaton theory	265
<i>J. Luis Blázquez-Salcedo, V. Cardoso, V. Ferrari, L. Gualtieri, P. Kanti, F. Scen Khoo, B. Kleihaus, J. Kunz, C. F. B. Macedo, S. Mojica, P. Pani & E. Radu</i>	
Black hole superradiance as a probe of ultra-light new particles	273
<i>R. Lasenby</i>	
Quantum electromagnetic phenomena far from small evaporating black holes. . .	279
<i>S. Emelyanov</i>	
Spectroscopy of candidate electromagnetic counterparts to gravitational wave sources.	283
<i>I. A. Steele, C. M. Copperwheat & A. S. Piascik</i>	
MAGIC electromagnetic follow-up of gravitational wave alerts	287
<i>B. D. Lotto, S. Ansoldi, A. Antonelli, A. Berti, A. Carosi, F. Longo & A. Stamerra on behalf of the MAGIC Collaboration</i>	

On the gamma-ray burst – gravitational wave association in GW150914	291
<i>A. Janiuk, S. Charzynski & M. Bejger</i>	
Search for UHE neutrinos in coincidence with LIGO GW150914 event with the Pierre Auger Observatory	295
<i>L. Yang, for the Pierre Auger Collaboration</i>	
What was the Initial Mass of Merging Black Holes in GW150914 ?	299
<i>H. Tagawa & M. Umemura</i>	
Black holes formed by direct collapse: observational evidences	303
<i>I. F. Mirabel</i>	
Topic 6: Technology Drivers and Future Capabilities	
Black hole astrophysics with HAWC, the High Altitude Water Cherenkov γ -ray observatory.	309
<i>A. Carramiñana for the HAWC Collaboration</i>	
Acceleration of particles up to PeV energies at the galactic centre	317
<i>S. Gabici, F. A. Aharonian, E. Moulin & A. Viana</i>	
Neutrino Astronomy with IceCube.	322
<i>K. J. Meagher on behalf of the IceCube Collaboration</i>	
LSST survey: millions and millions of quasars.	330
<i>Ž. Ivezić</i>	
X-ray polarimetry – A new Window on Black Hole Systems	338
<i>R. W. Goosmann on behalf of the XIPE consortium</i>	
KETJU: Post-Newtonian-Accurate Supermassive Black Hole Dynamics in GADGET- 3.	342
<i>A. Rantala, P. Pihajoki & P. H. Johansson</i>	
Ray-tracing and polarized radiative transfer in General Relativity	347
<i>P. Pihajoki, A. Rantala & P. H. Johansson</i>	
Observing shadow of the Schwarzschild black hole in presence of a plasma	351
<i>F. Atamurotov</i>	
Circular motion and Polish Doughnuts in NUT spacetime.	353
<i>P. I. Jefremov</i>	
A solution to unconstrained Einstein's equations for a relativistic radiation sphere	355
<i>L. Neslušan</i>	
MOPTOP: Multi-colour Optimised Optical Polarimeter	357
<i>H. Jermak, I. A. Steele & R. J. Smith</i>	
Author index	359

Preface

Black holes lie at the heart of some of the most fascinating astrophysical phenomena. The International Astronomical Union Symposium 324: “New Frontiers in Black Hole Astrophysics” marked the 100th anniversary of Schwarzschild’s solution of Einstein’s field equations, which set the scene for the theoretical prediction of black holes. Although they were at first considered as a purely mathematical curiosity, it is now well established that they are ubiquitously present in the Universe. In the last few decades our understanding of black holes has come an impressively long way, with the last major discovery in this field being coalescing black holes producing gravitational waves. Gravitational waves, also predicted in 1916, remained elusive for a long time - therefore, it was our outmost pleasure to mark during the symposium the first anniversary of the first direct gravitational wave detection, which started a new era in astronomy.

In addition to historical perspective, the symposium was timely also in terms of scientific and technological points of view. Technological advances across the electromagnetic spectrum and beyond to multi-messenger signature are coming of age. The new generation of gravitational wave detectors is operational, improved sensitivity in neutrino detectors is available, the multi-wavelength community has an impressive suite of ground- and space-based facilities covering a wide range of energy bands and timescales. And on the theoretical side, astrophysics communities are providing new testable predictions from advances in numerical simulations.

IAU symposium 324 was held from September 12 to 16, 2016 in Slovenia’s capital city Ljubljana. It was organized by the University of Nova Gorica and opened by the Slovenian Minister of Education, Science and Sport, Dr. Maja Makovec Brenčič. The symposium brought together 130 observational and theoretical experts from 30 countries across the globe to discuss the current state-of-the-art in the astrophysics of black-hole driven systems and their exploitation in testing fundamental theories of physics. The scientific program began with a historical introduction given by Virginia Trimble and concluded with the symposium summary by Carole Mundell. The program consisted of 24 invited talks, 57 contributed talks and 30 posters. Topics of presentations and discussions spanned a wide range and included similarity and diversity of black hole systems, gamma ray bursts, tidal disruption events, active galactic nuclei, gravitational waves, black hole systems as multi-messenger sources and tools for testing theories of gravity and elementary particles, current and future large experimental facilities, and opening of new observational horizons.

Scientific highlights of the symposium included presentations and discussions on:

- *Similarities and diversities of black hole systems*, how a large-scale disk dynamo creates large-scale, long-lived jets; influence of time-dependent collapse history, growth of supermassive black holes and seed black holes.
- *Magnetic field in black hole systems*, in particular spatially resolved images of jets, polarisation, multi-messenger signals, and advances in numerical simulations of the magnetic field effects.
- *Tidal Disruption Events* and origin of UV/optical emission in them, rareness of relativistic events, possible unification scheme, host galaxies properties, estimation of type and mass of disrupted star, and many other puzzles unresolved due to a small number of these events discovered so far.
- *The birth of gravitational wave astronomy*, the information contained in gravitational wave signals (inspiral, merger and ringdown phase), potential electromagnetic signals, and possibilities of constraining the neutron star equation of state.

- *Tests of fundamental physics and black holes*, including quantum gravity ‘zoo’ and advances in theoretical modelling of gravitational waves.

Poster’s presenters were given an opportunity to give a short highlight talk of their work and to take part in the best poster competition with prizes drawn from traditional Slovenian natural produce.

Social program of the symposium included a walking tour of Ljubljana, symposium dinner and trip to Postojna Caves and Lanthieri mansion in Vipava.

Symposium program was accompanied by several events for general public. In a public lecture on Sep 14, 2016, exactly on the 1st anniversary of the first direct detection of gravitational waves, Sheila Rowan presented a captivating story about detection of gravitational waves, in front of the packed full symposium hall. Exhibitions about black holes were on view during the symposium week in the National Assembly of the Republic of Slovenia and in the Cankar Centre, the symposium venue. After the symposium, one exhibition was put on display in Slovenian Museum of Natural History, while the other one is travelling and visiting Slovenian schools. To maximize educational outreach we invited all interested teachers to the symposium, to view the posters and listen to review talks. We organized a special teachers workshop on black holes in collaboration with the Society of Mathematicians, Physicists and Astronomers of Slovenia. General public and media exhibited large interest in the symposium, with all major TV stations and journals reporting news about the symposium and/or publishing interviews with symposium participants.

We were indeed very happy and honoured to host this symposium! It was not only the first International Astronomical Union Symposium held in Slovenia, but also the largest professional astronomy meeting in Slovenia so far.

I hope that these proceedings will serve as a summary of the highly interesting contributions and fruitful discussions held during the symposium, and that they will be especially useful to researchers and graduate students engaged in many different, yet all very exciting, research fields related to black holes.

Andreja Gomboc
Chair of the SOC and LOC
Ajdovščina, March 8, 2017

Acknowledgements

The symposium was sponsored by travel grants from the International Astronomical Union and supported by the International Astronomical Union Divisions A (Fundamental Astronomy), B (Facilities, Technologies and Data Science), C (Education, Outreach and Heritage), D (High Energy Phenomena and Fundamental Physics), J (Galaxies and Cosmology), and Commission 44 (Space & High Energy Astrophysics).

We are grateful to members of the Scientific Organizing Committee and the Local Organizing Committee for their highly valuable contributions.

Many special thanks to Carole Mundell for co-chairing the symposium!

Financial support by Aresis Ltd. and IPZ d.o.o. is gratefully acknowledged.

Scientific Organizing Committee:

Andreja Gomboc, University of Nova Gorica (chair)
Carole Mundell, University of Bath (co-chair)
Felix Aharonian, Max Planck Institute for Nuclear Physics
Dave Burrows, The Pennsylvania State University
Paula Chadwick, Durham University
Stefano Covino, INAF- Astronomical Observatory Brera - Merate
Gabriela Gonzales, Louisiana State University
Shiho Kobayashi, Liverpool John Moores University
Stefanie Komossa, Max Planck Institute for Radio Astronomy
Elina Lindfors, University of Turku
Stephan Rosswog, Stockholm University
Subir Sarkar, University of Oxford
Kenji Toma, Tohoku University
Diana Worrall, University of Bristol

Local Organizing Committee:

Andreja Gomboc (chair)
Aurora Clerici
Uroš Kostić
Gašper Kukec Mezek
Marta Trini
Gabrijela Zaharijaš
Lili Yang

Sponsors:

Aresis Ltd.
IPZ d.o.o.

Cover image text:

Logo of the IAU Symposium 324 on the background of NGC 6240 (Logo Credit: B. Žalar, Photo Credits: X-ray: NASA/CXC/MIT/C. Canizares, M. Nowak; Optical: NASA/STScI)

CONFERENCE PHOTOGRAPH





Photo 1. Introductory review of the black hole concept and development of black hole research field given by Prof. Virginia Trimble (12 Sep 2016, photo: D. Novakovič/STA).

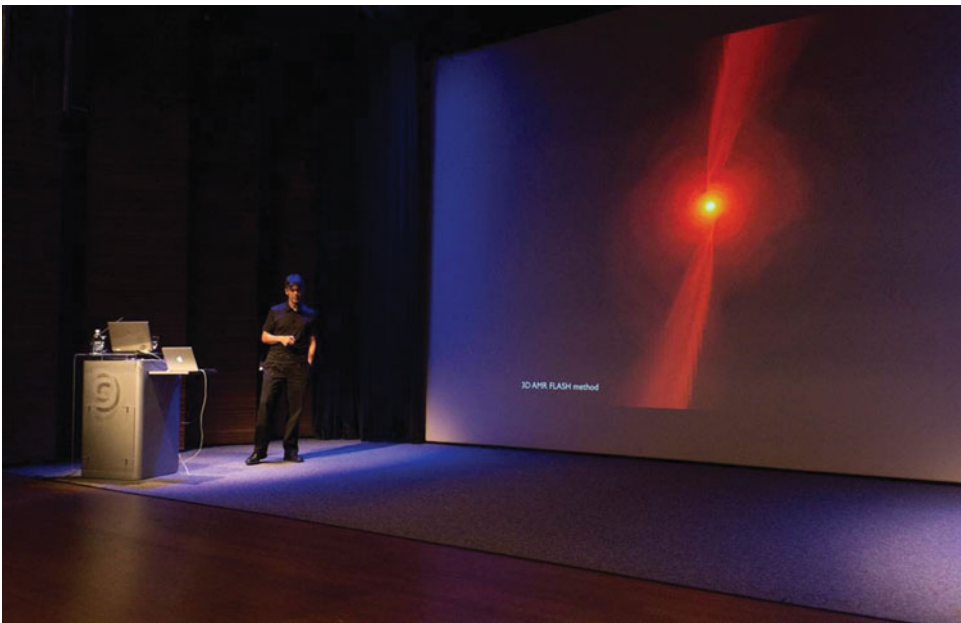


Photo 2. Enrico Ramirez-Ruiz reviewing numerical simulations of tidal disruption events (13 Sep 2016, photo: G. Kukec Mezek).



Photo 3. Discussions during a coffee break (photo: G. Kukec Mezek).



Photo 4. Symposium trip to Postojna Cave (14 Sep 2016, photo: G. Kukec Mezek).



Photo 5. Announcement of the poster competition winners (15 Sep 2016, photo: G. Kukec Mezek).



Photo 6. Public lecture on gravitational waves given by Sheila Rowan on the first anniversary of the first direct detection by the LIGO observatory (14 Sep 2016, photo: N. Tejić/STA).



Photo 7. Exhibition about black holes in the National Assembly of the Republic of Slovenia (12-16 Sep 2016, photo: B. Peršolja).

PARTICIPANTS

Tal Alexander	Weizmann Inst. of Science, Israel	tal.alexander@weizmann.ac.il
Cornelia Arcaro	INFN Padova & Padova Univ., Italy	cornelia.arcaro@pd.infn.it
Farruh Atamurotov	Ulugh Beg Astronomical Institute, Uzbekistan	farruh@astrin.uz
Patrycja Bagińska	Adam Mickiewicz Univ., Poland	patibag@gmail.com
Charles Bailyn	Yale Univ. / Yale-NUS College, USA	charles.bailyn@yale.edu
Maxim Barkov	University of Potsdam, Germany	barmv05@gmail.com
Josefa Becerra Gonzalez	NASA Goddard SFC, USA	jbecerragonzalez@gmail.com
Alessio Berti	INFN, University of Trieste, Italy	alessioberti90@gmail.com
Geoffrey Bicknell	RSAA, Australian National Univ., Australia	geoff.bicknell@anu.edu.au
Akos Bogdan	Harvard-Smithsonian CfA, USA	abogdan@cfa.harvard.edu
Edi Bon	Astronomical Observatory, Serbia	ebon@aob.rs
Nataša Bon	Astronomical Observatory, Serbia	nbon@aob.rs
Iztok Bončina	Astronomsko društvo Javornik, Slovenia	iztok.boncina@guest.arnes.si
Željka Marija Bošnjak	University of Rijeka, Croatia	bosnjak@uniri.hr
Martin Bourne	Kavli Institute for Cosmology, IoA, UK	mabourne@ast.cam.ac.uk
Katja Bricman	University of Ljubljana, Slovenia	katjabricman@gmail.com
Alberto Carraminana	INAOE, Mexico	alberto@inaoep.mx
Brad Cenko	NASA GSFC, USA	brad.cenko@nasa.gov
Paula Chadwick	University of Durham, UK	p.m.chadwick@durham.ac.uk
Sunil Chandra	TIFR, India	sunil.chandra355@gmail.com
Marisa Charisi	Columbia University, USA	mc3561@columbia.edu
Surajit Chattopadhyay	PCMT, India	surajitchatto@outlook.com
Aurora Clerici	University of Nova Gorica, Slovenia	aurora.clerici@ung.si
Carlos Coimbra Araujo	Univ. Federal do Paraná, Brazil	carlos.coimbra@ufpr.br
Stefano Covino	INAF / Brera, Italy	stefano.covino@brera.inaf.it
Andrej Čadež	University of Ljubljana, Slovenia	andrej.cadez@fmf.uni-lj.si
Miha Černetič	University of Ljubljana, Slovenia	miha@filetki.si
Colin Degraf	IoA, University of Cambridge, UK	cdegraf@ast.cam.ac.uk
Barbara De Lotto	University of Udine & INFN, Italy	barbara.delotto@uniud.it
Anja Dobravec	University of Ljubljana, Slovenia	anja.dobravec@gmail.com
Dijana Dominis Prester	University of Rijeka, Croatia	dijana@phy.uniri.hr
Ioana Duțan	Institute of Space Science, Romania	idutan@spacescience.ro
Viacheslav Emelyanov	KIoT, IoTP, Germany	viacheslav.emelyanov@kit.edu
Dimitrios Emmanoulopoulos	University of Southampton, UK	d.emmanoulopoulos@soton.ac.uk
Dunja Fabjan	University of Ljubljana, Slovenia	dunja.fabjan@fmf.uni-lj.si

Vandad Fallah Ramazani Juan Antonio Fernández Ontiveros Sandor Frey	University of Turku, Finland Inst. de Astrof. de Canarias, Spain Satellite Geod. Observatory, Hungary	vafara@utu.fi jaf@iac.es frey.sandor@fomi.hu
Krisztina Gabányi	Satellite Geod. Observatory, Hungary	gabanyik@sgo.fomi.hu
Stefano Gabici Mikhail Garasev	Laboratoire APC, France Institute of Applied Physics, Russian Federation	gabici@apc.in2p3.fr garasev@appl.sci-nnov.ru
Sarah Gibson Andreja Gomboc	University of Leicester, UK University of Nova Gorica, Slovenia	slg44@le.ac.uk andreja.gomboc@ung.si
Rene Goosmann	Obs. astron. de Strasbourg, France	rene.goosmann@astro.unistra.fr
Diego Götz Minfeng Gu	CEA Saclay, France Shanghai Astronomical Obs., CAS, China	diego.gotz@cea.fr gumf@shao.ac.cn
Mark Hannam Carlos Herdeiro Talvikki Hovatta	Cardiff University, UK Aveiro University, Portugal Aalto Univ. Metsahovi Radio Obs., Finland	mark.hannam@astro.cf.ac.uk herdeiro@ua.pt talvikki.hovatta@aalto.fi
Xiaoli Huang Samo Ilc	Guangxi University, China University of Ljubljana, Slovenia	1536756072@qq.com samo.ilc37@gmail.com
Susumu Inoue Kunihito Ioka	RIKEN, Japan YITP, Kyoto University, Japan	susumu.inoue@riken.jp kunihito.ioka@yukawa.kyoto-u.ac.jp
Željko Ivezić Agnieszka Janiuk	University of Washington, USA Center for Theor. Physics, PAS, Poland	ivezic@astro.washington.edu agnes@cft.edu.pl
Taj Jankovič	University of Ljubljana, Slovenia	taj.jankovic@gmail.com
Pavel Jefremov	ZARM, Univ. Bremen, Germany	paulefremov@gmail.com
Helen Jermak Aleksej Jurca Anton Jurca Vassilis Karamanavis	Lancaster University, UK Gimnazija Bežigrad, Slovenia Max-Planck-Inst. für Radioastr., Slovenia Germany	h.jermak@lancaster.ac.uk vkaraman@mpifr-bonn.mpg.de
Sergey Karpov Shai Kaspi Nobuyuki Kawai	SAO RAS, Russian Federation Tel Aviv University, Israel Tokyo Inst. of Technology, Japan	karpov.sv@gmail.com shai@wise.tau.ac.il nkawai@phys.titech.ac.jp
Norita Kawanaka	University of Tokyo, Japan	norita@astron.s.u-tokyo.ac.jp
Minjin Kim	Korea Astr. and Space Sc. Inst., Republic of Korea	mkim@kasi.re.kr
Shiho Kobayashi Serguei Komissarov Stefanie Komossa Uroš Kostič Gašper Kukec Mezek	ARI, Liverpool JMU, UK University of Leeds, UK MPIFR, Germany Aalta Lab d.o.o., Slovenia University of Nova Gorica, Slovenia	S.Kobayashi@ljmu.ac.uk s.s.komissarov@leeds.ac.uk stefanie.komossa@gmx.de uros.kostic@aalta-lab.com gasper.kukec@ung.si
Pawan Kumar Jutta Kunz	Univ. of Texas at Austin, USA University of Oldenburg, Germany	pk@astro.as.utexas.edu jutta.kunz@uni-oldenburg.de
Samo Kupper	Fizikalno društvo Kočuha, Austria	samo.kupper@expi.at
Gavin Lamb Robert Lasenby	ARI, Liverpool JMU, UK Perimeter Institute, Canada	g.p.lamb@2010.ljmu.ac.uk robertlasenby@gmail.com

Shuangliang Li	Shanghai Astronomical Obs., China	lisl@shao.ac.cn
Enwei Liang	Guangxi University, China	LEW@GXU.EDU.CN
Elina Lindfors	Tuorla Obs., Univ. of Turku, Finland	elilin@utu.fi
Tamilan Mageshwaran	Indian Institute of Astrophysics, India	mageshwaran@iiap.res.in
Pablo Marchant	Universität Bonn, Germany	pamarca@gmail.com
Paola Marziani	INAF - Astron. Obs. Padova, Italy	paola.marziani@oapd.inaf.it
Jin Matsumoto	RIKEN, Japan	jin.matsumoto@riken.jp
Tatsuya Matsumoto	Kyoto University, Japan	matsumoto@tap.scphys.kyoto- u.ac.jp
Kevin Meagher	Univ. libre de Bruxelles, Belgium	kmeagher@ulb.ac.be
Attila Meszáros	Charles University, Czech Republic	meszaros@cesnet.cz
Felix Mirabel	CEA-Saclay-France, France	felix.mirabel@cea.fr
Carole Mundell	University of Bath, UK	c.g.mundell@bath.ac.uk
Saeede Nafsooshe	Trieste University, Italy	saeede.nafsooshe@ung.si
Priyamvada Natarajan	Yale University, USA	priyamvada.natarajan@yale.edu
Lubos Neslusan	AISAS, Slovakia	ne@ta3.sk
Zsolt Paragi	Joint Inst. for VLBI ERIC, Netherlands	zparagi@jive.eu
Qiuhe Peng	Nanjing University, China	qhpeng@nju.edu.cn
Bradley Peterson	Ohio State Univ./STSI, USA	peterson.12@osu.edu
Pauli Pihajoki	University of Helsinki, Finland	pauli.pihajoki@helsinki.fi
Peter Raffai	Lorand Eotvos University, Hungary	praffai@bolyai.elte.hu
Enrico Ramirez-Ruiz	UCSC, USA	enrico@ucolick.org
Antti Rantala	University of Helsinki, Finland	antti.rantala@helsinki.fi
Sheila Rowan	University of Glasgow, UK	sheila.rowan@glasgow.ac.uk
Richard Saxton	XMM SOC / ESAC, Spain	rsaxton@sciops.esa.int
Luka Seliškar	University of Ljubljana, Slovenia	lmdogg@gmail.com
Roberto Serafinelli	Univ. of Rome ‘Tor Vergata’, Italy	roberto.serafinelli@roma2.infn.it
Samo Stanič	University of Nova Gorica, Slovenia	samo.stanic@ung.si
Iain Steele	ARI, Liverpool JMU, UK	i.a.steele@ljmu.ac.uk
Lisa K. Steinborn	Univ.-Sternwarte München, Germany	steinborn@usm.lmu.de
Petra Sukova	CTP PAS, Poland	psukova@cft.edu.pl
Tachibana Yutaro	Tokyo Inst. of Technology, Japan	tachibana@hp.phys.titech.ac.jp
Hiroimichi Tagawa	University of Tokyo, Japan	tagawahr@nao.ac.jp
Ataru Tanikawa	University of Tokyo, Japan	tanikawa@ea.c.u- tokyo.ac.jp
Nial Tanvir	University of Leicester, UK	nrt3@le.ac.uk
Alexander Tchekhovskoy	UC Berkeley, USA	atckeho@berkeley.edu
Tomislav Terzić	University of Rijeka, Croatia	tomislav.terzic@gmail.com
Kenji Toma	Tohoku University, Japan	toma@astr.tohoku.ac.jp
Virginia Trimble	UC Irvine & Queen Jadwiga Obs., USA	vtrimble@astro.umd.edu
Marta Trini	University of Nova Gorica, Slovenia	marta.trini@ung.si
Audrey Trova	AIASCR, Czech Republic	trova@asu.cas.cz
Rok Vogrinčič	University of Ljubljana, Slovenia	rokvogrincic@gmail.com
Serguei Vorobiov	University of Nova Gorica, Slovenia	sergey.vorobyev@ung.si

Amri Wandel	Hebrew Univ. of Jerusalem, Israel	amri@huji.ac.il
Vojtěch Witzany	ZARM, Univ. Bremen, Germany	witzany@zarm.uni- bremen.de
Lukasz Wyrzykowski	Warsaw Universit, Poland	lw@astrouw.edu.pl
Lili Yang	University of Nova Gorica, Slovenia	lili.yang@ung.si
Farhad Yusef-Zadeh	Northwestern University, USA	zadeh@northwestern.edu
Gabrijela Zaharijas	University of Nova Gorica, Slovenia	gabrijela.zaharijas@ung.si
Luca Zampieri	INAF-Ast. Obs. Padova, Italy	luca.zampieri@oapd.inaf.it
Sebastjan Zamuda	Gimnazija Bežigrad, Slovenia	
Danilo Zavrtnik	University of Nova Gorica, Slovenia	danilo.zavrtnik@ung.si
Shuqing Zhong	Guangxi University, China	1548771042@qq.com
Tomaž Zwitter	University of Ljubljana, Slovenia	tomaz.zwitter@fmf.uni-lj.si
Maruša Žerjal	University of Ljubljana, Slovenia	marusa.zerjal@fmf.uni-lj.si