

Annual Report 2014
Instituto de Astrofísica
Facultad de Física
Pontificia Universidad Católica de Chile

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Abstract

The Institute of Astrophysics (IA) at PUC currently has 14 faculty members and hosted 47 postdoctoral researchers through 2014. The IA members published 188 refereed articles during 2014. In the academic year 2014, eight students received their *Licenciatura* degree, seven obtained an M.Sc., and one a Ph.D.

1 Introduction

The *Instituto de Astrofísica* (Institute of Astrophysics, IA) is one of the two academic divisions of the Faculty of Physics of *Pontificia Universidad Católica de Chile* (PUC). The Institute offers an undergraduate (*Licenciatura*) degree in Astronomy, and Ph.D. and Master's programmes in Astrophysics.

The mission of the IA is to be an international centre of excellence for studies in the field of Astrophysics, covering a broad range of topics in observational and theoretical astrophysics, and to prepare the next generations of students that will benefit from the superb observational facilities available to Chilean astronomers and their collaborators. In addition, the IA together with the associated Center for Astro-Engineering (AIUC) are engaged in innovative telescope instrumentation projects and high-performance computing programs. In this report, we review the main activities at IA from January until December 2014.

2 Personnel

2.1 Changes in 2014

2.1.1 New Postdocs

- Dr. D.A. Boettger arrived from the University of California, San Diego, USA.
- Dr. S.K.J. Chan arrived from Instituto de Astrofísica de Canarias, Spain.
- Dr. H. Drass arrived from the Ruhr-University Bochum, Germany.
- Dr. S. Duffau arrived from the University of Heidelberg, Germany.
- Dr. I. Lacerna arrived from UNAM, Mexico.

- Dr. N. Laporte arrived from Instituto de Astrofísica de Canarias, Spain.
- Dr. S.A. do Nascimento arrived from Universidade Federal do Rio Grande do Norte, Brazil.
- Dr. R. Nikutta arrived from Universidad Andrés Bello.
- Dr. T. Palma arrived from Universidad Nacional de Córdoba, Argentina.
- Dr. L. Sbordone arrived from the University of Heidelberg, Germany.
- Dr. Z. Zheng arrived from the Arizona State University, USA.

2.1.2 Postdoc Departures

- Dr. R. Angeloni left to take on a Gemini Science Fellowship at Gemini Observatory in Chile
- Dr. P. Arévalo left to take on a faculty position at Universidad de Valparaíso.
- Dr. E. Ibar left to take on a faculty position at Universidad de Valparaíso.
- Dr. J. Mitchell left to complete his joint postdoctoral position at the University of Bonn, Germany.
- Dr. M. Montesinos left to take on a postdoctoral position at Universidad de Chile.
- Dr. Á. Orsi left to take on a postdoctoral position at CEFCA, Spain.
- Dr. C. Sáez left to take on a postdoctoral position at the University of Maryland, US.
- Dr. T.E. Tecce left to take on a position at a software company in Buenos Aires, Argentina.

2.1.3 Faculty Departure

Dr. D. Minniti moved to Universidad Andrés Bello.

2.2 IA Faculty

- Dr. Felipe Barrientos, Associate Professor (Ph.D. University of Toronto, Canada, 1999) – *Galaxy evolution and morphology. Elliptical galaxies. Clusters of galaxies. Observational cosmology.*
- Dr. Franz E. Bauer, Associate Professor (Ph.D. University of Virginia, USA, 2001) – *AGN Demographics, Feeding, and Evolution. Coeval Growth of Galaxies and Super-Massive Black Holes. Deep Blank-field Surveys (Radio through X-ray). Nearby Supernovae and X-ray Binaries. Structure Formation and Galaxy Cluster Evolution.*
- Dr. Márcio Catelan, Full Professor (Ph.D. Universidade de São Paulo, Brazil, 1996) – *Stellar structure and evolution. Globular clusters. Variable stars. Stellar Populations. Galaxy formation and evolution.*
- Dr. Julio Chanamé, Assistant Professor (Ph.D. The Ohio State University, USA, 2005) – *Stellar dynamics. The Milky Way and the Local Group. Stellar structure and evolution.*
- Dr. Alejandro Clocchiatti, Full Professor (Ph.D. University of Texas at Austin, USA, 1995) – *Supernovae, near and far. Radiative Transfer. Galaxy Clusters. Cosmology.*
- Dr. Jorge Cuadra, Assistant Professor (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2006) – *Gas dynamics around massive black hole binaries. Accretion onto Sgr A*. Protoplanetary discs. Star formation and dynamics in galactic nuclei.*
- Dr. Rolando Dünner, Adjunct Assistant Professor, (Ph.D. PUC, 2009) – *Large scale structure and cosmology. Astronomical instrumentation.*
- Dr. Gaspar Galaz, Associate Professor and IA Director since April 2014 (Ph.D. Université de Paris, France, 1998) – *Stellar population in galaxies. Galaxy evolution. Statistical properties of the galaxy distribution.*
- Dr. Leopoldo Infante, Full Professor (Ph.D. University of Victoria, Canada, 1990) – *Galaxy and structure evolution. Pairs, groups and clusters of galaxies. LSB, dwarf and star forming galaxies in relation to environment. High-z QSOs. Correlation functions. The very high redshift universe.*
- Dr. Andrés Jordán, Associate Professor (Ph.D. Rutgers University, USA, 2004) – *Search and characterization of transiting exoplanets. Galaxies in nearby clusters. Star clusters.*
- Dr. Nelson Padilla, Associate Professor (Ph.D. Universidad Nacional de Córdoba, Argentina, 2001) – *Numerical astrophysics. Galaxy and Structure Formation. Cosmology.*
- Dr. Thomas H. Puzia, Assistant Professor (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2003) – *Star clusters and star cluster systems. Chemical evolution and enrichment histories of galaxies. Galaxy formation and evolution. Stellar dynamics. Stellar populations. Population synthesis models. Stellar abundances. Hierarchical structure formation. Mass assembly of galaxies.*
- Dr. Andreas Reisenegger, Full Professor and IA Director until March 2014 (Ph.D. Caltech, USA, 1993) – *Theoretical Astrophysics and Cosmology. Neutron Stars. Stellar Magnetic Fields. Structure Formation. Clusters and Superclusters of Galaxies.*
- Dr. Manuela Zoccali, Associate Professor, (Ph.D. Università degli Studi di Padova, Italy, 2000) – *Stellar Populations in the Milky Way. The Galactic Bulge. Star Clusters. Chemical Abundances.*

2.3 Postdoctoral Fellows 2014

The following scientists held postdoctoral positions at the IA during the reported period.

- Dr. Javier Alonso-García (Ph.D. University of Michigan, USA, 2010) – *Stellar populations. Galactic astronomy. Stellar evolution. Stellar variability. Photometry.*
- Dr. Rodolfo Angeloni (Ph.D. University of Padova, Italy, 2009) – *Symbiotic Stars. Interstellar Dust. Stellar variability. Photometry. Nebular Spectroscopy.*
- Dr. Patricia Arévalo (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2006) – *AGN structure. X-ray/optical/IR variability. Galaxy clusters.*
- Dr. David A. Boettger (Ph.D. University of California, San Diego, USA, 2014) – *TBD*
- Dr. Mark Booth (Ph.D. Cambridge University, UK, 2010) – *Debris discs. Planetary systems. Small Solar System Bodies. Astrobiology.*
- Dr. Mia Bovill (Ph.D. University of Maryland, USA, 2011) – *Galaxy formation.*
- Dr. Siu Kuen Josephine Chan (Ph.D. University of Calgary, Canada, 1992) – *Infrared astronomy. Astro-statistics. Astro-informatics. Interstellar dust/matter. Star-formation regions. YSOs. Nearby*

- galaxies. Late-type stars. Stellar evolution. Circumstellar dust/matter. Galactic chemical evolution. Astro-chemistry.*
- Dr. Rodrigo Contreras Ramos (Ph.D. University of Bologna, Italy, 2010) – *Stellar structure and evolution. Globular clusters. Variable stars. Stellar Populations. Galaxy formation and evolution. Photometry.*
 - Dr. Jesús M. Corral-Santana (Ph.D. IAC, Spain, 2012) – *Observational studies of compact objects in X-ray binaries. Stellar evolution: Dynamical confirmation of stellar-mass black holes. Transient X-ray binaries. Photometry. Spectroscopy.*
 - Dr. István Dékány (Ph.D. Eötvös Loránd University, Hungary, 2010) – *Photometry. Time-series analysis. Stellar pulsation. Stellar evolution.*
 - Dr. Holger Drass (Ph.D. Ruhr–University of Bochum, Germany, 2014) – *Brown dwarfs and free-floating planetary mass objects in nearby star-forming regions. Instrumentation.*
 - Dr. Sonia Duffau (Ph.D. Universidad de Chile, 2008) – *Stellar populations. Structure and chemistry of our Galaxy. Streams in the halo. Variable stars. RR Lyrae.*
 - Dr. Alex Dunhill (Ph.D. University of Leicester, UK, 2013) – *Planet–disc interactions. Binary super-massive black holes. Numerical hydrodynamics.*
 - Dr. Paul Eigenthaler (Ph.D. University of Vienna, Austria, 2011) – *Fossil Galaxy Groups, Compact Galaxy Groups, Stellar populations, Tidal Dwarf Galaxies, Spectroscopy.*
 - Dr. Cristóbal Espinoza (Ph.D. University of Manchester, UK, 2010) – *Pulsar Astronomy: timing, spin evolution, glitches and timing noise.*
 - Dr. Roberto González (Ph.D. PUC, 2009) – *Cosmology: Large scale structure, DM–galaxy connection, environment. Computational Astrophysics: N-body codes, initial conditions, LSS and cluster/single galaxy zoom simulations, halo and structure identification.*
 - Dr. Maren Hempel (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2004) – *Globular cluster systems. Stellar Populations. Galaxy formation and evolution.*
 - Dr. Eduardo Ibar (Ph.D. University of Edinburgh, UK, 2009) – *Observational cosmology, including: galaxy formation and evolution, star-forming galaxies and active galactic nuclei, submm galaxies, deep radio, X-ray surveys and cosmic star-formation rate.*
 - Dr. Matías Jones (Ph.D. Universidad de Chile, 2013) – *Stellar spectroscopy. Extrasolar planets. Instrumentation.*
 - Dr. Sam Kim (Ph.D. University of California at Irvine, USA, 2012) – *Compact overdensity and proto-cluster study. High redshift galaxy evolution. Strong lensing phenomena of submm bright galaxies. Cosmological mass assembly.*
 - Dr. Régis Lachaume (Ph.D. Université de Grenoble, France, 2003) – *Optical long-baseline interferometry. Young stellar objects. Multiple stellar systems.*
 - Dr. Iván Lacerna (Ph.D. PUC, 2012) – *Formation and evolution of galaxies. Large-scale structure.*
 - Dr. Nicolas Laporte (Ph.D. Université de Toulouse III, France, 2013) – *First galaxies. Galaxy evolution. Epoch of reionization. NIR spectroscopy. Luminosity Function.*
 - Dr. Loïc Maurin (Ph.D. Université Paris Diderot, France, 2013) – *Cosmology. Polarization of the cosmic microwave background.*
 - Dr. Adal Mesa-Delgado (Ph.D. Instituto de Astrofísica de Canarias, Spain, 2010) – *Interstellar Medium. HII regions. Chemical abundances.*
 - Dr. Joe Mitchell (Ph.D. Florida State University, USA, 2012) – *Simulations of the singly degenerate progenitors of SNe Ia. Nuclear Astrophysics. Nuclear structure. MHD simulations, stellar magnetic fields.*
 - Dr. Matías Montesinos Armijo (Ph.D. Observatoire de la Côte d’Azur, France, 2011) – *Accretion disks. Active Galactic Nuclei. Supermassive black holes. Numerical Simulations.*
 - Dr. Marcelo Mora (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2008) – *Stellar populations. Extragalactic star clusters systems*
 - Dr. Roberto Muñoz (Ph.D. PUC, 2009) – *Galaxy evolution. Galaxy dynamics. Galaxy clusters. Dark matter mass profiles. Gravitational lensing.*
 - Dr. David Murphy (Ph.D. Durham University, UK, 2011) – *Large-scale structure & extragalactic physics. Filaments and clusters of galaxies. Galaxy evolution*

- Dr. Sânzia Alves do Nascimento (Ph.D. Universidade Federal do Rio Grande do Norte, Brazil, 2012) – *Spectroscopy. Stellar abundances. Globular clusters. Variable stars. Astro-statistics.*
 - Dr. Robert Nikutta (Ph.D. University of Kentucky, USA, 2012) – *Physics of AGN central regions. Clumpy torus. Dust radiative transfer. SED modeling. IR properties & X-ray variability of AGN. Bayesian inference. Astro-statistics. Big data.*
 - Dr. Álvaro Orsi (Ph.D. Durham University, UK, 2010) – *Galaxy formation. Large Scale structure. Semi-analytical modelling. High redshift galaxies. Ly α radiative transfer.*
 - Dr. Tali Palma (Ph.D. Universidad Nacional de Córdoba, Argentina, 2013) – *Stellar populations. Star clusters and star cluster systems. Stellar variability. Galactic and extragalactic chemical evolution.*
 - Dr. Karla Peña Ramírez (Ph.D. Instituto de Astrofísica de Canarias, Spain, 2010) – *Brown dwarfs and planetary mass objects: circumstellar matter, luminosity function, mass function, open clusters and associations.*
 - Dr. Sibilla Perina (Ph.D. University of Bologna, Italy, 2010) – *Stellar populations. Star clusters. Stellar evolution. Population synthesis models. Photometry.*
 - Dr. Markus Rabus (Ph.D. Universidad de la Laguna, Spain, 2009) – *Search and characterization of exoplanets.*
 - Dr. Cristina Romero-Cañizales (Ph.D. Universidad de Granada, Spain, 2011) – *AGN and star formation activity in luminous infrared galaxies. Core-collapse supernovae. Astronomical masers.*
 - Dr. Cristián Sáez (Ph.D. Penn State University, USA, 2010) – *Active Galactic Nuclei. AGN X-ray evolution. AGN winds in broad absorption line (BAL) quasars.*
 - Dr. Luca Sbordone (Ph.D. Università di Roma Tor Vergata, Italy, 2005) – *Stellar chemical abundances. Stellar atmosphere modelling. Chemical evolution of the Milky Way and its satellites. Extremely metal poor stars.*
 - Dr. Steve Schulze (Ph.D. University of Iceland, 2012) – *Gamma-ray bursts. Core-collapse Supernovae. High-redshift galaxies. Photometry. Spectroscopy.*
 - Dr. Tomás E. Tecce (Ph.D. Universidad de Buenos Aires, Argentina, 2011) – *Galaxy formation. Extragalactic astronomy. Galaxy clusters. Cosmology. Numerical methods.*
 - Dr. Paulina Troncoso (Ph.D. La Sapienza Università di Roma, Italy, 2013) – *Galaxy evolution. High redshift galaxies. 3D spectroscopy.*
 - Dr. Aldo A.R. Valcarce (Ph.D. PUC, 2011) – *Stellar Evolution: Modelling, Chemical Abundances. Star Clusters: Formation, Evolution, Multiple Populations. Stellar Populations. Galaxy: Formation.*
 - Dr. Millarca Valenzuela (Ph.D. Universidad de Chile, 2011) – *Flux of extraterrestrial matter to Earth (meteorites, micrometeorites and cosmic spherules). Petrology and geochemistry of ordinary and carbonaceous chondrites. Weathering processes in deserts. Atacama Desert Meteorite Collection. Antarctic multidisciplinary studies on Geology, Astrobiology, Astronomy and Glaciology. Impact cratering. Cosmogenic nuclides (10Be, 36Cl, 14C).*
 - Dr. Jingcheng Yu (Ph.D. Shanghai Astronomical Observatory, China, 2012) – *Star Clusters. N-body Simulations.*
 - Dr. Zhenya Zheng (Ph.D. University of Science and Technology of China, 2012) – *High redshift emission line galaxies. Active Galactic Nuclei (AGN): x-ray properties and variability.*
- Support for the postdoctoral fellows comes mostly from the FONDECYT programme, grants from the Joint ESO–Chile Committee for the Development of Astronomy in Chile, the ALMA–CONICYT and Gemini–CONICYT funds, the Millennium Scientific Initiative, and the Basal programme (see § 6).

2.4 Technical Staff and Assistants

- Luis Mauricio Barz *Caretaker.*
- Karina Charris *Administrative Assistant.*
- Carmen Gloria Cordovez *Administrative Assistant.*
- Lorena Guzmán (Journalist) *Outreach activities.*
- Lilena Montenegro *Administrative Assistant.*
- Vincent Suc (Electrical Engineer, INSA, Lyon, France) *Local engineer for HAT-South and Megacam / MMIRS. Engineer at Teaching Observatory at Santa Martina.*
- Dr. José Miguel Fernández (Ph.D. PUC, 2009) *Astronomer at Teaching Observatory at Santa Martina.*

- Giselle Ulloa *Administrative Coordinator of the Institute.*
- Juan Véliz *System Manager. Software Specialist.*
- Mariela Villanueva *IT Assistant.*

2.5 Recognitions, Awards and Sabbaticals

N. Espinoza received the Grad Student Prize for his contribution to the Chilean Astronomical Society (SOCHIAS) XI Annual Meeting. He also received the People’s Choice Award at PUC’s 3-Minute Thesis Competition, which involved all doctoral programmes in the University.

L. Infante spent his sabbatical period during 2014 at the University of Victoria, Canada, and at Gemini Observatory, Hilo, Hawaii, USA. During this period he accepted an invitation to participate in the AURA Board of Directors and represented Chile in the AURA Management Council for LSST (AMCL).

N. Padilla finished his sabbatical period in July 2014 at the Max-Planck-Institut für Astrophysik (Garching, Germany).

A. Reisenegger started his sabbatical period in August 2014. He used this period to participate in conferences in Russia, and to pay collaboration visits at the University of Bonn, Germany, and McGill University, Canada.

3 Academic Programmes and Teaching

The IA offers graduate and undergraduate programmes in Astrophysics, as detailed below. Our faculty members are in charge of all Astrophysics courses, both for our programmes and for students from other majors, plus some courses on Physics.

During 2014, we taught 28 semester-long courses, which can be categorised as follows:

- Astrophysics undergrad core courses (7)
- Astrophysics graduate core courses (5)
- Astrophysics elective courses (6)
- sections of Astronomy/Physics courses for non-majors (8)
- Physics service courses (2)

From these courses we could highlight the creation of a new elective course, *Putting Numbers on the Earth and the Universe*, by A. Reisenegger, aimed at improving the student’s skills related to quantitative reasoning, numerical estimates, and appreciation of orders of magnitude and units of measurement. In this first version, the course was completed by 16 students from the fields

of Biological Sciences, Biochemistry, Geography, Engineering, Astronomy, Physics, and the College of Natural Sciences and Mathematics. Also, each semester we offer a section of the basic Astronomy course in English, and most of the graduate courses are taught in English.

3.1 Graduate Programme

The IA offers Ph.D. and Master programmes in Astrophysics. They include core courses on Physical Processes in Astrophysics, Advanced Stellar Astrophysics, and Advanced Extragalactic Astrophysics. The programmes are completed with elective courses, supervised research, and a thesis. Students typically start research projects during their first year.

3.1.1 Degrees obtained

- Cristóbal Armaza obtained his Master’s Degree, defending his thesis entitled “*On magnetic equilibria in barotropics stars*”, supervised by A. Reisenegger and J.A. Valdivia (UCh). He then moved to the Institute of Physics, PUC, to take on a research assistant position.
- Dr. Mauricio Carrasco obtained his Ph.D. Degree, defending his thesis entitled “*Mass distribution in galaxy clusters: strong lensing and dynamical mass analysis*”, supervised by F. Barrientos and M. Bartelmann (Heidelberg). He then moved to the University of Heidelberg, Germany, to take on a postdoctoral position.
- Esteban Castillo obtained his Master’s Degree, defending his thesis entitled “*On the integration of files and quanta in time-dependent backgrounds*”, supervised by B. Koch (Physics, PUC) and G. Palma (UCh). He then joined the Ph.D. programme at the Institute of Physics, PUC.
- Andrea Corvillón obtained her Master’s Degree, defending her thesis entitled “*Fotometría de cúmulos globulares en el infrarrojo cercano*”, supervised by M. Catelan. She then moved to ALMA, to take on a PHT Operations Specialist position.
- Rodrigo Leiva obtained his Master’s Degree, defending his thesis entitled “*E+A Galaxies in the SDSS*”, supervised by G. Galaz. He then joined the Ph.D. programme at the IA.
- Camila Navarrete obtained her Master’s Degree, defending her thesis entitled “*Near-IR period–luminosity relations for variable stars in ω Centauri*”, supervised by M. Catelan. She then joined the Ph.D. programme at the IA.
- Felipe Rojas obtained his Master’s Degree, defending his thesis entitled “*Making maps with ACT Data*”,

supervised by R. Dünner. He is now working for the Atacama Cosmology Telescope.

- Pedro Salas obtained his Master’s Degree, defending his thesis entitled “*A two-element radio interferometer for education*”, supervised by R. Dünner. He then joined the Ph.D. programme at the University of Leiden, Netherlands.

3.2 Undergraduate Programme

The PUC undergraduate programme in Astronomy currently has ~ 100 students, who are consistently drawn from the top 2% of the $\sim 300,000$ high school seniors who take the nationally administered entrance examination (PSU) each year.

A group of 33 new students registered in the programme through the regular admission process to start in March 2015. The last admitted student scored 715.3 points at the PSU. Additionally, eight students registered through the Special Admissions process.

Undergraduate students work full time during the last semester of the program on a research project under the supervision of a faculty member. The 8 students who obtained their degree during this period, the subject of their theses, and their supervisors are:

- Jorge Anais *Un nuevo software astrométrico para el Telescopio Swope* – (M. Zoccali)
- Camilo Fontecilla *Simulación en una dimensión de discos de acreción en un sistema binario de agujeros negros supermasivos* – (J. Cuadra)
- Stefano García *Evolución de las propiedades físicas de galaxias con formación estelar en el rango $0.52 < z < 1.35$* – (L. Infante)
- Diego Godoy *Age-Rotation Constraints using Wide Binaries in the Kepler Field* – (J. Chanamé)
- Nicolás Godoy *QSOs en dirección del bulbo galáctico* – (M. Zoccali)
- Luis Rodríguez *Torque magnético interno en estrellas* – (A. Reisenegger)
- María Paz Sepúlveda *Cinemática de Binarias Anchas del Halo en el Entorno Solar* – (J. Chanamé)
- José Vergara *Parallelization of the BLS algorithms for Exoplanet Photometric Time Series* – (A. Jordán)

4 Interdisciplinary Center: The UC Center for AstroEngineering, AIUC

AIUC was created in 2009 as a joint venture between the IA and the PUC Faculty of Engineering. The Center’s mission is to serve as channel to carry out research

and to generate new technological and computational opportunities in the areas of astronomy and engineering in Chile. Currently the AIUC includes three main parts: a Laboratory of Astronomical Instrumentation, a Center of data mining and numerical computation and a Astronomical Service area. The purpose of the first is to generate alliances with international observatories present in Chile, participate in the construction of optical and infrared instruments and trigger technological transfer to the country. The Computer Lab offers to the astronomical community a powerful tool for numerical computation and data analysis and provides the computing capability needed to handle large amounts of data collected by telescopes in Chile. Finally, the mission of the Service Area is to provide astronomical and engineering support to the international observatories located in Chile and facilitate specialized human resources.

5 Colloquia, seminars and science activities

Starting in 2012, the IA organises a series of astronomy colloquia that, modelled after similar programs with long traditions at major astronomical institutions in the world, targets outstanding speakers selected not only for their scientific achievements but also for their ability to communicate them well to a diverse audience. Among the obvious advantages of a Colloquium series of such characteristics, this plan is part of an integral effort by our Institute to improve the quality of our Graduate program, adding even more stimulating experiences to our daily scientific atmosphere.

Below is the programme of our Colloquia during 2014:

- 18/03 YARA JAFFE (Universidad de Concepción, Chile) *The Effect of Environment on the Gas and the Stars of Distant Galaxies*
- 25/03 KATRIEN STEENBRUGGE (Universidad Católica del Norte, Chile) *Cygnus A Revisited: Precessing Jets, Multiple Jet Activity, Periods, and Hotspot Shock-fronts*
- 01/04 THOMAS HENNING (Max Planck Institute for Astronomy, Germany) *From Gas Disks to Exoplanet Atmospheres*
- 08/04 SUBO DONG (Kavli Institute for Astronomy and Astrophysics, Peking University, China) *Direct Collision of White Dwarfs as a Major Channel for Type Ia Supernovae Explosions*
- 15/04 ROLANDO DÜNNER (Pontificia Universidad Católica de Chile, Chile) *The Era of CMB Polarization: Probing Fundamental Physics Through Cosmology*

- 22/04 HENRI BOFFIN (European Southern Observatory, Chile) *When Stellar Couples' Squabbling Leads to Cosmic Bubbles*
- 29/04 ALBERTO BOLATTO (University of Maryland, USA) *The ALMA View of One of the Nearest Starbursts*
- 20/05 JENNIFER YEE (Harvard-Smithsonian Center for Astrophysics, USA) *Microlensing: Beyond Planet Detection*
- 27/05 JAYMIE MATTHEWS (University of British Columbia, Canada) *A TransformerTM in space: Asteroseismology and Exoplanetary Science with the MOST Microsat*
- 03/06 LUCAS CIEZA (Universidad Diego Portales, Chile) *Transition Disks as Disk Evolution and Planet Formation Laboratories*
- 10/06 ARMIN REST (Space Telescope Science Institute, USA) *An Astronomical Time Machine: Light Echoes from Historic Supernovae and Stellar Eruptions*
- 17/06 PAUL MARTINI (The Ohio State University, USA) *The Mystery of Dust in Early-Type Galaxies*
- 24/06 ELENA D'ONGHIA (University of Wisconsin-Madison, USA) *Spiral Arms and Wobbles in Galactic Disks*
- 19/08 GARY STEIGMAN (The Ohio State University, USA) *BBN and the CMB Probe Cosmology and Particle Physics*
- 02/09 AMELIA BAYO (Universidad de Valparaíso, Chile) *Studying Low-Mass Stars in the VO... and Other Things!*
- 09/09 STEFFEN MIESKE (European Southern Observatory, Chile) *The Origin of the Mysterious Ultra-Compact Dwarf Galaxies*
- 23/09 MICHAEL RAUCH (Carnegie Observatories, USA) *Insights into High Redshift Galaxy Formation from Lyman Alpha Emission*
- 07/10 ANDREW CUMMING (McGill University, Canada) *Magnetic Field Evolution in Neutron Star Crusts*
- 14/10 ANDREA BELLINI (Space Telescope Science Institute, USA) *The Ultimate Catalog of omega Centauri: 26-band Photometry and Proper Motions*
- 21/10 ALAN DRESSLER (Carnegie Observatories, USA) *Faint Lyman-Alpha Emitters and the Reionization of the Universe*
- 28/10 ANDREI TOKOVININ (Cerro Tololo Inter-American Observatory, Chile) *The Origin of Multiple Stars*
- 04/11 MAJA VUČKOVIĆ (Universidad de Valparaíso, Chile) *Hot Subdwarf Stars as a Critical Test for Binary Stellar Evolution*
- 11/11 CLÉMENT BARUTEAU (University of Toulouse, France) *Planet-Disc Interactions and the Early Evolution of Planetary Systems*
- 18/11 CARLTON BAUGH (Durham University, United Kingdom) *A New Model of Galaxy Formation*
- 25/11 FÉLIX MIRABEL (CEA-Saclay, France, & CONY CET, Argentina) *Black Holes at the Dawn of the Universe*
- 02/12 RENÉ MÉNDEZ (Universidad de Chile, Chile) *Decision and Information Theory as Applied to Astronomy: The Case of Astrometry and Photometry*
- 09/12 AMINA HELMI (Kapteyn Astronomical Institute, The Netherlands) *Cosmology with the Galaxy*

In addition to the colloquium series, we continuously host talks from collaborators visiting the IA, and from astronomers stopping by before or after their observing runs at one of the observatories based in Chile. During 2014, 37 such seminars were held; for a complete list check

<http://www.astro.puc.cl:8080/astropuc/seminars>.

Additionally, every day after lunch, graduate students, postdocs, and faculty meet for an informal, 30-minute discussion of the latest developments in astronomy. Usually 2–3 topics are debated each day, and these are typically based on papers posted during the last few days on the arXiv Preprint Server (astro-ph) and on astronomy news appearing in the public press. These daily meetings are also used to introduce our many visitors and colleagues upon their arrival to the IA.

6 Grants

6.1 Institute Grants

The BASAL Centre for Astrophysics and Associated Technologies is a large institutional grant from CONICYT, Chile, awarded to the IA, the Astronomy Department of Universidad de Chile, and the Astrophysics Department of Universidad de Concepción. This Centre supports research in astrophysics, national and international academic exchange, and collaborations with the Observatories in Chile, providing funds for research, graduate student fellowships, organisation of workshops

and conferences, and travel. The focus of the UC node is currently incrementing its efforts in astronomical instrumentation and large databases and computing for future observing facilities, in association with the IA and the Center for Astro-Engineering.

6.2 Group Grants

6.2.1 *Instituto Milenio*

The Millennium Institute of Astrophysics (MAS) is funded by the Millennium Scientific Initiative. It is dedicated to the study of stellar populations, supernovae and the observation of the central regions of the Milky Way. It is lead by Mario Hamuy (U de Chile) but two thirds of its core researchers belong to the Institute of Astrophysics. One of the main characteristics of MAS is the multidisciplinary approach, because the team is composed not only by astronomers but also by statisticians, who would help to handle and exploit large observational databases becoming available. The members of MAS at Universidad Católica are Susana Eyheramendy, Márcio Catelan, Alejandro Clocchiatti, Franz Bauer, Andrés Jordán, Manuela Zoccali, Felipe Barrientos, and Julio Chanamé.

6.2.2 *Anillos*

Establishing the Role of Mergers in Black Hole Growth and Galaxy Evolution is a grant from CONICYT awarded to a team of astronomers from U de Concepción (E. Treiester [PI], N. Nagar, R. Demarco), PUC (F. Bauer, J. Cuadra), U de Chile (A. Escala), and U de Valparaíso (P. Arévalo). The goal of the project is to understand the role of super-massive black hole growth in galaxy evolution, by characterising this growth observationally and interpreting it through comparisons with simulations. Using the new facilities and instruments such as ALMA, NuSTAR, and optical/NIR IFUs, as well as start-of-the-art simulations, the project seeks to refine our knowledge about how and when this growth occurs, and what the observable effects on galaxy evolution are.

ATLAS Andino is a CONICYT grant awarded to a team of scientists of the PUC Institute of Physics (M.A. Díaz [PI], J. Alfaro, M. Bañados, B. Koch, and U. Volkmann), the IA (G. Galaz, A. Reisenegger), and external collaborators. Its goals are: a better understanding of the elementary particles, to be studied by means of the ATLAS Detector of the Large Hadron Collider (LHC); the understanding of the nature of Dark Matter and its effects on Astrophysics and Cosmology; the creation of an ATLAS Grid node at PUC, including the expansion of the Grid technology to other areas; and the study of ATLAS muon chambers in view of the LHC upgrade. It is also promoting the establishment of the southern Cherenkov Telescope Array (CTA) in Chile, and Chilean

participation in the CTA Consortium. It organised the visit of CTA Spokesperson Prof. Werner Hofmann to Chile in November 2014, which included meetings with scientists and government authorities, as well as a joint Physics–Astrophysics Colloquium at PUC.

7 Exchange Agreements and International Networks

7.1 Bilateral agreements

The IA has agreements with several institutions with the goal of strengthening its research activity and its graduate program. These agreements allow exchange visits of researchers and students. In some cases, the thesis is recognised by both institutions, resulting in a double PhD degree. Currently, we have agreements with the Universities of Heidelberg (see § 7.6), Johns Hopkins, Maryland, Padova, and Princeton.

As a result of these agreements, PUC–Heidelberg PhD students Cristina García and Mirko Simunovic have spent one year working in Heidelberg, and Dr. Mauricio Carrasco received the first double PUC–Heidelberg PhD degree. Additionally, Maryland–PUC PhD student Jonathan Fraine spent several months at PUC.

7.2 Marie Curie network LACEGAL

The Latin American–Chinese–European Galaxy Formation (LACEGAL) network was approved in November 2010 to bring together internationally recognised experts in the theory of galaxy formation and growth of cosmic structure. The network allows new research collaborations to be made between the main groups working in the subject in Latin America and China, and the principal centres in computational galaxy formation and astrophysics in Europe. The local coordinator is Nelson Padilla.

Visiting trips during the year 2014 were awarded to P. Arévalo, M. Bovill, S. Contreras, R. González, A. Muñoz, D. Murphy, and N. Padilla.

7.3 DFG–Conicyt Joint Project

The research project “Magnetic Fields of Massive Stars and their Compact Remnants” is funded jointly by DFG (Germany) and CONICYT (Chile) over the 3-year period 2012–2014 (extended until September 2015) as part of a program to strengthen collaboration between scientists of both countries. The German team is composed of Norbert Langer (German PI; University of Bonn), Henk Spruit (Max-Planck-Institut für Astrophysik), and Jon Braithwaite (University of Bonn), while the Chilean researchers are Andreas Reisenegger (Chilean PI; IA-PUC) and Juan Alejandro Valdivia (Universidad de Chile). The project funds a “Chile-Germany Postdoctoral Fellow in Stellar Magnetism”,

Joseph Mitchell (PhD at Florida State University), who is spending half of his time at PUC and the other half in Bonn, as well as graduate students and trips in both directions. It joins expertise in stellar evolution (Langer), magnetohydrodynamics (Spruit), compact objects (Reisenegger), and numerical simulations (Braithwaite and Valdivia), in order to gain a fuller understanding of the co-evolution of massive stars and their magnetic fields from birth to death.

7.4 UMI-FCA

The French–Chilean Joint International Astronomy Unit (UMI-FCA) was established by agreement between the CNRS and PUC, U. de Chile and U. de Concepción. This “Joint International Unit” facilitates collaborations between astronomers of the participating institutions, and allows them to use the facilities of their counterpart.

7.5 Chile–MPG Network

The exchange project “Chile–MPG Network on Super-Massive Black Hole Binaries” was funded by CONICYT over the 2013–14 period. The Chilean team included scientists from PUC (J. Cuadra [PI] and P. Arévalo) and U de Chile (A. Escala and P. Lira), while the Max-Planck team included researchers from the Max Planck Institutes for Radio Astronomy (S. Komossa), Gravitational Physics (P. Amaro-Seoane and A. Sesana) and Astrophysics (T. Tanaka). The main activities were a Workshop that took place at PUC’s Marine Research Laboratory (ECIM) in Las Cruces, 3-month visits of PhD students F. Garrido (PUC) and L. del Valle (U de Chile) to the MPI for Gravitational Physics, and several short-term visits in both directions. The network joined the expertise of theoretical and observational astronomers to improve our understanding of the gas dynamics around super-massive black hole binaries, in particular their future observability.

7.6 Heidelberg University–PUC Agreement

2014 was the last year of the original Heidelberg University–PUC agreement for astronomy funded by the German DAAD. Its activities consist in a joint doctoral program, a strong academic exchange plan, the organisation of summer schools (instrumentation school in 2014) and a strong outreach program (school teacher workshops). During this year the program was evaluated by the DAAD through a panel of experts. They visited PUC and Heidelberg University. The evaluation was very positive and resulted in a strong recommendation for further funding. The program will continue in 2015.

8 Office, Computing and Teaching facilities

The IA occupies 1,887 m² of a building in the San Joaquín Campus of PUC, to the south of downtown San-

tiago. Of that surface, 1482 m² correspond to the IA proper, while the remaining 405 m² are occupied by the Centre for Astro-Engineering (§ 4). This includes offices for faculty, postdocs, graduate students and administrative and technical staff, optics and electronics workshops, a special room for our super-computer, and conference rooms. The same building also hosts the “Ninoslav Bralić” auditorium, shared with Physics and Mathematics, which seats 100 people.

In the adjacent building, the “Gauss” Physics and Math library has a collection of ~30,000 books and journal volumes. Staff members, students and visitors also have access to the University library system with more than 300,000 books and hundreds of periodical publications, including around 60 titles in different branches of physics. The University supports, in addition, on-line access to all major astrophysics journals. Finally, the IA hosts since 1998 the first Latin-American mirror of NASA’s Astrophysical Data System (ADS).

The IA has a computer network maintained by a full-time software engineer and an assistant. It includes a cluster, managed by the AIUC, consisting of 64 nodes with a total of 128 Intel Xeon Quad-Core CPUs (512 cores), 1024 GB of RAM, 40 TB of disk space (iSCSI), and a Linux system for 64-bit architecture running over a 10 Gbps ethernet network (a 10 fold increase with respect to the previous year). Development and execution tools include Intel Fortran and Intel C compilers (ifort, icc), mpich2, Distributed Resource Management (DRM) software SGE (Sun Grid Engine), and other standard tools (gcc, g++, gfortran, etc). In early 2013, this cluster was complemented by a brand-new 520-core CPU cluster, with 18 Tflops, and 3 TB of memory. To the original 30 TB of disk space we have added 150TB of normal access disks and 45 TB of fast I/O disks, using funds provided by QUIMAL 130008 (PI N. Padilla). We also house a GPU cluster with 1792 NVidia Tesla Cores, with 96 GB of memory. Users at IA have access to the cluster via personal accounts and get access to the cluster resources by the DRM system that defines use and priority of each user to the total resources. Postdoctoral fellow Roberto González dedicates a fraction of their time to help manage the use of the computing cluster.

8.1 Santa Martina Observatory

The IA maintains a small Observatory (OUC) in the eastern outskirts of Santiago at an altitude of 1450 m, some 60-minute drive from Campus, mostly dedicated to teaching and astronomy laboratories for our undergraduate students. Permanently installed in a joint dome are a 50 cm telescope (the old ESO 50 cm), and a 40 cm telescope (one of the two old CTIO 16-inch telescopes) and, in a separate dome, a commercial Meade 40 cm used with a CCD camera for basic teaching. The two profes-

sional telescopes have locally-upgraded control systems and new instrumentation, including CCD and IR cameras, spectrographs and a new, built in-house fibre spectrograph at the 50 cm. All three are controlled from a common control room when needed. The two professional telescopes are partly used for testing and developing instrumentation and for some advanced student research programs. A Meade 30 cm is available for visual observations by students and visitors. Besides, the site hosts the dome of one of the SLOOH world network telescopes, remotely controlled via the Web. In addition to the optical telescopes, two radio telescopes were installed in the Observatory to teach radioastronomy. They are 2.5 and 3 meters in diameter and are equipped to observe at 21 cm wavelength in both single dish and interferometric configurations. The system will be fully implemented during 2015. A small planetarium is also available to teach students the celestial coordinate systems. Current activities take place three to four times weekly (weather permitting) and include teaching, scientific and outreach experiences.

8.2 Manuel Foster Historical Observatory

The IA also maintains this historical observatory in the Metropolitan Park on San Cristóbal hill near downtown Santiago. It was established in 1903 by an expedition from the Lick Observatory of the University of California, and purchased and donated to PUC in 1929 by the lawyer, politician, and PUC professor Manuel Foster, in this way starting astronomical activities at the University. It was used on and off until the early 1990s, but is now no longer useful for research because of the strong light pollution. In 2010, it was declared a National Historic Monument. It is being opened to the public on selected days.

9 Meetings supported

One of the activities of the IA is to support meetings and graduate schools in Chile to foster the development of local professional astronomy. In the period reported, activities organised, sponsored, and/or supported were (name of meeting, place and date)

- *Workshop on Super-Massive Black Hole Binaries* (ECIM, Las Cruces, March 2014).
- *The 5th VVV Science Meeting* (Con-Con, April 2014).
- *MAD workshop: Protoplanetary disks and the planets they form* (Santiago, Nov 2014).

10 Outreach

The IA organized and supported several outreach activities during 2014:

- In May 25th, the The Manuel Foster Historical Observatory was opened to all public to commemorate the National Heritage day, receiving nearly 300 visitors.
- Members of the Institute provided more than 70 interviews and notes to the media, including TV, radio, newspapers and digital media, in response to the mayor astronomical events of the year. Some highlights were the arrival of the Rosetta Spacecraft to the Comet 67P/Churyumov-Gerasimenko and several publications in Nature by members of the IA.
- Since October 2014, members of the IA have been publishing weekly columns in *Emol*, the web site of *El Mercurio*, the main Chilean newspaper. These columns are devoted to bring scientific topics down to the general public.
- Once again the IA organised an astronomy course for elder people through the Outreach Centre UC. The course is divided in three 3-month courses on general topics in astronomy.
- As done in previous years, the IA, together with the Heidelberg Center, organised a workshop in January 2014 to train school teachers on astronomy.
- The IA helped to organise the second “Galileo Teacher Training Program” (GTTP), together with NRAO, to train Chilean teachers on how to bring astronomy to the classroom.
- The IA, together with the Physics Institute UC, organised a workshop on scientific research for school teachers in October 2014, focused on the different research activities done in physics and astronomy at UC.
- The IA also participated in different outreach activities from the University, including science fairs for school students and vocational classes for young students.
- Together with Astromanía, the IA organised a story writing competition where a prize was given to the best short story on an astronomy related topic.
- The IA participated in the “Semana de la Ciencia”, activity organized by Explora CONICYT.
- The IA, together with the consulting company Verde, and other scientific and touristic Chilean institutions, won a grant to develop a study on local capabilities and perspectives for astronomical tourism in the country, which will take place during 2015 and 2016.

11 Refereed Publications

Astronomers from the IA, including students, participated in 188 refereed papers published in 2014. The full list is given below.

1. Aasi J., et al. (incl. **Espinoza C.M.**), LIGO Scientific Collaboration, Virgo Collaboration: *Gravitational Waves from Known Pulsars: Results from the Initial Detector Era*. ApJ 785, 119
<http://adsabs.harvard.edu/abs/2014ApJ...785..119A>
2. Anderson J.P., González-Gaitán S., Hamuy M., Gutiérrez C.P., Stritzinger M.D., Olivares E.F., Phillips M.M., **Schulze S.**, Antezana R., Bolt L., Campillay A., Castellón S., Contreras C., de Jaeger T., Folatelli G., Förster F., Freedman W.L., González L., Hsiao E., Krzemiński W., Krisciunas K., Maza J., McCarthy P., Morrell N.I., Persson S.E., Roth M., Salgado F., Suntzeff N.B., Thomas-Osip J.: *Characterizing the V-band Light-curves of Hydrogen-rich Type II Supernovae*. ApJ 786, 67
<http://adsabs.harvard.edu/abs/2014ApJ...786...67A>
3. **Angeloni R.**, **Contreras Ramos R.**, **Catelan M.**, **Dékány I.**, **Gran F.**, **Alonso-García J.**, **Hempel M.**, **Navarrete C.**, **Andrews H.**, Aparicio A., **Beamín J.C.**, Berger C., Borissova J., Contreras Peña C., Cunial A., de Grijs R., **Espinoza N.**, Eyheramendy S., Ferreira Lopes C.E., Fiaschi M., **Hajdu G.**, Han J., **Helminiak K.G.**, Hempel A., Hidalgo S.L., Ita Y., Jeon Y.-B., **Jordán A.**, Kwon J., Lee J.T., Martín E.L., Masetti N., Matsunaga N., Milone A.P., Minniti D., Morelli L., Murgas F., Nagayama T., Navarro C., Ochner P., Pérez P., Pichara K., Rojas-Arriagada A., Roquette J., Saito R.K., Siviero A., Sohn J., Sung H.-I., Tamura M., Tata R., Tomasella L., **Townsend B.**, Whitelock P.: *The VVV Templates Project Towards an automated classification of VVV light-curves. I. Building a database of stellar variability in the near-infrared*. A&A 567, A100
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4. **Angeloni R.**, **Ferreira Lopes C.E.**, Masetti N., Mille F.D., Pietrukowicz P., Udalski A., Schaefer B.E., Parisi P., Landi R., **Navarrete C.**, **Catelan M.**, **Puzia T.H.**, Guzman D.: *Symbiotic stars in OGLE data - I. Large Magellanic Cloud systems*. MNRAS 438, 35
<http://adsabs.harvard.edu/abs/2014MNRAS.438...35A>
5. Annunziatella M., Biviano A., Mercurio A., Nonino M., Rosati P., Balestra I., Presotto V., Girardi M., Gobat R., Grillo C., Kelson D., Medezinski E., Postman M., Scodeggio M., Brescia M., Demarco R., Fritz A., Koekemoer A., Lemze D., Lombardi M., Sartoris B., Umetsu K., Vanzella E., Bradley L., Coe D., Donahue M., **Infante L.**, Kuchner U., Maier C., Regős E., Verdugo M., Ziegler B.: *CLASH-VLT: The stellar mass function and stellar mass density profile of the $z = 0.44$ cluster of galaxies MACS J1206.2-0847*. A&A 571, A80
<http://adsabs.harvard.edu/abs/2014A%26A...571A..80A>
6. **Arévalo P.**, **Bauer F.E.**, Puccetti S., Walton D.J., Koss M., Boggs S.E., Brandt W.N., Brightman M., Christensen F.E., Comastri A., Craig W.W., Fuerst F., Gandhi P., Grefenstette B.W., Hailey C.J., Harrison F.A., Luo B., Madejski G., Madsen K.K., Marinucci A., Matt G., **Saez C.**, Stern D., Stuhlinger M., Treister E., Urry C.M., Zhang W.W.: *The 2-79 keV X-Ray Spectrum of the Circinus Galaxy with NuSTAR, XMM-Newton, and Chandra: A Fully Compton-thick Active Galactic Nucleus*. ApJ 791, 81
<http://adsabs.harvard.edu/abs/2014ApJ...791...81A>
7. **Arévalo P.**, Markowitz A.: *Deconvolving X-Ray Spectral Variability Components in the Seyfert 1.5 NGC 3227*. ApJ 783, 82
<http://adsabs.harvard.edu/abs/2014ApJ...783...82A>
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<http://adsabs.harvard.edu/abs/2014MNRAS.445...850A>
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<http://adsabs.harvard.edu/abs/2014ApJ...789...134B>
10. Baloković M., Comastri A., Harrison F.A., Alexander D.M., Ballantyne D.R., **Bauer F.E.**, Boggs S.E., Brandt W.N., Brightman M., Christensen F.E., Craig W.W., Del Moro A., Gandhi P., Hailey C.J., Koss M., Lansbury G.B., Luo B., Madejski G.M., Marinucci A., Matt G., Markwardt C.B., Puccetti S., Reynolds C.S., Risaliti G., Rivers E., Stern D., Walton D.J., Zhang W.W.: *The NuSTAR View of Nearby Compton-thick Active Galactic Nuclei: The Cases of NGC 424, NGC 1320, and IC 2560*. ApJ 794, 111
<http://adsabs.harvard.edu/abs/2014ApJ...794...111B>
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<http://adsabs.harvard.edu/abs/2014A%26A...570A...76B>
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<http://adsabs.harvard.edu/abs/2014A%26A...570L...8B>
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<http://adsabs.harvard.edu/abs/2014ApJ...785...155B>
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<http://adsabs.harvard.edu/abs/2014ApJ...791...68B>
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