Annual Report 2010

Departamento de Astronomía y Astrofísica
Facultad de Física
Pontificia Universidad Católica de Chile

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1 Introduction

The *Departamento de Astronomía y Astrofísica* (Department of Astronomy and Astrophysics, DAA) is one of the two academic divisions of the Faculty of Physics of *Pontificia Universidad Católica de Chile* (PUC). This faculty offers undergraduate (*Licenciatura*) degrees in Astronomy and in Physics, and Ph.D. and Master's programs in Astrophysics and in Physics. The mission of the DAA is to be an international center of excellence for studies in Astronomy and Astrophysics, covering a broad range of topics in observational and theoretical astrophysics, and to prepare the next generations of students that will profit from the superb observational facilities available to Chilean astronomers and their collaborators. In this report, we review the main activities at DAA from January until December 2010.

2 Highlight of the Year: The Center for Astro-Engineering

A major instrumentation, computing and astronomical service effort is being carried out at PUC. A Center for Astro-Engineering (AIUC) was created in 2009 and its new premises were inaugurated in 2010. It is the first of its class in Chile. The Centre has two laboratories (instrumentation and computing) and an astronomical service area. In collaboration with several groups in Europe, USA and Japan, new concept instruments are being developed. These include wide field Adaptive Optics and NIR spectrographs for the new generation of giant telescopes in Chile (E-ELT, GMT, TAO, etc.). The AIUC operates a cluster computer (512 cores) which is openly offered to the Chilean astronomical community. For more details about the AIUC, see § 6.1.

3 Personnel

3.1 Changes in 2010

3.1.1 New Faculty

- Dr. J. Cuadra arrived from the Max-Planck Institute for Astrophysics in Garching, Germany, to take on an Assistant Professor position.
- Dr. T.H. Puzia arrived from the NRC Herzberg Institute of Astrophysics in Victoria, BC, Canada, to take on an Assistant Professor position.

3.1.2 New Postdocs

- Dr. J. Alonso-García arrived from the University of Michigan in Ann Arbor, USA, to take on a postdoctoral position.
- Dr. A. Alves-Brito arrived from the Swinburne University, Australia, to take on a postdoctoral position.
- Dr. I. Dékány arrived from the Konkoly Observatory, Hungary, to take on a postdoctoral position.
- Dr. K. Hełminiak arrived from the Nicolaus Copernicus Astronomical Center in Toruń, Poland, to take on a postdoctoral position.
- Dr. R. Lachaume arrived from Mexico, to take on a postdoctoral position.
- Dr. Á. Orsi arrived from the Institute of Computational Cosmology at Durham University, UK, to take on a postdoctoral position.
- Dr. S. Sale arrived from the Imperial College in London, UK, to take on a postdoctoral position.

No faculty or postdocs left the DAA during 2010

3.2 DAA 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, Assistant 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, Professor (Ph.D. Universidade de São Paulo, Brazil, 1996) – *Stellar structure and evolution. Globular clusters. Variable stars. Stellar Populations. Galaxy formation and evolution.*

- Dr. Alejandro Clocchiatti, 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) – *Numerical astrophysics. Galactic nuclei. Super-massive black holes.*

- Dr. Rolando Dünner, Adjunct Assistant Professor, (Ph.D. PUC, 2009) – *Large scale structure and cosmology. Astronomical instrumentation.*

- Dr. Gaspar Galaz, Associate Professor (Ph.D. Université de Paris, France, 1998) – *Stellar population in galaxies. Galaxy evolution. Statistical properties of the galaxy distribution.*

- Dr. Leopoldo Infante, 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.*

- Dr. Andrés Jordán, Assistant Professor (Ph.D. Rutgers University, USA, 2004) – *Search and characterization of transiting exoplanets. Galaxies in nearby clusters. Star clusters.*

- Dr. Dante Minniti, Professor (Ph.D. University of Arizona, USA, 1993) – *Globular clusters. Stellar populations and evolution. Extrasolar planets. Galaxy formation. Galactic structure. Gravitational microlensing. Astrobiology.*

- 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. Hernán Quintana, Professor (Ph.D. Cambridge University, UK, 1973) – *Observational astrophysics. Clusters of galaxies. Interacting galaxies. Large scale structure.*

- Dr. Andreas Reisenegger, Professor and DAA Chairman (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.*

3.3 Postdoctoral Fellows 2010

The following scientists held postdoctoral positions at the DAA 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. Alan Alves-Brito (Ph.D. Universidade de São Paulo, Brazil, 2008) – *Stellar populations. Chemical abundances. High-resolution spectroscopy.*

- Dr. Rodolfo Angeloni (Ph.D. University of Padova, Italy, 2009) – *Symbiotic Stars. Interstellar Dust. Stellar variability. Photometry. Nebular Spectroscopy.*

- Dr. Timo Anguita (Ph.D. Ruprecht Karls Universität Heidelberg, Germany, 2009) – *Gravitational lensing. Galaxy evolution. Galaxy clusters.*

- Dr. István Dékány (Ph.D. Eötvös Loránd University, Hungary, 2010) – *Photometry. Time-series analysis. Stellar pulsation. Stellar evolution.*

- Dr. Harold Francke (Ph.D. Universidad de Chile, 2009) – *Galaxy formation and evolution. Cosmology and large scale structure of the universe.*

- Dr. Maren Hempel (Ph.D. Ludwig-Maximilians-Universität München, Germany, 2004) – *Globular cluster systems. Stellar Populations. Galaxy formation and evolution.*

- Dr. Krzysztof Hełminiak (Ph.D. Nicolaus Copernicus Astronomical Center, Poland, 2010) – *Derivation of fundamental parameters of late-type stars in binaries using precise photometry. High-resolution spectroscopy. Imaging with adaptive optics and optical interferometry.*

- Dr. Régis Lachaume (Ph.D. Université de Grenoble, France, 2003) – *The vertical structure of accretion discs around young-mass young stars.*

- Dr. Álvaro Orsi (Ph.D. Durham University, UK, 2010) – *Galaxy formation. Large Scale structure. Semi-analytical modelling. High redshift galaxies. Lyα radiative transfer.*

- Dr. Jason Quinn (Ph.D. Notre Dame University, USA, 2007) – *Supernova Spectro-polarimetry. Error analysis. Numerical methods.*
- Dr. Markus Rabus (Ph.D. Universidad de la Laguna, Spain, 2009) – *Search and characterization of exoplanets.*
- Dr. Roberto K. Saito (Ph.D. Universidade Federal de Santa Catarina, Brasil, 2008) – *Cataclysmic Variable Stars. Stellar Astrophysics. Astronomical Data Processing.*
- Dr. Stuart E. Sale (Ph.D. Imperial College London, UK, 2009) – *Interstellar extinction. Galactic astronomy. Stellar variability. Photometry.*

Support for the postdoctoral fellows comes from a combination of DAA funds, grants from the Joint ESO–Chile Committee for the Development of Astronomy in Chile, the ALMA–FONDECYT and ALMA–Gemini funds, the Millennium Scientific Initiative, the FONDECYT program, and the FONDAP program (see § 6).

3.4 Technical Staff and Assistants

- Fernando Álvarez *Caretaker.*
- Dr. Maurizio Baffico (Electrical Engineer, PUC, 2005; Ph.D. in Physics, Universidad de Chile, 1997) *In charge of telescopes at Santa Martina.*
- Lilena Montenegro *Administrative Assistant.*
- Carlos Oliva (Journalist) *Outreach activities.*
- Gladys Reineking (Bilingual Secretary, PUC) *Secretary of the Department*
- Vincent Suc (Electrical Engineer, INSA, Lyon, France) *Engineer for HAT-South and LDSS-3 / Megacam / MMIRS.*
- Ignacio Toledo *Teaching Observatory.*
- Giselle Ulloa (Administrator, PUC Valparaiso) *Administrative Coordinator of the Department.*
- Juan Véliz (Software Engineer, Universidad de Chile, 1991), *System Manager. Software Specialist.*
- Mariela Villanueva *IT Assistant.*

3.5 Recognitions, Awards and Sabbaticals

G. Galaz took sabbatical leave, partly at the University of Maryland, and partly at the University of Washington, USA.

H. Quintana took sabbatical leave, partly at the Université de Liège, Belgium.

4 Academic Programs

4.1 Graduate Program and Students 2010

4.1.1 Graduate Program

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

4.1.2 Graduate Students

Students enrolled during this period were:

Paula Aguirre, Ma. Luisa Alonso, Pía Amigo, Heather Andrews, Ignacio Araya, Pamela Arriagada, Juan Carlos Beamín, Claudio Cáceres, Daniela Carrasco, Mauricio Carrasco, Carlos Contreras, Sergio Flores, Cristina García, Denis González, Jorge González, Nicolás González, Paulina González, Lucia Guaita, Iván Lacerna, Pablo Marchant, Gustavo Morales, Mauricio Ortiz, Joaquín Prieto, Lara Rodriguez, Álvaro Rojas, Felipe Rojas, Cristobal Sifón, Gabriel Torrealba, Aldo Valcarce, Sergio Vásquez, Nicolás Viaux, Paula Zelaya, and Mónica Zorotovic.

4.1.3 Visiting Graduate Students

Andrés Ruiz (Córdoba, Argentina) and Tomás Tecce (Buenos Aires, Argentina).

4.1.4 New Admissions

Juan Carlos Beamín (PUC) and Cristina García (PUC) were admitted to the Ph.D. program starting August 2010. Daniela Carrasco (PUC), Álvaro Rojas (PUC), Gustavo Morales (PUC) and Gabriel Torrealba (PUC) were admitted to the M.S. program starting August 2010.

Alejandra Muñoz (PUC), Osmar Rodríguez (PUC), Mirko Šimunović (PUC) and Martha Talavera (UNAN, Nicaragua) were admitted to the Ph.D. program starting March 2011. Esteban Castillo (U Chile), Andrea Corvillón (PUC), Rodrigo Leiva (UTFSM), and Alejandra Rojas (PUC), were admitted to the M.S. program starting March 2011.

4.1.5 Degrees obtained, Student News & Flux

- Carlos Contreras obtained his Master's Degree, defending his Thesis entitled "*Variable stars in the globular cluster NGC 6402 (M14)*", supervised by M. Catelan. He will soon move to the University of Hertfordshire, UK, to start a Ph.D. program.
- Denis González obtained his Master's Degree, defending his Thesis entitled "*Internal heating of old*

neutron stars: contrasting different mechanisms", supervised by A. Reisenegger. He received a *Beca Chile* and will soon start a Ph.D. program abroad.

- Dr. Roberto González obtained his Ph.D. Degree, defending his Thesis entitled "*Dark-Matter halo and galaxy properties in the large scale structure*", supervised by N. Padilla. He then moved to the University of Chicago, USA, to take on a postdoctoral position.

- Dr. Lucia Guaita obtained her Ph.D. Degree, defending her Thesis entitled "*Studying Lyman alpha emitters at $z = 2$*", supervised by N. Padilla. She then moved to the University of Stockholm, Sweden, to take on a postdoctoral position.

- Dr. Anna Fabiola Marino obtained her Ph.D. Degree, awarded in conjunction between PUC and Padova. She defended her thesis, entitled "*Multiple stellar populations in globular clusters: spectroscopic evidence*", supervised by M. Zoccali at PUC and G. Piotto at Padova. She then moved to the Max-Planck Institute for Astrophysics in Garching, Germany, to take on a postdoctoral position.

- Dr. Joaquín Prieto obtained his Ph.D. Degree, defending his Thesis entitled "*Gas turbulences in the dark matter assembly process: Seeds for primordial star formation*", supervised by L. Infante. He then moved to the University of Barcelona, Spain, to take on a postdoctoral position.

Heather Andrews and Ignacio Araya obtained graduate fellowships from CONICYT

Iván Lacerna received a graduate fellowship and a grant for a month-long internship at Swinburne University of Technology, Australia, both from MECESUP.

4.2 Undergraduate Program and Theses

The PUC undergraduate program in Astronomy currently has ∼105 students, who are consistently drawn from the top 2% of the ∼280,000 high school seniors who take the nationally administered entrance examination (PSU) each year.

A group of 28 new students registered in the program to start in March 2011. The last admitted student scored 708.70 points at the PSU.

Undergraduate students work full time the last semester of the program on a research project under the supervision of a faculty member, sometimes with a co-supervisor from another institution. The 21 students who obtained their degree during this period, the subject of their theses, and their supervisors are:

- Paulo Ayala *Búsqueda de objetos con gran movimiento propio hacia el centro galáctico* – (D. Minniti).

- Eduardo Bañados *La cola débil de la función de luminosidad en cúmulos de galaxias cercanos y fotometría de campos LAE-LBG* – (L. Infante)

- J. Carlos Beamín *RR lyrae del bulbo de la Vía Láctea* – (D. Minniti)

- Daniela Carrasco *Pares de QSOs en campos del RCS* – (F. Barrientos)

- Andrea Corvillón *Cross-correlation masks for precise radial velocity measurements* – (A. Jordán)

- María del R. Escribano *Caracterización de la atmósfera de Chajnantor utilizando el ACT* – (R. Dünner)

- Cristina García *Determinación de masa para cúmulos del RCS* – (F. Barrientos)

- Camila Gatica *Techniques for astronomical site testing and monitoring* – (L. Vanzi)

- Aracely Gómez *Óptica del ACT y efectos de la temperatura sobre los espejos* – (R. Dünner)

- Graciela López *Fotometría strömgren en el cúmulo globular NGC 2808* – (M. Catelan)

- Cristóbal Meunier *Modeling the prolific radio emission from the CSM-interacting SN1996cr* – (F. Bauer)

- Gustavo Morales *Simulated observations of supercluster collapse* – (A. Reisenegger)

- Alejandra Muñoz *The abundance of high-z submillimeter sources in models and observations* – (N. Padilla)

- Camilo Muñoz *Estabilidad de los espejos del Atacama Cosmology Telescope* – (L. Infante).

- Francisco Paz *Search and identification of cluster in the dwarf local group galaxy NGC6822* – (M. Catelan)

- Osmar Rodríguez *Física de la polarización en el CMB* – (L. Infante; M. Bañados)

- Alejandra Rojas *Fuentes de alta energía hacia el bulbo de la vía láctea* – (D. Minniti).

- Álvaro Rojas *Simultaneous determination of iron abundance and stellar parameters through a genetic algorithm* – (M. Zoccali; A. Jordán)

- Mirko Simunović *On the study of the VVV color-magnitude diagram of globular cluster Palomar 6* – (A. Jordán)

- Gabriel Torrealba *Galaxy rotation curves in EBI theory* – (A. Reisenegger)
- Luis Valdés *Formación de nubes moleculares en las galaxias Wolf-Lundmark-Melotte* (M. Rubio, CONICYT)

5 DAA Visitors and Colloquium Program

The DAA has an active visitors program that profits from the large number of astronomers that come to the international observatories on observing trips and can, in turn, benefit from longer periods of activity in Chile, sometimes in between different runs. The DAA serves them as an academic home ground in Chile. Long-term visitors qualify as Chilean astronomers for the purposes of telescope time request.

During the reported period, the following astronomers stayed with us:

- Mario Abadi (Córdoba, Argentina) visited N. Padilla,
- Mª Victoria Alonso (Córdoba, Argentina) visited D. Minniti,
- Sol Alonso (ICATE, Argentina) visited N. Padilla,
- Martin Altmann (U. Heidelberg, Germany) visited M. Catelan,
- Andrew Baker (Rutgets, USA) visited L. Infante,
- Gaspar Bakos (CfA, USA), visited A. Jordán,
- Charles Bennett (Johns Hopkins, USA) visited R. Dünner,
- Alberto Bolatto (Maryland, USA) visited D. Minniti,
- Paul Butler (Carnegie, USA) visited D. Minniti,
- Dana Casetti-Dinescu (Yale, USA) visited M. Catelan,
- Julio Chanamé (Carnegie, USA) visited A. Reisenegger,
- Lucas Cieza (Hawaii, USA) visited the DAA,
- Sofía Cora (La Plata, Argentina) visited N. Padilla,
- Andrew Cumming (McGill, Canada) visited A. Reisenegger,
- Ricardo Demarco (Concepción) visited A. Reisenegger,
- Duilia de Mello (CUA, USA) visited the DAA,
- Bruno Dias (IAG-USP, Brazil) visited R. Saito,
- Jim Emerson (Queen Mary, UK) visited D. Minniti,
- René Fassbender (MPE Garching, Germany) visited H. Quintana,
- Mathias Franck (ESO) visited L. Infante/A. Jordán,
- Sebastián Gurovich (ICATE, Argentina) visited D. Minniti,
- Melanie Hall (Queen's U, Canada) visited the DAA,
- Amina Helmi (Groningen, Netherlands) visited N. Padilla,
- Seth Hornstein (Colorado, USA) visited F. Barrientos,
- Jaime Hoyos (Medellín, Colombia) visited A. Reisenegger,
- James Jenkins (U de Chile) visited A. Jordán,
- Raúl Jiménez (Barcelona, Spain) visited L. Infante,
- Amanda Karakas (Mt Stromlo, Australia) visited A. Alves-Brito,
- Karen Kinemuchi (Florida State, USA) visited M. Catelan,
- Andrea Kunder (CTIO) visited M. Catelan,
- Nikos Kylafis (Crete, Greece) visited A. Reisenegger,
- Phil Lucas (Edinburgh, UK) visited D. Minniti,
- Nicola Masetti (Bologna, Italy) visited D. Minniti,
- Lorenzo Morelli (Padova, Italy) visited D. Minniti,
- Ana Pichel (La Plata, Argentina) visited D. Minniti,
- Jaime Pineda (Harvard, US) visited the DAA,
- Dominique Proust (Paris–Meudon, France) visited A. Reisenegger,
- Suzanna Randall (ESO, Germany) visited M. Catelan,
- Marina Rejkuba (ESO, Germany) visited D. Minniti,
- Andrés Ruiz (IATE, Argentina) visited N. Padilla,
- Ricardo Salinas (Concepción) visited M. Catelan,
- Christian Schröder (Oxford, UK) visited F. Barrientos,
- Andrew Stephens (Gemini, USA) visited M. Catelan,

- Andrew Szentgyorgyi (CfA, USA) visited A. Jordán,
- Tomás Tecce (IAFE, Argentina) visited N. Padilla,
- David Yong (Mt Stromlo, Australia) visited A. Alves-Brito.

Both visitors and astronomers on observing trips fuel the DAA Colloquium program. More than thirty talks took place during this period.[1]

6 Research Centers, Groups and Grants

6.1 Center for Astro-Engineering

The fact that the world largest telescopes operate and will operate in Chile, and the requirement that they be equipped with world-class instrumentation, opens up a wealth of opportunities for the development of high technology in Chile. Aware of this, the Center for Astro-Engineering (AIUC) was created as a joint effort between Astronomy and Engineering of the Pontificia Universidad Católica of Chile (PUC).

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 if formed by three main divisions: a Laboratory of Astronomical Instrumentation, a Center of data mining and numerical computation and an 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 especialized human resources.

The Center operates under a Board of Directors. The Director of the Center, currently professor L. Infante, and the Sub-Director, professor A. Guesalaga, have the responsibility to manage and execute the Center's tasks and respond to the board. Currently the AIUC has 2 optical labs, 1 instrumentation lab, 1 detector lab, a 512-core cluster and an astro-service area. Our instrumentation and computation laboratories are lead by professors L. Vanzi, from the PUC School of Engineering, and by A. Jordán, from the DAA, respectively. Our simulation area is lead by professor N. Padilla from the DAA.

[1]There is a list in our web page http://www.astro.puc.cl:8080/astropuc/seminars

Currently there are 16 faculty members (F. Barrientos, M. Catelan, D. Celentano, A. Clocchiatti, R. Dünner, G. Galaz, M. Guarini, D. Guzmán, L. Infante, A. Jordán, D. Minniti, N. Padilla, M. Torres, L. Vanzi, A. Guesalaga and M. Zoccali), 5 postdocs (T. Anguita, P. Escarate, R. Lachaume, Á. Orsi and M Rabus), 8 graduate students (P. Aguirre, A. Ananías, I. Blanchard, J. Chacón, A. Cortés, F. Henríquez, R. Olguín and M. Salas) and 8 engineers, technicians and support personnel (J. González, V. Suc, M. Baffico, J. Véliz, L. Valdés, I. Toledo, L. Montenegro and G. Ulloa) associated to the Center.

6.2 Department Grants

The DAA currently administers some special programs with specific goals and long time-scales.

The FONDAP Center for Astrophysics is a large institutional grant from CONICYT, Chile, to support research in astronomy and academic exchange between the DAA, the Astronomy Department of Universidad de Chile, and the Astrophysics Group of Universidad de Concepción. It provides funds for research, postdoctoral positions, graduate student fellowships, conferences, and travel.

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

6.3 Group Grants

6.3.1 Anillo

Development of technologies for astronomical observations. Chile: from host to active partner in the construction of the next generation astronomical telescopes is a grant from CONICYT awarded to a team of scientists from the PUC School of Engineering (L. Vanzi (PI), A. Guesalaga, D. Celentano, et al.) and the DAA (L. Infante, A. Jordán, et al.). The goal of the project is to acquire and develop front line technologies in a number of selected areas of science and engineering to be employed in the next generation astronomical telescopes, to make the institutes involved, competitive in the specific fields selected and to convert them in attractive partners for the international organizations leading the design and construction of the next generation telescopes, in Chile as well as abroad.

6.3.2 Milenios

The Milky Way Millennium Nucleus is a grant from MIDEPLAN awarded to a team of scientists from the DAA (M. Catelan (PI), D. Minniti, A. Jordán, M. Zoccali) and the Universidad de Valparaíso (J. Borissova). The main aim is to support research related with the formation and evolution of the Milky Way. Specifically, the research project has its core in the VISTA Variable in the Via Lactea ESO Public Survey, which will obtain a time series map of the whole Bulge and a large fraction of the Disk of our Galaxy. This grant provides funding for research, postdoctoral fellowships, studentships, outreach, organization of conferences and other networking activities. (`www.milenio-vialactea.cl`)

The Millennium Center for Supernova Studies is a triennial grant originally from MIDEPLAN, now administered by MINECON, awarded in 2008 to a team of astronomers from the DAA (A. Clocchiatti) and the Department of Astronomy of Universidad de Chile (M. Hamuy, and J. Maza). The goal of the project is to further the study of SNe from Chile, both in detail to better know the astrophysics of progenitors and the physics of explosions, and to improve their usage as cosmologically relevant distance estimators. The grant was competitively renewed in early 2011 for an additional period of three years. The team has been enlarged to include G. Pignata (U. Andrés Bello) and F. Bauer (DAA).

6.4 Individual Research Grants

6.4.1 FONDECYT Regular Projects

- F. Barrientos: *Probing the Universe With Galaxy Clusters.*
- F. Bauer: *The Role of AGN Feedback in the Coeval Growth of Supermassive Black Holes and Galaxies.*
- M. Catelan: *Stellar Populations and Variability in the Local Group.*
- G. Galaz: *The Impact of Environment on Stellar Formation in Low Surface Brightness Galaxies.*
- A. Jordán: *From Discovery to Understanding: the First 24-Hour Global Network to Find and Characterize Transiting.*
- D. Minniti: *Vista Variables in the Via Lactea.*
- A. Reisenegger: *Neutron Stars, Disks, and Magnetic Fields.*
- M. Zoccali: *Formation and Evolution of the Milky Way Spheroid.*

6.4.2 Other External Grants

- J. Cuadra: FONDECYT Initiation into Research Project *Black Hole Mergers and Kicks in Gas-Rich Galaxies.*
- R. Dünner: FONDECYT Initiation into Research Project *Chile ACT Ultradeep Survey*
- N. Padilla: FONDECYT International collaboration Research Project *Understanding the Origin and Evolution of Galaxies.*
- N. Padilla: GEMINI-CONICYT Project *Postdoc position for the Center of Astro-Engineering UC.*
- T.H. Puzia: GEMINI-CONICYT Research Project *The Next Generation Virgo Cluster Survey - Infrared (NGVS-IR).*

6.4.3 PUC-funded Grants

- J. Cuadra: PUC Vice-rectory for Research Initiation Project *Massive black holes, stars and gas in the central parsecs of galaxies.*
- R. Dünner: PUC Vice-rectory for Research Initiation Project *Chile ACT Ultradeep Survey*
- A. Reisenegger: PUC Vice-rectory for Research *Límite* Project *Magnetic fields and their effects on normal and compact stars.*

6.5 Exchange Agreements and International Networks

6.5.1 Bilateral agreements

The DAA 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 Padova, Princeton, Johns Hopkins, Heidelberg, Maryland, and the European Southern Observatory.

In september 2010, a collaboration program started between the DAA and the Department of Astronomy of University of Maryland. The program includes a double PhD degree between PUC and the Maryland, the first one of this kind at that institution.

This year, the first joint PhD degree was awarded between PUC and Padova to Anna Fabiola Marino.

6.5.2 Marie Curie network LACEGAL

The Latin American-Chinese-European Galaxy Formation (LACEGAL) network approved in November

2010 will bring together internationally recognised experts in the theory of galaxy formation and the modelling of the growth of cosmic structure. The network will allow 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. This includes the University of Durham (UK), the Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany), Universiteit Leiden (NL), Agencia Estatal Consejo Superior De Investigaciones Científicas (Spain), University of Sussex (UK), University of Nottingham (UK), Università Degli Studi Di Trieste (Italy), Shanghai Astronomical Observatory (China), Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina), Universidade de São Paulo (Brazil), Universidad Nacional Autonóma de México (Mexico), Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico), HITS GGMBH (Germany), Rijksuniversiteit Groningen (NL), and Pontificia U. Católica de Chile. The local coordinator is Nelson Padilla.

7 Facilities

7.1 Office, Computing and Teaching facilities

The DAA occupies 1,815 m^2 in the joint building of the Faculties of Physics and Mathematics, located in the San Joaquín Campus of PUC, to the south of downtown Santiago. Of that surface, 1410 m^2 correspond to the DAA proper, while the remaining 405 m^2 are occupied by the recently-created Centre for Astro-Engineering (see § 6.1). The building accommodates offices for faculty, postdocs and graduate students, optics and electronics workshops, a special room for our supercomputer, joint computer rooms for undergraduates, and conference rooms, including an auditorium seating 100 people.

The building also hosts the "Gauss" Physics and Math library with ∼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 DAA hosts since 1998 the first Latin-American mirror of NASA's Astrophysical Data System (ADS).

The DAA has a computer network maintained by a full-time software engineer and a half-time assistant. It includes a cluster consisting of 64 nodes with a total of 128 Intel Xeon Quad-Core CPUs (512 cores), 576 GB of RAM, 13 TB of disk space (iSCSI), and a Linux system for 64-bit architecture running over a 1 Gbps ethernet network. Development and execution tools include Intel Fortran and Intel C compilers (ifort, icc), mpich2, Distributed Resource Management (DRM) software SGE (Sun Grid Engine), and standard tools (gcc, g++, gfortran, etc). Users at DAA 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.

7.1.1 Santa Martina Observatory

The DAA maintains a small Observatory 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 professional telescopes have locally-upgraded control systems and new instrumentation, including CCD cameras, spectrographs and a new 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. A small planetary 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.

7.2 Telescopes

Scientists and students from the DAA, and qualifying visitors, can apply for time at the international observatories located in Chile. Time is granted in general within a 10% of the time reserved for Chilean institutions and is administered in different ways by each observatory.

During the period reported, DAA members performed observations for 244.5h + 0.7n at the ESO 8.2m VLTs, 10n at ESO 2.2m, 3n at ESO NTT, 150h at REM in La Silla, 29n at CTIO Blanco 4m, 6n at SOAR, 4n + 15h at CTIO 1.5m, 180h at CTIO 1.3m, 11n at CTIO 1m, 8n + 24h at CTIO 0.9m, 16n at LCO Clay 6.5m, 6.5n at LCO Baade 6.5m, 6n at LCO DuPont 2.5m, 5n + 18.5h at Gemini South, and 8h at ATCA.

8 Administrative Duties

Astronomers of the DAA have to take part on the Faculty and University councils and represent the public interest of Chilean Astronomy within national and multinational committees.

F. Bauer: co-chair of AGN panel for Swift Observatory TAC; member of the CNTAC; member of ALMA-Chile Working Group; member of PUC/Maryland Postdoctoral Fellowship Selection Committee; member of PUC Postdoctoral Fellowship Selection Committee.

F. Barrientos: member of ALMA-Chile Working Group.

M. Catelan: member of the GEMINI-CONICYT and ESO-Chile Committee; member of the Organizing Committee of Commission 27 (Variable Stars) of the International Astronomical Union.

A. Clocchiatti: Director of the DAA (until Sept. 2010); member of the CONICYT Astronomy Advisory Committee; member of the ad hoc Foreing Affairs Ministry E-ELT Advisor Committee; member of the ALMA-CONICYT fund Committee; member of the PUC Physics Faculty undergraduate commission.

L. Infante: President of SOCHIAS (2009, 2010); Chair LSST Chilean Science Commitee; President APEX Telescope Time Committee; member of the Conicyt Astronomy Advisor Committee; member Foreing Affairs Ministry E-ELT Advisor Committee; member of the ESO-Chile Joint Committee; consultant CONICET, Argentina; member ACT Board. board member ACT, Atacama Cosmology Telescope.

A. Jordán: member of the CNTAC; SOC and chaired the LOC for the Astrobio2010 workshop.

A. Reisenegger: Director of the DAA; member of the Faculty Qualification Committee of the PUC Faculty of Physics; elected member of the PUC Faculty of Physics Council; interim member of the PUC Faculty of Physics undergraduate committee; member of an ESO OPC panel; member of the Editorial Board of New Astronomy; coordinator of the Physics/Astronomy graduate programs Chilean accreditation committee; member of the Physics/Astronomy Graduate Fellowship Committee of CONICYT; member of the ESO-Chile Astronomy Fund Committee.

N. Padilla: member of the Physics Faculty Council.

T.H. Puzia: member of the CNTAC.

9 Meetings supported

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

- *ASTROBIO 2010* (PUC; Cepal, Santiago, Feb. 2010)
- *Super-computing techniques in Astronomy – International School and Workshop* (AIUC; Campus San Joaquín, Santiago, April 2010).
- *Lyman Alpha Emitters Summit* (PUC; Campus San Joaquín, Santiago, October 2010).
- *First VISTA Variables in the Vía Láctea (VVV) Science Meeting* (PUC; Viña del Mar, Dec. 2010)

10 Special Outreach Activities

Astronomers and students at the DAA take part in dozens of outreach events every year (radio, TV, and/or printed press). Some special activities have been organized or coordinated by the DAA and are listed below.

D. Minniti, R. Saito and J. Alonso-García organized and taught the course "Mundos Lejanos: Planetas, estrellas y vida en el Universo" within the framework of the PUC *PENTA* initiative, where gifted elementary and high school students in social risk spent the Fridays and Saturdays in campus to develop their intellectual capabilities.

With the help of graduate students, N. Padilla developed a display entitled "El Universo", which consists on posters and a video on different topics of Astronomy. The installation has been shown in several venues, including the Centro Cultural Palacio La Moneda, the Biblioteca Nacional, several of the main secondary schools in Santiago, and the main library in our campus. Along with a series of talks, the display was also shown in several schools in La Pintana, on the outskirts of Santiago.

A. Clocchiatti led the effort that resulted in the declaration of Observatorio Foster as a *Monumento Nacional*. Several steps were and are being taken to improve the physical conditions of the observatory to turn it into a visitor's center capable of receiving primary and secondary students.

A. Alves-Brito organized the first Astronomy course for senior citizens, which took place in Campus San Joaquín and the Santa Martina Observatory. The course consisted in 10 talks delivered to an audience of over 50 people", and was supported by the Milky Way Millennium Nucleus.

Milky Way Millennium Nucleus members, including M. Catelan, A. Jordán, M. Zoccali, J. Alonso-García, R.K. Saito, A. Valcarce and C. Contreras, organized and participated in a series of 5 radio shows, in the framework of the *Foro Ciudadano* series. These shows were broadcast over more than 100 radio stations all over Chile.

C. Oliva, the DAA journalist, wrote several articles on our research and other activities, which appeared on important newspapers in Santiago. He was also in charge of supervising several of the presentations of the display "El Universo" and also developed the first DAA Newsletter, which contains important news from the Department as well as the entire Chilean Astronomical community.

C. Oliva and A. Clocchiatti developed a pilot series of radio micro-shows which were broadcasted by PUC

Fig. 1.— A. Alves-Brito and students of the first Astronomy course for seniors at the Santa Martina Observatory.

AM radio. We are currently searching for a sponsor to sustain the project.

R. Saito organized talks on astronomy and astronomical observations with a telescope for kids at the "Toma de Peñalolén", a squatter settlement in Santiago, invited by the NGO "Un Techo para Chile". Additionally, many DAA members have given outreach talks at schools and community centres.

11 Scientific Activities 2002/2003

11.1 Extrasolar planets

A. Jordán is the node manager of the Las Campanas station of the HAT-South project. HAT-South is the first global survey for transiting exoplanets, with stations in Namibia, Australia and Chile. The project started gathering data in 2010 and is a collaboration between the Harvard-Smithsonian CfA, the Max-Planck Institut für Astrophysik, the Australian National University and PUC. The PUC team is constituted of A. Jordán, M. Rabus and V. Suc.

Together with collaborators from Poland, K. Hełminiak is involved in construction and erection of a new global network of robotic telescopes - *Solaris* - dedicated for the search of circumbinary extrasolar planets by precise eclipse timing. The first telescopes of the *Solaris* network are expected to be operational in 2011.

C. Cáceres, in collaboration with D. Minniti; V.D. Ivanov, C. Melo, D. Naef, F. Selman (ESO); E. Mason (STScI); G. Pietrzynski (UdeC); and A. Burrows (Princeton University) has continued his efforts in studying transiting planetary systems, with the use of high-cadence NIR photometry. The analysis of the light curve of the transiting planet WASP-4b, during the occultation phase, has revealed a hot atmosphere, with an absent thermal inversion, and an extremely inefficient redistribution of heat from the day-side to the night-side of the planet, with a brightness temperature of around 2000 K in its day-side.

11.2 Stars and sub-galactic stellar systems

F. Bauer, D. Dewey (MIT), and V. Dwarkadas (University of Chicago) continued several lines of research to study the nearby SN1996cr including: performing 1-D hydrodynamical simulations to match X-ray light curves; analyzing high-resolution X-ray data from Chandra and XMM-Newton, and acquiring Magellan FIRE near-IR and Gemini T-ReCS mid-IR spectra. F. Bauer, C. Meunier, and V. Dwarkadas (University of Chicago) used the 1-D hydrodynamical model to simulate radio light curves to match against existing radio data.

F. Bauer, C. DeWitt (University of Florida), R. Bandyopadhyay (University of Florida), S. Eikenberry (University of Florida) obtained near-IR spectra with OSIRIS on SOAR and FIRE on Magellan for dozens of high-mass X-ray binary candidates in the Galactic Center.

F. Bauer, A. Clocchiatti, J. Quinn, J. Maund (Kapetyn Institute), M. Phillips (Las Campanas Observatory), N. Morrell (Las Campanas Observatory), and J. Prieto (Carnegie Observatory) obtained several epochs of VLT FORS2 polarimeter, Magellan FIRE, DuPont echelle spectroscopy on the exceptionally bright type IIn SN2010jl to study the evolution of inferred explosion geometry from the ejecta and circumstellar material.

K. Hełminiak with collaborators from Poland and USA continued studies on detached eclipsing binaries with low-mass ($< 1M_{\odot}$) components, confirming and characterizing several new objects of this rare class.

R. Lachaume, J. Girard (ESO Chile), G. Weigelt (Max-Planck-Institut, Bonn, GER), et al. "High angular and spectral resolution study in the IR of the young stellar system Mon R2 IRS 3", observations being carried out at ESO

R. Lachaume, L. Luis Noriega & P. D'Alessio (UNAM, Morelia, MEX), modelling of the inner part of proto-planetary discs, one paper in preparation and one research note submitted to A&A.

M. Zorotovic, M.R. Schreiber (Valparaíso), B.T. Gänsicke (Warwick) and A. Nebot Gómez-Morán (AIP) reconstructed the evolutionary history of the largest sample of post-common-envelope binaries (PCEBs), and put new constraints to the common-envelope efficiency. They also compared the primary mass distribution of cataclysmic variables (CVs), pre-CVs and PCEBs in a paper already submitted to A&A.

A. Reisenegger continued his efforts to understand the thermal evolution of very old, internally re-heated neutron stars. With Master's student Denis González, he compared different heating mechanisms, concluding that both the friction exerted by vortices moving inside the neutron star crust and the rotochemical heating process (previously proposed by him) are compatible with existing data and could be distinguished by further observations. With students Cristóbal Petrovich and Nicolás González-Jiménez, he explored the interesting implications of neutron and proton superfluidity on rotochemical heating.

Reisenegger also explored the conditions for and consequences of stable magnetic field structures in fluid stars. With Master's student Pablo Marchant and former postdoc Taner Akgün, he revisited the Flowers–Ruderman instability of poloidal fields and the stabilizing effect of including a toroidal component as well. With Akgün, Marchant, and U. of Melbourne PhD student Alpha Mastrano, he studied the explicit form of the Tayler instability of toroidal fields and its stabilization by a poloidal component. With Mastrano, Akgün, and

Fig. 2.— R. Saito and children from the squatter settlement "Toma de Peñalolén".

Mastrano's thesis advisor Andrew Melatos, he studied the gravitational radiation from rotating neutron stars of (likely stable) equilibrium configurations with combined poloidal and toroidal fields. Finally, with former postdoc Jaime Hoyos and U. de Chile professor Juan A. Valdivia, he explored the evolution of neutron star magnetic fields in the presence of ambipolar diffusion.

M. Catelan and former PUC M.Sc. student R. Contreras completed the study of the variable star population in the globular cluster M62 (NGC 6266). They found that this is quite possibly the most RR Lyrae-rich globular cluster ever, and provided a detailed catalogue and description of the variable star properties in this cluster (Contreras et al. 2010, AJ, 140, 1766).

M. Catelan, PUC Ph.D. student M. Zorotovic, and an additional 16 PUC students at the Ph.D., M.Sc., and B.Sc. levels completed the stellar variability study of the globular cluster NGC 5286, which is a candidate member of the putative Canis Major dwarf spheroidal galaxy. They provide a detailed catalogue and description of the variable star properties in this cluster, finding it to be unlike the variable star populations typically found in systems associated with dwarf spheroidal galaxies (Zorotovic et al. 2010, AJ, 140, 912).

M. Catelan and his colleagues of the Catalina Realtime Transient Survey (CRTS) have reported on the discovery and initial observations of the energetic type IIn supernova 2008fz, suggesting that the optical energy emitted by this supernova may have been the highest ever observed for a supernova (Drake et al. 2010, ApJ, 718, L127).

11.3 Stellar populations in the Milky Way

M. Zoccali has been investigating the 3D structure and the stellar population of the Milky Way Bulge. It was demonstrated for the first time that the Galactic bulge is X-shaped (Zoccali 2010, IAUS 265 271, McWilliam & Zoccali 2010, ApJ, 724, 1491). The radial metallicity gradient found by Zoccali et al. (2008) was confirmed with HST-ACS imaging by Brown et al. (2010, ApJ, 725, L19), and a rapid formation timescale, inferred from the enhancement of alpha elements, was confirmed by González et al. (2011, in press). Bimodality in the kinematics was also found at $(l, b) = (0, -4)$, with the metal-rich stars on stream motions in a bar-like kinematics, while the metal poor show a velocity dispersion consistent with a classical spheroid (Babusiaux et al. 2010, A&A, 519, 77). An ESO Large Programme was approved this year (140h, PI: Zoccali), aimed at a large scale chemical characterization of the bulge stellar population, with FLAMES@VLT.

I. Dékány, as a VVV science team member, has been working on the detection and characterization of stellar variability in the first year's data of the VVV Public Survey. He has also been working in the VVV Templates Project, aimed at creating a large database of well-defined, high-quality near-infrared light curves for a large number of different variable star classes, in order to provide template data for the automatic light curve classification algorithms of the VVV Public Survey.

A. Alves Brito worked on the detailed chemical abundances analysis of giant stars in the different Galactic components (halo, bulge and disks) using high-resolution optical and infrared spectra. He also worked on the analysis of integrated spectra of extragalactic globular clusters.

M. Catelan and PUC Ph.D. student A. Valcarce have implemented a new, fully functional, highly updated and parallelized version of the Princeton-Goddard stellar evolution code – the so-called PGPUC stellar evolution code – at the DAA's geryon cluster.

11.4 Nearby Galaxies

T.H. Puzia is leading one project on high spatial-resolution, wide-field imaging of the globular cluster system in NGC 1399 using HST/ACS and Chandra/ACIS. He is also PI and working on HST/ACS imaging of intermediate-GCs in the LMC and SMC to determine the time spread in their formation epochs. In addition, he leads a spectroscopic program of compact stellar systems in the Fornax galaxy cluster. He is PI on a high-resolution spectroscopy project of Local Group star clusters and the theoretical modeling of their SEDs, and PI of the Next Generation Virgo Survey-IR and is leading an international team of collaborators, including A. Jordán, to exploit this immense imaging dataset. He is co-I on the optical CFHT Next Generation Virgo Survey (NGVS), the HST/ACS Coma Cluster Survey, the CFHT Pan-Andromeda Archaeological Survey (PanDAS), and the Keck/AO Local Group Infrared Cluster Survey (LoGICS).

A. Jordán maintains several programs whose subjects of study are galaxies in nearby clusters. He is a co-I in the CFHT Next Generation Virgo Survey (NGVS), and is involved in several programs to study galaxies and stellar clusters in Virgo and Fornax.

11.5 Galaxies and larger structures

T. Anguita and F. Barrientos have built a catalog of galaxy scale lenses in the RCS2. Follow up VLT, GEMINI and Magellan observations have been scheduled to confirm the nature of the candidates. Lens models of the systems in the catalog will allow the study of dark to bright matter evolution of galaxies from $z = 0.5$ to $z = 0.2$. Additionally, taking advantage of the magnification produced by gravitational lensing, a study of the bright star forming source galaxies at high redshift will be performed.

In collaboration with M. Strauss, C. Lagos, L. Hao and S. Cora, N. Padilla studied possible alignments between the galaxy disc and the accretion disk around the SMBH in the SDSS. With S. Cora and students at Católica (A. Muñoz, F. Garrido), N. Padilla continued to develop a semi-analytic model of galaxy formation (SAG). R. González and N. Padilla finished the development of a large-scale filament finder applicable in numerical simulations. With D. Lambas, N. Padilla studied the environmental effects suffered by galaxies with and without AGN. L. Guaita and N. Padilla, in collaboration with the Rutgers and Penn State groups studied the $z = 2.1$ population of Lyman-α emmiters. With E. Gawiser, D. Marchesini and D. Christlein, N. Padilla studied ways to follow descendants of high redshift early-type galaxies

11.6 Large Scale Structure

I. Lacerna and N. Padilla used a numerical simulation to redefine the overdensity that characterizes each galaxy using the information of its virial mass and the relative stellar age. This new definition is proposed as a better alternative than the virial mass to account for the assembly bias effect. Galaxies do not show significant differences in the two-halo regime for objects of equal mass but different age using this formalism.

R. Dünner, in collaboration with L. Infante, F. Barrientos, P. Aguirre, F. Rojas, J. González and C. Sifón initiated the project CACTUS, to study SZ selected clusters of galaxies and radio sources found in a 30 square degree patch of the ACT survey. Data reduction and map-making was developed locally. Optical follow up of the cluster candidates was used to determine dynamical their mass, which can be related to their Compton-y parameter and constrain the σ_8 parameter for non-linear structure formation.

11.7 Quasars

F. Bauer, in collaboration with A. Sajina (Haverford College), L. Yan (Spitzer Science Center), and D. Alexander (Durham University) completed a study on the X-ray emission of ultraluminous infrared galaxies at redshift z 2 using Chandra, concluding that the majority were likely to host AGN obscured by Compton-thick material.

F. Bauer, in conjunction with the large international CDF-S collaboration, worked on several X-ray related projects including: reduction and identification of the new 4Ms dataset, the analysis of X-ray spectra from $>$ 1000 distant AGN and galaxies as well as a handful of X-ray spectra side-projects.

F. Bauer, P. Lira (UChile), S. Silva (UChile), and D. Alexander (Durham University) obtained near-IR (i.e., rest-frame optical) spectra with MMIRS and FIRE on Magellan to study the black hole and feedback properties from a sample of distant obscured AGN.

F. Bauer, A. Goulding (Harvard University), D. Alexander (Durham University) characterized a sample of obscured AGN candidates within nearby luminous infrared galaxies using mid-IR imaging and spectroscopy with Gemini T-ReCS.

J. Cuadra, together with C. Baruteau and D. Lin (Santa Cruz) studied numerically the evolution of binary stars embedded in a gaseous disc. Fragmentation of a massive accretion disc is the likely origin of the young stars observed in the inner parsec of the Galaxy, and some of the stars are expected to form as binaries. The left-over gas affects the young binaries, hardening their orbits while making them migrate towards the central black hole. The study concluded that binaries harden faster than they migrate.

J. Cuadra, together with H. Bartko and A. Gualandris (Garching), is studying the orbital distribution of stars originally in a disc, under the effect of N-body scattering. They are comparing the simulation results with observations of the Galactic centre stars, finding that different origins are required for O/WR and B stars.

Together with a team of German- and Italian-based scientists, J. Cuadra is studying the evolution of massive black hole sub-pc binaries hardening under the effect of a circumbinary gaseous disc. In particular, they are studying the eccentricity evolution of the binary, and whether any gas remains bound to the black holes (available for accretion) at the moment of coalescence.

J. Cuadra, together with S. Nayakshin (Leicester) are studying the effect of a post-merger 'kicked' supermassive black hole on its host galaxy. The winds from the off-centre quasar unbind the galaxy gas, stopping both the black hole and stellar growth, possibly setting the M–σ relation.

11.8 Cosmology

R. Dünner continues collaboration with the ACT project (Princeton University), constraining cosmological parameters out of the CMB power spectrum measured by the ACT telescope.

L. Infante, collaborators, postdocs and students have carried out research in several areas in observational and theoretical cosmology. Research in 2010 include: (i) The Chile-ACT Ultradeep Survey (CACTUS): deep mapping of a 30 sq.deg. region of the Atacama Cosmology Telescope southern strip. Started in 2009, the goal is to to probe deeper into the luminosity function of submm galaxies, and to lower the mass limit on the mass function of galaxy clusters. (ii) Pop III stars from gas turbulence at $z = 11$: Student Joaquín Prieto, under the supervision of Infante, finished his PhD degree at PUC studying turbulent environments at $z = 11$ identified as formation sites for the first generation of stars in

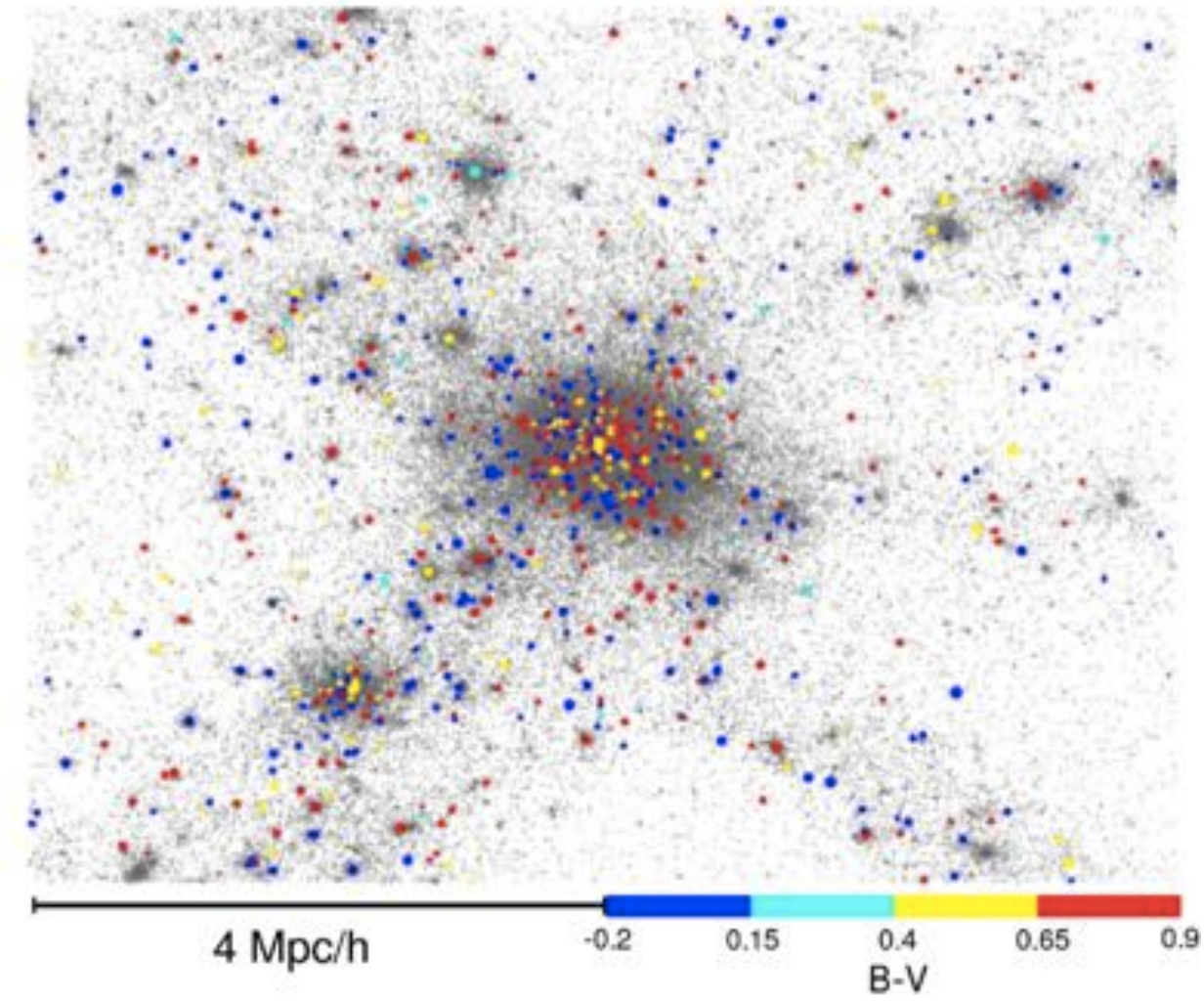

Fig. 3.— Positions of dark matter particles (grey points) and semi-analytic galaxies (color points) for a re-simulation of a galaxy cluster in a LCDM simulation, at redshift zero. The side of the figure measures $8h^{-1}$ Mpc. The larger points represent galaxies with bright M_B, and the colors of the galaxy points corresponds to the $B-V$ color index (as indicated in the key).

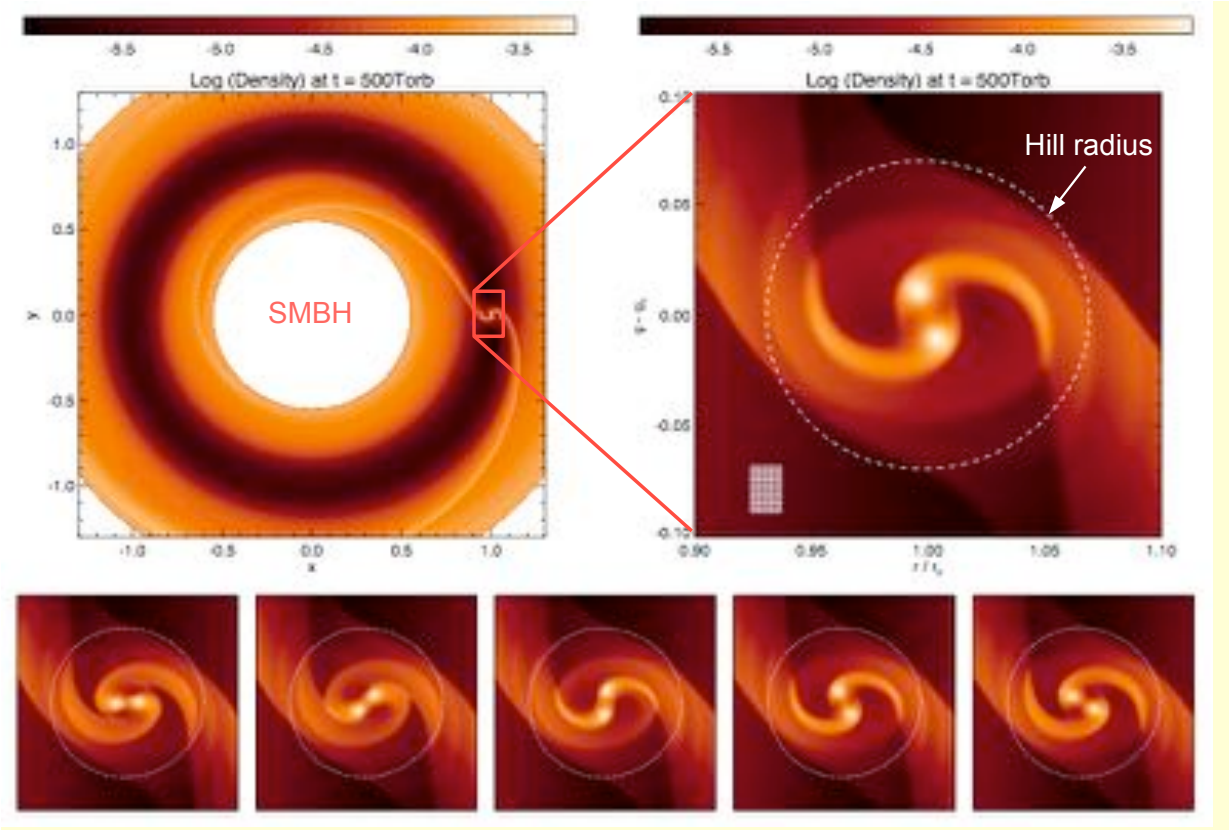

Fig. 4.— Simulation of a binary star migrating in the gaseous disc. This situation, reminiscent of planet migration, is relevant for the formation of stars around the massive black hole in the inner parsec of the Galaxy. (Baruteau, Cuadra & Lin, 2011)

the universe. (iii) Lyman-break Galaxy Redshift Survey at $z \gg 3$, which contains 2100 galaxy redshifts obtained with VLT VIMOS. The goal of this project is to study luminosity functions, clustering studies and gas outflows. (iv) The LABOCA Survey of Clusters at All Redshifts (LASCAR): ESO/MPG/OSO/Chile survey to obtain LABOCA 870 μm maps of 15 of the most massive galaxy clusters in a 450 degree southern strip surveyed by the Atacama Cosmology Telescope (ACT). (v) Galaxies at $z > 7$: We have Initiated a collaboration within the CLASH (Cluster Lensing And Supernova survey with Hubble) consortium to follow up galaxies at redshifts larger than 7.

11.9 Astronomical Instrumentation

R. Dünner collaborates with the ACT project characterizing several aspects of the ACT telescope including thermal stability and its implications in the nightly pointing error, mirror illumination and "spill over" contamination and determination of far side lobes. In a related topic, he studied the effects of atmospheric turbulences affecting the ACT data.

12 Participation in International Conferences

The following lists include the talks given by DAA scientists and students at international astronomy conferences.

Review Talks

- N. Padilla: *The Nature of Assembly Bias*. (at *Jornadas de Formación de Galaxias*, Argentina).
- A. Reisenegger: *Basic principles of stellar structure*. (at the *II International Congress in Formation and Modeling of Basic Sciences*, Colombia).
- A. Reisenegger: *The accelerated Universe*. (at the *II International Congress in Formation and Modeling of Basic Sciences*, Colombia).

Invited Talks

- J. Alonso-García: *Observing the inner Galactic globular clusters in optical and infrared: a new approach*. (at the *First VVV Science Meeting*, Chile).
- A. Alves-Brito: *On the chemical connection between the bulge and the thick-disk*. (at the *XIII Latin American IAU Regional Meeting*, Mexico).
- M. Catelan: *Constraints on the Formation History of the Milky Way: The RR Lyrae Perspective*. (at *The Milky Way, from the South, in the South*, Chile).
- A. Clocchiatti: *Supernovae type Ia and the acceleration of the expansion of the Universe*. (at the *International Conference on Two Cosmological Models*, Mexico).
- I. Dékány: *Towards the automatic classification of VISTA variables in the Vía Láctea*. (at the *First VVV Science Meeting*, Chile).
- A. Jordán: *HAT-South: a 24-hr Global Network to Find Transiting Exoplanets*. (at *ASTROBIO 2010*. Chile).
- D. Minniti: *The VVV Survey: Progress Report*. (at the *First VVV Science Meeting*, Chile).
- D. Minniti: *The VVV Survey: Current Status and Future Prospects*. (at the *Meeting of the Asociación Argentina de Astronomía*, Argentina).
- D. Minniti: *A Southern Search for Exoplanets*. (at *ASTROBIO 2010*. Chile).
- D. Minniti: *The Magellan Exoplanet Search*. (at the *ESO Workshop on Exoplanets*. Chile).
- N. Padilla: *Assembly of Early Type Galaxies*. (at the *XIII Latin American Regional IAU Meeting*, Mexico).
- R. Saito: *Vista Variables in the Vía Láctea (VVV): current status and perspectives*. (at the *XIII Latin American Regional IAU Meeting*, Mexico).

Contributed Talks

- J. Alonso-García: *Observing the Milky Way using the VVV infrared survey* . (at the *ESO workshop on The Spiral Structure of the Milky Way: Confronting Observations and Theory*, Chile).
- C. Cáceres: *High-cadence NIR observations of extrasolar planets*. (at the *XIII Latin American Regional IAU Meeting*, Mexico).
- I. Lacerna: *The nature of assembly bias: clues from a ΛCDM cosmology*. (at the *XIII Latin American Regional IAU Meeting*, Mexico).
- A. Muñoz: *A variable IMF slope to fit the LCDM picture to observed high-z submillimeter sources*. (at the *XIII Latin American Regional IAU Meeting*, Mexico).
- R. Saito: *Vista Variables in the Via Láctea (VVV): um survey público de variabilidade para a Via Láctea no infravermelho próximo*. (at *XXXV Annual Meeting of the Brazilian Astronomical Society*, Brazil).
- A. Reisenegger: *Rotochemical heating of old neutron stars*. (at *Pulsar Conference 2010 – Radio pulsars: An astrophysical key to unlock the secrets of the Universe*, Italy).

- M. Zorotovic: *Understanding Close Compact Binary Evolution from Post Common Envelope Binaries.* (at *Binary star evolution: Mass loss, accretion, and mergers*, Greece).

13 Invited Colloquia

DAA scientists have given the following invited colloquia or seminars.

- A. Alves-Brito: *On the chemical connection between the bulge and the thick disk.* (ESO, Germany).
- N. Padilla: *The Assembly of Early-Type Galaxies.* (Durham, UK).
- T.H. Puzia: *Star Clusters and their Stellar Populations.* (Zentrum für Astronomie, Heidelberg, Germany).

14 Refereed Publications and Impact

Astronomers from the DAA, including students, participated in 81 refereed papers published in 2010. The full list is given below.

According to Thomson Scientific (date April 13, 2011), DAA astronomers published alone or in collaboration 612 papers during the last decade (ranking as the 107th institution in the world in this category), and these publications received 16605 citations (ranking as the 100th in the world). This makes up a total of 27.13 citations per paper, figure that ranks the DAA as number 55 in the world.

For the fifteen faculty members listed in Section 3.2 we use the ADS system to screen the peer-review publication performance up until December of 2010 using several indices and publication scores which are summarized in Figure 5. The plots show that the research productivity and impact of the corresponding peer-review publications of our research faculty is on par with top-tier astronomy departments and institutes in North America.

The publication list includes all papers published in refereed journals during 2010 by the DAA staff, students or visitors (if a substantial portion of the work was done at DAA).

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- **Bañados E.**, Hung L.-W., De Propris R., West M.J. 2010 *The Faint End of the Galaxy Luminosity Function in A1689: A Steep Red Faint End Upturn at z = 0.18*, ApJ 721, L14
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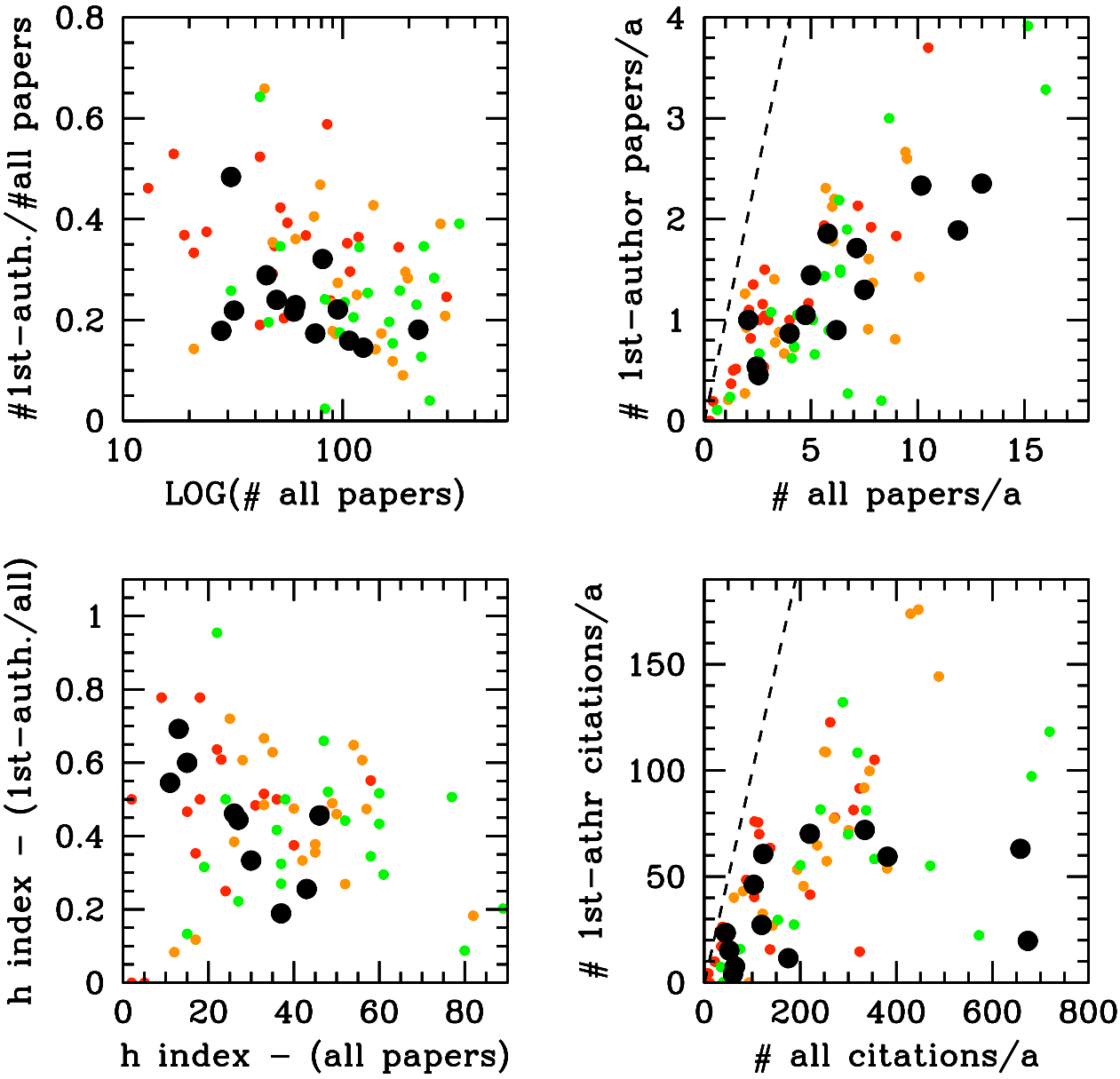

Fig. 5.— In the top-left panel of the figure we show the number of first-author citation per year versus the number of total citation per year since their PhD for each faculty member. The dashed line is always the one-to-one relation. The top-right panel shows the number of first-author vs. n-th author papers per year since PhD and the bottom-right panel illustrates the number of first-author papers versus the total amount of papers. The bottom-left panel depicts the h-index [see Hirsch, J.E. (2005) PNAS 102, 16569] of all first-author papers as a function of the h-index of all papers ever published by a faculty member. To set a reference we perform the same analysis for three other astronomy and astrophysics departments, namely the Department of Astronomy and Astrophysics at the University of Toronto (red), the Ohio State University Department of Astronomy (orange), and the Astronomy and Astrophysics Department of the University of California at Santa Cruz (green).

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