Gaia, brown dwarfs and cool neighbours: an M-, L- and T-dwarf Archive of Interest for Astrophysics

MAIA

Cover Page:
Name of the Principal Investigator (PI): **José A. Caballero**
Name of the PI's host institution for the project: **Centro de Astrobiología, Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC)**
Proposal duration in months: **60**

Proposal summary:
In 1995, the coolest stars known in the Galaxy had spectral type M9 V, and brown dwarfs were only a theoretical prediction. Twenty years later, astronomers have extended the famous OBAFGKM sequence to L, T and Y spectral types, which translate into an effective temperature range from 2200 K to only about 300 K, and found thousands of brown dwarfs in young open clusters, as companion to stars, or free floating in our solar neighbourhood.

In spite of the numerous works on late-type stars and brown dwarfs in the last two decades, there are still some major questions without definitive or precise answers, such as: Is there any universal slope of the substellar mass function? How do metallicity and age affect photospheres and colours? How do ultra-wide low-mass binaries form? Do the least massive stars have habitable exoplanets? To tackle these and numerous other issues, experts worldwide urgently need the most comprehensive, homogeneous, bias-free sample of cool and ultra-cool targets and of their astrophysical parameters.

I propose to take advantage of the forthcoming ESA's *Gaia* astrometric data releases, my long expertise on low-mass stars and brown dwarfs, multi-mode observations, astronomical databases and management, and the willing collaboration of numerous colleagues worldwide to set up MAIA, a public, exhaustive "M-, L- and T-dwarf Archive for Astrophysics". MAIA will far supersede, in size and accuracy, any previous cool dwarf catalogue and be an obligatory reference point for future low-mass star and brown dwarf studies. The ambitious project will not only service to the public, but also answer once for all the major open questions at the bottom of the main sequence and beyond.

Web site:
http://exoterrae.eu/maia/

Section a: *Extended Synopsis of the scientific proposal (max. 5 pages)*

A few very late M dwarfs discovered in the field by Luyten and van Biesbroeck in the late 60s, a peculiar companion to the white dwarf GD 165, half a dozen radial-velocity companions to HD 114762, γ Cep and the pulsar PSR B1257+12, and a bunch of very red objects in the young star-forming region of Chamaeleon were the least massive objects known to astronomers at the beginning of 1995. However, at the end of that annus mirabilis, 51 Peg b (Mayor & Queloz 1995, Nature, 378, 355), the first exoplanet around a main sequence star, and Teide 1 (Rebolo et al. 1995, Nature, 377, 129) and Gl 229 B (Nakajima et al. 1995, Nature, 378, 463), the first brown dwarfs, started to populate ever-increasing catalogues of cool low-mass stars, brown dwarfs and exoplanets.

In just 20 years, we have passed from an era in which brown dwarfs and exoplanets were almost science fiction (see, e.g. the 1989 Isaac Asimov's novel *Nemesis*), through a thrilling epoch in which almost every month there was a new amazing discovery (the first L dwarf, the first Uranus-like exoplanet, the coolest T dwarf, the first exoplanet around an M dwarf, the closest brown dwarf, the first exoplanet with a period longer than 100 days, the first wide L-dwarf binary, the first determination of density of a transiting exoplanet, the first Y dwarf, the first exoplanet in habitable zone…), to the current period of time.

In the meantime, we have defined three new spectral types cooler than M (i.e., L, T and Y), discovered objects with effective temperatures that resemble more to those of the Solar System planets than of stars, and that are surprisingly close to our Sun, identified hundreds of Earth-*size* planet candidates with *Kepler* and a few Earth-*mass* planet candidates with precise spectrographs (such as HARPS), and launched the *Gaia* astrometric mission.

There are comprehensive exoplanet catalogues that are frequently used by astronomers on both sides of the Atlantic[1]. However, there is no obligatory reference for cool and ultra-cool dwarfs: for, example, the DwarfArchives[2], possibly the most complete catalogue of late-type dwarfs, was updated for the last time in November 2012. A new, exhaustive cool and ultra-cool dwarf catalogue should (or shall) be public, as useful as possible for astronomers worldwide, and virtual-observatory compliant. It should collect homogeneous low- and high- resolution spectroscopy and multi-band photometry obtained with ground telescopes, together with *Gaia* parallaxes and proper motions, from which deriving accurate luminosities, effective temperatures, surface gravities, radii, spatial densities and Galactocentric velocities, among other key parameters. In a sense, it would resemble a mixture of the *Gaia*-ESO survey archive (Gilmore et al. 2012, Messenger, 147, 25) and the Exoplanet Encyclopaedia.

The European Space Agency's *Gaia* space mission was launched on 19 Dec 2013 and is expected to deliver an overwhelming amount of data crucial for a quantitative and qualitative leap forward in stellar and substellar Astrophysics. There have been some attempts of starting the construction of a "*Gaia* brown dwarf" catalogue, but at a much smaller scale than proposed here. One of those catalogues was publicly available at the

---

[1] http://exoplanet.eu, http://exoplanets.org
[2] http://dwarfarchives.org

website of the *"Gaia and the unseen. The brown dwarf question"* workshop[3] and had hyperlinks to spectroscopic observations with Keck and ESO telescopes (Smart 2015, MmSAI, 85, 649). However, creating a *"Gaia* cool and ultra-cool dwarf" catalogue is not a one-man's task: it requires the close collaboration between experts in data archiving and mining, low- and high-resolution spectroscopy, multi-band photometry and spectral energy distributions, astrophysical properties of ultracool dwarfs, and *Gaia* data analysis. Remarkably for this ERC-CoG proposal, such catalogue must be centralised and coordinated from a single place by a motivated, well-prepared, compact, research team, which must be led by an individual with a long experience in low-mass stars and brown dwarfs, astrometric, photometric and spectroscopic observations, astronomical databases, coordination of large international consortia, and with a large number of colleagues willing to share their expertise and data with the team. *I am that individual*.

Morevover, given the 750 MEUR total cost of the *Gaia* space mission, fully paid by ESA (including manufacture, launch and ground operations, but not counting the manpower of astronomers), and the relevance of low-mass stellar and substellar studies in the 21st century Astronomy, one may wonder if establishing a small team of European astronomers devoted to create a *"Gaia* cool and ultra-cool dwarf" catalogue is not a moral obligation. I propose the name MAIA, from 'M-, L- and T dwarf Archive of Interest for Astrophysics', for the catalogue. The MAIA concept was presented at the *"Gaia and the unseen. The brown dwarf question"* workshop, and had a very good acceptance among the participants (**Caballero** 2015, MmSAI, 85, 757).

There are rare times in science when by lucky chance or a fortunate combination of diverse activities we can make a break through in our understanding. The combination of *Gaia*, deep large infrared surveys and high-resolution spectroscopy will allow us to leap frog our understanding of the formation, evolution and contribution to the Galaxy of low-mass stars, brown dwarfs and planets. This will require the innovative combination of new, diverse datasets with the latest computer tools and state-of-the-art synthetic astrophysical models, all of them powered by the engine of a public, easy-to-use data server and the brain and heart of a brilliant team.

The *Gaia* M-, L- and T-dwarf sample will be 20 times larger than the current best cool dwarf compilation with distances, and will have a precision on average four times better. Therefore, we will be able to address the formation differences between low-mass stars and brown dwarfs, find the effect of metallicity and maybe other effects on the mass division between brown dwarfs and stars, and will be able to calibrate to 1% the absolute magnitude scale, just to mention a few examples. As described in detail in document B2, the content of the MAIA meta-archive will allow us to provide accurate and definitive answers to perhaps the four major questions in low-mass star and brown-dwarf Astrophysics: *Is there any universal slope of the substellar mass function? How do metallicity and age affect photospheres and colours? How do ultra-wide low-mass binaries form? Do the least massive stars have habitable exoplanets?*

---

[3] http://gaiabds.oato.inaf.it/

Resources: project costs. Total requested European Union contribution for the completion of the project is **1.999 MEUR** for **60 months**. Approximately 94% of the total direct costs is for personnel. With this amount of money, the host institution will contract the **PI** (5.0 yr), **three postdocs** (4.5 yr each), **one computer engineer** (5.0 yr) and **one PhD student** (4.0 yr). All salaries follow the host institution rules. The remaining 6% of the total direct costs is for travel, equipment (including data server hardware) and other goods and services. Since the PI is not a senior staff of the host institution, CSIC imposes that his dedication must be 100%. The official dedication value and resources devoted to personnel would decrease accordingly if, as expected from the current PI's contract (he has a tenure-track position – *Ramón y Cajal*), he becomes a senior staff during the execution of the project.

Methodology: work packages. The MAIA "mind map" in Fig. 1 illustrates the planned project management. Each postdoc will take leadership of one of the three science workpackages (WPs) of the MAIA project (WP1, 3 and 4). Each science WP radiates to or from the central WP of data server and compilation (WP2), which will be carried out by the computer engineer and the PhD student. The final responsibility and global supervision of the whole project will fall on the shoulders of the PI. The four WPs are as follow:

- **WP1: Input**. The MAIA meta-archive needs the input from **catalogues** (WP1.1: DwarfArchives, RECONS, the CARMENES input catalogue, the latest version of the Gliese & Jahreiss catalogue and all public catalogues listing M, L, T and Y dwarfs, either single or as companions to stars), previous and new **observations** (WP1.2, especially for spectroscopy) and **data mining** in the virtual observatory (WP1.3, especially for multi-band photometry: *Gaia* itself, *WISE* and *Akari*, 2MASS, UKIDSS and VISTA, the latest data releases of SDSS, UCAC and CMC, *GALEX* and past and forthcoming all-sky X-ray surveys). The sample selection criterion must be as homogenous as possible. Document B2 describes how MAIA will increase smoothly from hundreds of cool and ultra-cool dwarfs to several thousands. Observations from the ground complementary to *Gaia* and public VO databases are fundamental in this project. European astronomers will soon be able to use a suite of near-infrared spectrographs with large wavelength coverage and moderate and high resolutions: X-Shooter & CRIRES+/8.2m VLT, PHOENIX/4 m Mayall, GIANO/3.6 m TNG, ESPaDOnS & SPIRou/3.6 m CFHT, CARMENES/3.5 m Calar Alto, and NET/2.6 m NOT. Not by chance, most of the near-infrared spectrographs in the northern hemisphere are located in Spain, the PI's and host institution country. In the meantime, the PI and some external collaborators (including R. J. Smart, F. Marocco, D. Pinfield, H. R. Jones) have been awarded time of 10.4 m Gran Telescopio Canarias for obtaining Osiris spectra of northern moderately-bright L dwarfs, and are submitting a large proposal for international time in telescopes at Observatorio del Roque de Los Muchachos and another one for spectroscopy of southern moderately-bright L dwarfs with X-Shooter at the Very Large Telescope. Besides, the PI participates in an initiative led by A. J. Burgasser and E. Solano for making available the numerous SpeX/IRTF spectra of the former using a virtual observatory-compliant developed by the latter. It has been planned that this initiative and others similar involving J. D. Kirkpatrick and J. K. Faherty's spectroscopic data would be "absorbed" by MAIA if eventually funded.

- **WP2: Meta-archive**. For each brown dwarf, MAIA will tabulate at least the following data: identifier and discovery name, *Gaia* coordinates and proper motions (and parallactic distances after second release), radial velocities from high-resolution spectroscopy with ground telescopes, Galactocentric spatial velocities (and potential membership in kinematic group), magnitudes in as much photometric systems as possible (e.g, from *GALEX NUV* and *FUV*, through SDSS *ugriz*, *Gaia BP* and *RP* and 2MASS, UKIDSS and VISTA *YZJHK*, to *WISE W1-4* – preliminary data from the forthcoming Large Synoptic Survey Telescope may also be available before the completion of the project), wide multiplicity data (if the cool dwarf is a common proper-motion companion to a brighter star, one can extrapolate certain parameters for the fainter taget – e.g., metallicity, more precise distance), close multiplicity data (roughly one out of five field brown dwarfs is a close binary), activity indicators (pseudo-equivalent widths of Hα and calcium triplet emission, X-rays), rotational velocity, photometric period, hyperlinks to public low- and high-resolution spectroscopic data and high-resolution imaging data, all homogeneously derived astrophysical parameters (T_{eff}, log$g$, R, L, M, some reliable [Fe/H] proxy, age, etc. – or, at least, as homogeneous as possible if the origin of the spectrophotometric data is heterogeneous), any remark relevant for the reader, and references for each item. Data will be updated periodically. The archive will be publicly available through a powerful web-based data server based on technology already used for the CARMENES Guaranteed Time Observations archive.
- **WP3: Output**. Photometry and spectral energy distribution fitting provides a first-order estimation of effective temperature. Low-resolution spectroscopy provides a better T_{eff} estimation, as well as hints to gravity, activity and metallicity, which in turn give information on, e.g., age, multiplicity and population membership. However, the data that best complement the accurate *Gaia* parallaxes and proper motions are the high-resolution spectroscopic ones. For measuring precise radial and rotational velocities, reliable metallicities, abundances and, especially, effective temperatures and surface gravities in ultracool dwarfs, we will use the moderate- and high-resolution spectroscopic data obtained in WP1.2 and the latest grids of synthetic models and atomic line databases.
- **WP4: Science exploitation**. Seven large scientific blocks have been defined: Multiplicity, Luminosity/mass function, Young stars and brown dwarfs, Fundamental parameters, Benchmark objects, Peculiar objects and Targets for exoplanet searches. They cover virtually all areas of study related to low-mass stars and brown dwarfs: from stellar and substellar formation, through confrontation of theory vs. observations, to the relationship between activity, magnetic field, rotation and age. The three postdocs and the PhD student will help the PI to lead works related to as much science blocks as possible, within the research team only or in collaboration with other experts worldwide (listed in document B2), who would enrich the project with their knowledge.
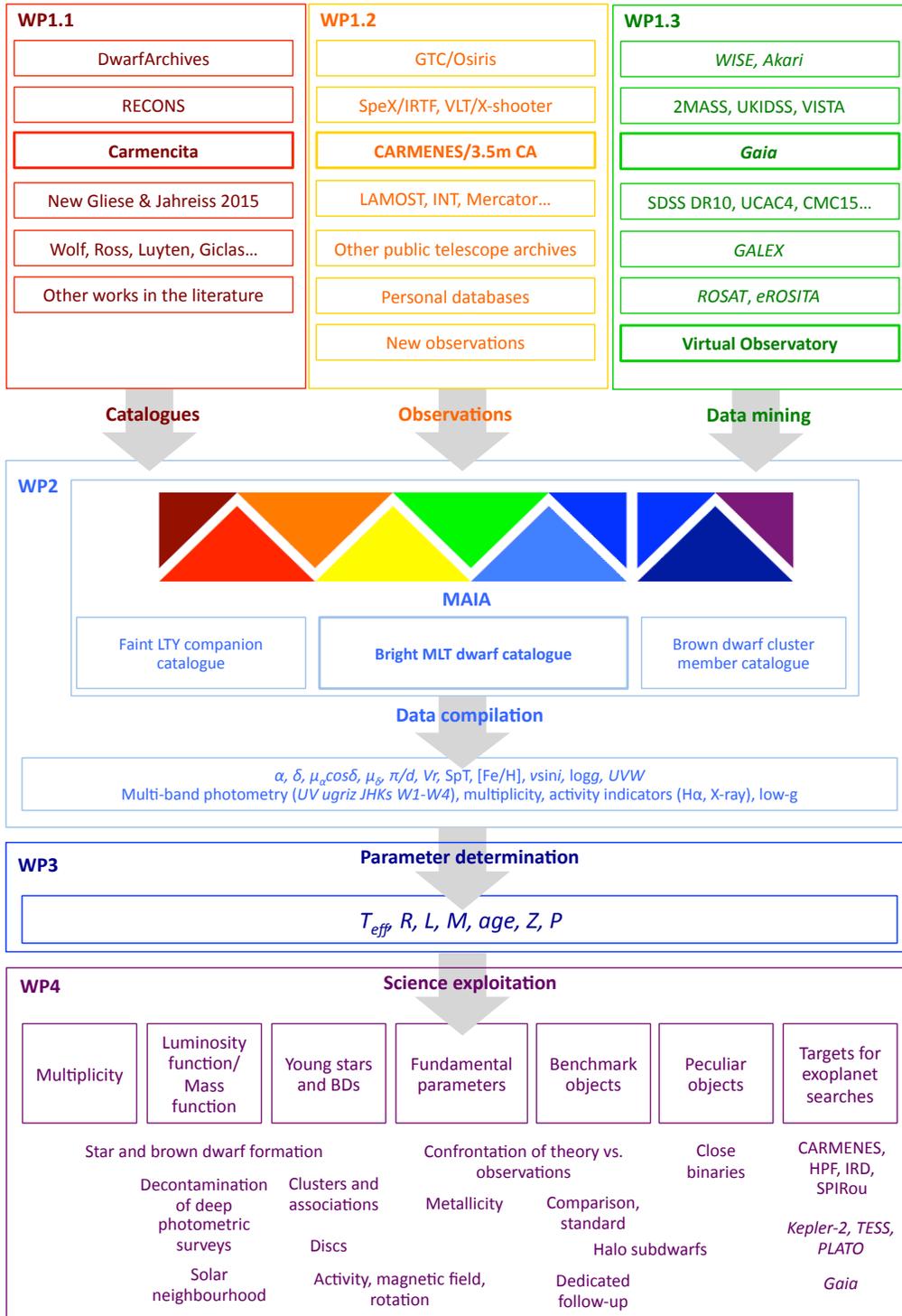
WP1.1
- DwarfArchives
- RECONS
- **Carmencita**
- New Gliese & Jahreiss 2015
- Wolf, Ross, Luyten, Giclas...
- Other works in the literature

WP1.2
- GTC/Osiris
- SpeX/IRTF, VLT/X-shooter
- **CARMENES/3.5m CA**
- LAMOST, INT, Mercator...
- Other public telescope archives
- Personal databases
- New observations

WP1.3
- *WISE, Akari*
- 2MASS, UKIDSS, VISTA
- *Gaia*
- SDSS DR10, UCAC4, CMC15...
- *GALEX*
- *ROSAT, eROSITA*
- **Virtual Observatory**

Catalogues   **Observations**   **Data mining**

WP2

MAIA

- Faint LTY companion catalogue
- **Bright MLT dwarf catalogue**
- Brown dwarf cluster member catalogue

Data compilation

α, δ, $\mu_\alpha cos\delta$, μ_δ, π/d, Vr, SpT, [Fe/H], $vsini$, $logg$, UVW
Multi-band photometry (*UV ugriz JHKs W1-W4*), multiplicity, activity indicators (Hα, X-ray), low-g

WP3   **Parameter determination**

T_{eff}, R, L, M, *age*, Z, P

WP4   **Science exploitation**

- Multiplicity
- Luminosity function/ Mass function
- Young stars and BDs
- Fundamental parameters
- Benchmark objects
- Peculiar objects
- Targets for exoplanet searches

Star and brown dwarf formation

Confrontation of theory vs. observations

Close binaries

CARMENES, HPF, IRD, SPIRou

Decontamination of deep photometric surveys

Clusters and associations

Metallicity

Comparison, standard

Kepler-2, TESS, PLATO

Discs

Halo subdwarfs

Solar neighbourhood

Activity, magnetic field, rotation

Dedicated follow-up

Gaia

Fig. 1. MAIA "mind map" with work packages WP1 through WP4.

Section b: Curriculum vitæ (max. 2 pages)

PERSONAL INFORMATION
Family name, First name: **Caballero Hernández, José Antonio** (**"Caballero, J. A." in ADS)**
Date of birth: **24 Feb 1977**
Nationality: **Spanish**
URL for web site: **http://exoterrae.eu/ (personal), http://exoterrae.eu/maia/ (this project)**

EDUCATION
2006   PhD in Astrophysics, Instituto de Astrofísica de Canarias, Universidad de La Laguna, Spain
2003   MSc in Astrophysics, Instituto de Astrofísica de Canarias, Universidad de La Laguna, Spain
2000   BSc in Physics, Facultad de Física, Universidad Complutense de Madrid, Spain

CURRENT POSITION
2010 – 2015   *Investigador Ramón y Cajal* (post-doc fellow, tenure track)
               Centro de Astrobiología, Consejo Superior de Investigaciones Científicas, Spain

PREVIOUS POSITIONS
2007 – 2009   *Investigador Juan de la Cierva* (post-doc fellow)
               Departamento de Astrofísica, Universidad Complutense de Madrid, Spain
2006 – 2007   *Alexander von Humboldt Stipendiat* (post-doc fellow)
               Max-Planck-Institut für Astronomy, Heidelberg, Germany
2005 – 2006   *College Based Sandwich Student* (support astronomer)
               Isaac Newton Group of Telescopes, Particle Physics and Astronomy Research Council, UK
2001 – 2005   *Astrofísico residente* (PhD student)
               Instituto de Astrofísica de Canarias, Spain
2001   *Becario de Formación de Personal Universitario* (PhD student)
               Departamento de Astrofísica, Universidad Complutense de Madrid, Spain
2000 – 2001   *Becario de la Fundación Iberdrola* (MSc student)
               Instituto de Astrofísica de Canarias, Spain
2000   *Colaborador* (MSc student)
               Laboratorio de Astrofísica Espacial y Física Fundamental, Spain

FELLOWSHIPS AND AWARDS
2014   Certificate of the programme I3 (Incentives for the incorporation and strengthening of research
            activity) for Ramón y Cajal researchers, Ministerio de Economía y Competitividad, Spain
2013 – 2014   Profesor honorífico (Honorary Professor)
               Departamento de Astrofísica, Universidad Complutense de Madrid, Spain
2008   Premio Tesis SEA 2006-2007 (Award to the best Spanish PhD thesis in Astrophysics)
               Sociedad Española de Astronomía
1999 – 2000   Becario-colaborador (BSc scholarship)
               Departamento de Astrofísica, Universidad Complutense de Madrid, Spain

SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS
2015   **1** business trainee
            European Space Astronomy Centre, ESA/Spain
2008 – 2016   **2** PhD students, **13** MSc students and **2** BSc students
               Departamento de Astrofísica, Universidad Complutense de Madrid, Spain

TEACHING ACTIVITIES
2013 – 2014   Lecturer – *Sistema Solar y exoplanetas*, Máster de Astrofísica (MSc)
                         Universidad Complutense de Madrid, Spain
2010 – 2013   Lecturer – *Física del Sistema Solar*, Máster Interuniversitario de Astrofísica (MSc)
                         Universidad Complutense de Madrid & Universidad Autónoma de Madrid, Spain
2008 – 2010   Assistant lecturer – *Astrofísica*, Licenciatura de Física (BSc)
                         Universidad Complutense de Madrid, Spain
2007 – 2009   Lecturer – *Del quark al Cosmos*, Licenciatura de Física (BSc)
                         Universidad Complutense de Madrid, Spain

ORGANISATION OF SCIENTIFIC MEETINGS
2015   IV international Pro-Am meeting on binary and multiple stars, LOC member, Spain
2015   Satellite meeting at Pathways towards habitable planets, Chair of convenors, Switzerland
2015   Amazing science with CARMENES, SOC member, Spain
2010 – 2015   CARMENES, LOC (co-)chair, Spain & Germany (numerous internal consortium meetings)
2009   AstroCAM School on Young Stellar Objects: from cool stars to exoplanets, LOC chair and
                         SOC co-chair, Spain
2005   IAC/TNG workshop on ultra low-mass star formation and evolution, LOC member, Spain

INSTITUTIONAL RESPONSIBILITIES
2010 – 2015   Faculty member, Centro de Astrobiología, Spain
2009   Member of BSc theses review panel, Universidad Complutense de Madrid
2007 – 2009   Board member, Departamento de Astrofísica y Ciencias de la Atmósfera, Universidad
                         Complutense de Madrid, Spain
2006 – 2007   Organiser of PSF low-mass group meetings, Max-Planck-Institut für Astronomie

COMMISSIONS OF TRUST
2015   Observing Programme Committe, European Southern Observatory, Germany
2013 – 2014   ORM Time Allocation Committee, Instituto de Astrofísica de Canarias, Spain
2012 – 2013   Chair of 2 contract panels, Centro de Astrobiología, Spain
2012 – 2015   Member of 4 PhD thesis review panels (UCM, ULL)
2010 – 2014   Reviewer of research project proposals (Czech Republic, Argentina, Chile)

MEMBERSHIPS OF SCIENTIFIC SOCIETIES
2010 –   Co-project manager of instrument CARMENES for the 3.5 m Calar Alto telescope
2010 –   Coordinator of the low-mass research line of the *Red de Explotación Científica de Gaia*
2010   Project scientist of instrument GO-IRS for the 10.4 m Gran Telescopio Canarias (GTC)
2007 –   Member of the ISSIS/*WSO-UV* science working group
2004 –   Member of the instrument science working groups of CanariCam/GTC, EMIR/GTC,
                         NAHUAL/GTC, WEAVE/WHT, PANIC/Calar Alto
2000 –   Member of the Sociedad Española de Astronomía

MAJOR COLLABORATIONS
             R. Rebolo, V. J. S. Béjar, S. Simón-Díaz (IAC), M. R. Zapatero Osorio, E. L. Martín, D. Barrado, E. Solano (CAB), D. Montes (UCM), R. Mundt, T. Henning, C. A. L. Bailer-Jones (MPIA), A. Quirrenbach, W. Seifert, H. Mandel, O. Stahl (LSW), A. Reiners, S. V. Jeffers, S. Dreizler (IAG), E. W. Guenther, J. Eislöffel, A. Hatzes (TLS), J. H. M. M. Schmitt, H.-J. Hagen (HS), P. J. Amado (IAA), I. Ribas (ICE), A. J. Burgasser (UCSD), J. Ge (UF)

On-going grants

Project title	Funding source	Amount (EUR)	Period	Role of the PI	Relation to current ERC proposal
AYA2011-30147-C03-03 CARMENES-CAB: exoplanetas, enanas marrones y estrellas de baja masa	Ministerio de Ciencia e Innovación (Spain)	260150	Jan 2010 – Jul 2015	Principal investigator	Medium/high
Uni-HD: CARMENES – A search for nearby twins of the Earth	Universität Heidelberg (Germany)	20000	2015 – 2016	Co-investigator, co-responsible of Spanish node	Medium
I-LINK0867 CARMENES: a radial-velocity survey for terrestrial planets in the habitables zones of M dwarfs	Consejo Superior de Investigaciones Científicas (Spain)	30000	2014 – 2015	Co-investigator, responsible of CAB node	Medium
AvH: Blaue Erden bei roten Zwergen	Alexander von Humboldt Foundation (Germany)	~3400	2015	Principal investigator	Medium/high
The IACOB project: a new era in the study of Galactic OB stars	Instituto de Astrofísica de Canarias (Spain)	19000	2014 – 2018	External collaborator	None

Grant applications

Project title	Funding source	Amount (EUR)	Period	Role of the PI	Relation to current ERC proposal
Search for terrestrial planets around cool stars with new-technology astronomical instruments. Brown dwarfs and planets in clusters and around stars	Ministerio de Economía y Competitividad (Spain)	>200000	2015 – 2017	Co-investigator of a large team	Medium
Red Española de Centros de Datos Astronómicos	Ministerio de Economía y Competitividad (Spain)	>100000	2015 – 2017	Co-investigator of a very large network	Medium/high

Section c: Early achievements track-record (max. 2 pages)

[Full curriculum vitæ at http://exoterrae.eu]

Publication summary
- 63 refereed publications in A&A, ApJ, Obs, AN, MNRAS, AJ, including four letters; 30 of them (48%) as a first or single author, and 11 of them (17%) as a second author; 53 of them (84%) in the first quartile of impact factor
- 11 publications at the SPIE, 5 refereed and 102 non-refereed published contributions to international meetings, 31 unpublished contributions, 5 circulars, 6 VizieR catalogues, 3collaborations in books, 13 outreach articles, numerous technical documents for instrument design reviews
- Metrics from the SAO/NASA Astrophysics Data System (12 Mar 2015): Total citations 1639, First-author citations 731, Author-normalised citations 545, age-adjusted total-research-impact index riq=180, Entries 148, Hirsch index h=23

Most relevant publications *[citations]*
1. *CARMENES input catalogue of M dwarfs. I. Low-resolution spectroscopy with CAFOS*, F. J. Alonso-Floriano, J. C. Morales, **J. A. Caballero**, D. Montes et al. *2015, A&A*, in press, DOI: 10.1051/0004-6361/201525803
2. *Search for bright nearby M dwarfs with Virtual Observatory tools*, M. Aberasturi, **J. A. Caballero**, B. Montesinos, M. C. Gálvez-Ortiz, E. Solano, E. L. Martín *2014, AJ*, 148, 36 *[1]*
3. *CARMENES. I: instrument and survey overview*, A. Quirrenbach, P. J. Amado, W. Seifert, M. A. Sánchez Carrasco, H. Mandel, **J. A. Caballero**, R. Mundt, I. Ribas, A. Reiners et al. *2012, SPIE*, 8446, E0R *[41]*
4. *Identification of red high proper motion objects in Tycho-2 and 2MASS catalogues using Virtual Observatory tools*, F. M. Jiménez-Esteban, **J. A. Caballero**, R. Dorda, P. Miles, E. Solano *2012, A&A*, 539, A86 *[3]*
5. *A third massive star component in the σ Ori AB system*, S. Simón-Díaz, **J. A. Caballero** & J. Lorenzo *2011, ApJ*, 742, 55 *[13]*
6. *Reaching the boundary between stellar kinematics groups and very wide binaries. II. α Lib + KU Lib: a common proper motion system in Castor separated by 1.0 pc*, **J. A. Caballero** *2010, A&A*, 514, A98 *[17]*
7. *Polarisation of very-low-mass stars and brown dwarfs. I. VLT/FORS1 observations of ultracool dwarfs*, B. Goldman, J. Pitann, M. R. Zapatero Osorio, C. A. L. Bailer-Jones, V. J. S. Béjar, **J. A. Caballero** & T. Henning *2009, A&A*, 502, 929 *[12]*
8. *Contamination by field late-M, L, and T dwarfs in deep surveys*, **J. A. Caballero**, A. J. Burgasser & R. Klement *2008, A&A*, 488, 181 *[45]*
9. *Stars and brown dwarfs in the σ Orionis cluster: the Mayrit catalogue*, **J. A. Caballero** 2008, *A&A, 478*, 667 *[39]*
10. *The widest ultracool binary*, **J. A. Caballero** *2007, A&A*, 462, L61 (A&A highlight of the week, considered for cover page) *[34]*

Other remarkable publications
- *The Gaia-ESO Public Spectroscopic Survey*, Gilmore et al. 2012, Messenger, 147, 25 [166]
- *A Methane, Isolated, Planetary-Mass Object in Orion*, Zapatero Osorio et al. 2002, ApJ, 578, 536 [105]
- *The substellar mass function in σ Orionis. II. Optical, near-infrared and IRAC/Spitzer photometry of young cluster brown dwarfs and planetary-mass objects*, **Caballero** et al. 2007, A&A, 470, 903 [94]

- *Photometric variability of young brown dwarfs in the σ Orionis open cluster*, **Caballero** et al. 2004, A&A, 424, 857 [58]
- *CARMENES: Calar Alto high-resolution search for M dwarfs with exo-earths with a near-infrared Echelle spectrograph*, Quirrenbach, Amado, Mandel, **Caballero** et al. 2010, SPIE, 7735, E37 [51]
- *Dynamical parallax of σ Ori AB: mass, distance and age,* **Caballero** 2008c, MNRAS, 383, 750 [36]
- *Reaching the boundary between stellar kinematic groups and very wide binaries. The Washington double stars with the angular separations,* **Caballero** 2009, A&A, 507, 251 [21]

Presentations
- Invited oral contributions to plenary sessions in international meetings "Multi-wavelength Astronomy and Virtual Observatory ESA/EURO-VO Workshop" (Caballero 2009, mavo.proc) and "VIII Meeting of the Spanish Astronomical Society" (Caballero 2010, hsa5.conf, 79)
- Plenary invited oral contributions to "Workshop for the WSO Working Group and Spanish UV Astronomy" and "II International Meeting of Double Stars Observers" (unpublished)
- Plenary speaker at "*Gaia* and the unseen. The brown dwarf question" (Caballero 2015, MmSAI, 85, 757), "Stellar clusters and associations: a RIA workshop on *Gaia*" (Caballero 2011, sca.conf, 108) and "50 years to brown dwarfs: from theoretical predictions to astrophysical studies"
- Invited scientific seminar and talks at European Space Astronomy Centre, Universidad Autónoma de Madrid, Australian Astronomical Observatory, Centro de Astrobiología, Instituto de Astrofísica de Andalucía, University of Missouri–St. Louis, Universidad Complutense de Madrid, Universidad de Alicante, Isaac Newton Group/Nordic Optical Telescope/Telescopio Nazionale Galileo, Max-Planck-Institut für Astronomie, Instituto de Astrofísica de Canarias
- Lecturer of lab session "Searching for discs with Aladin" at advanced international school "Young Stellar Objects: from cool stars to exoplanets" (AstroCAM, 2009)

Observation skills
- Principal investigator or co-investigator of dozens of observing proposals at 1- to 10-m class telescopes, accepted by international time allocation commitees
- Almost nights of on-site observational experience with 23 instruments of 12 telescopes at four observatories (Roque de los Muchachos, La Silla, Calar Alto, Teide): WHT (NAOMI, INGRID, LIRIS, ISIS, WYFFOS, PFCAM), TNG (AdOpt, NICS, OIG), 3.6 m ESO (EFOSC-2), NTT (SofI), 3.5 m Calar Alto (ALFA, Omega-2000), NOT (ALFOSC), INT (WFC –support astronomer–, IDS), 2.2 m Calar Alto (MAGIC, CAFE), TCS (CAIN-2), OGS (ESACCD), JKT (JAG), IAC80 (CAMELOT, old CCD)
- Additional data analysis of: GTC (OSIRIS), Keck (LRIS), LBT (LBC), VLT (ISAAC), CFHT (CFHT-IR), 2.2 m Calar Alto (CAFOS); *Hubble* (NICMOS), *Spitzer* (IRAC, MIPS), *XMM-Newton* (EPICS), *Chandra* (HRC-I, ACIS), *IUE* (SW, LW)
- Virtual Observatory tools and data mining in astronomical catalogues

Popular science
- Founder member of •united**sounds**of**cosmos**, an astro-rock band with artist Antonio Arias (http://exoterrae.eu/usc/); artificer and science consultant of *Multiverso* (2009) and *Multiverso II* (2014), music albums by Antonio Arias; eight astro-concerts with key guests (e.g., science: Nobel laureate Prof. Robert W. Wilson, Prof. C. Frenk, Prof. D. Jou; music: Lagartija Nick, Los Planetas, Lori Meyers...); media: television, main radio stations and journals
- Contributing editor of *AstronomíA* outreach magazine
- Popular talks, journals and newspapers, International Year of Astronomy 2009