



Astronomy and Astrophysics in Comunidad de Madrid: ***Research and Technology***

Prepared by the AstroMadrid Steering Committee

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INDEX

- **Introduction**
- **Research groups**

Universidad Complutense de Madrid.

Department of Earth Physics, Astronomy and Astrophysics II. *Extragalactic Astrophysics.*

Universidad Complutense de Madrid.

Department of Earth Physics, Astronomy and Astrophysics II. *Stellar Astrophysics.*

Universidad Complutense de Madrid.

Department of Earth Physics, Astronomy and Astrophysics II. *Instrumentation.*

Universidad Complutense de Madrid.

Department of Atomic, Molecular and Nuclear Physics. *Astroparticle Physics.*

Universidad Complutense de Madrid.

Department of Earth Physics, Astronomy and Astrophysics I. *Astronomy and Geodesy.*
AEGORA (Astronomía Espacial y Gestión Óptima de Recursos Astronómicos).

Universidad Autónoma de Madrid.

Department of Theoretical Physics. *Astrophysics Group*

Universidad de Alcalá.

Space Plasmas & Astroparticle Group.

Universidad de Alcalá.

Space Research Group (SRG-UAH).

Universidad Politécnica de Madrid.

Faculty of Computing Sciences. *Collaborative Learning Group Ciclope.*

Centro de Astrobiología (CSIC-INTA).

Department of Astrophysics.

Centro de Astrobiología (CSIC-INTA).

Department of Astrophysics. *Virtual Observatory.*

Centro de Astrobiología (CSIC-INTA).

Department of Instrumentation.

Instituto Nacional de Técnica Aeroespacial (INTA).

Department of Space Programs & Systems.

Instituto Nacional de Tecnología Aeroespacial (INTA).

Department of Space Sciences and Electronical Technologies.

Observatorio Astronómico Nacional (OAN).

CIEMAT.

Division of Astroparticle Physics.

- **AstroMadrid Industries**
- **Madrid Cluster Aeroespacial**

Introduction

Astronomy and Astrophysics are experiencing a golden era. Just the last 10-20 years have brought epochal discoveries which have excited the society, from the first planets orbiting around other stars to the accelerating Universe, dominated by the still-enigmatic Dark Matter and Dark Energy. Europe is at the forefront of all areas of contemporary astronomy. In a world of ever-fiercer global competition, European astronomy has reached its current position by learning to cooperate on a multilateral basis, especially through the European Southern Observatory (ESO) and the European Space Agency (ESA). Yet, the backbone of European Astronomy remains the scientists, the research programs and the technological developments at national universities, research organizations and specialized industries.

These enormous advances in all fields of Astrophysics have been triggered by the technological developments of the last decades. Ground based observatories have increased their collecting power by a factor of 6, with active optical systems that provide superb image quality, even correcting from the effect of the atmosphere. The new detectors have completely replaced the old photographic plates and primitive electronic devices, producing data of exceptional quality, with a very large dynamic range. A fleet of powerful space observatories provide now access to all energy ranges, from far infrared to high energy gamma rays. A network of smaller robotic telescopes cover all the world examining automatically the sky searching for optical transient events (supernova explosions, gamma ray bursts,...). The probes of the Cosmos include presently also the analysis on space of the high energy particles originated in several astrophysical scenarios, complementing the capabilities of the large arrays operating from the ground. Finally, the power of the new computers and mass memories has allowed to develop complex mathematical simulations and models of different astrophysical scenarios. Organizing the huge volumes of data becoming available has been made possible thanks to new tools for data archiving and data mining, within the framework of the so-called Virtual Observatory, an international effort to develop a network connecting all astronomical databases over the World.

The astrophysics researchers working on different Universities and Institutes in the *Comunidad de Madrid* have contributed very significantly to the technological developments of the last 2 decades. Just to mention some examples, researchers in *Comunidad de Madrid* have contributed to the development of space instrumentation (INTEGRAL-OMC, JWST-MIRI, MINISAT-LEGRI/EURD, Herschel, AMS, MSL *Curiosity*), high energy ground based observatories (MAGIC, Pierre Auger), ground based instruments (GTC-EMIR, GTC-FRIDA, MEGARA, robotic telescopes), the Virtual Observatory and state of the art models and cosmological simulations. Aerospace companies located in *Comunidad de Madrid* have contributed significantly to most of these projects, in close collaboration with the research groups.

Professional Astronomy started in Madrid with the creation of the National Observatory (*Observatorio Astronómico Nacional – OAN*) in 1790, located in the *Retiro* gardens, then at the outskirts of Madrid. The creation in the late 70's of last century of specialized studies in Astrophysics at the Faculty of Physics of *Universidad Complutense* marked the definitive push to modern Astronomy and Astrophysics in Madrid. Since then several research groups working on Astronomy and Astrophysics were constituted, associated to different institutions: university departments, INTA, CSIC, OAN, Ciemat,... The geographical spread

within the *Comunidad de Madrid*, together with the administrative splitting in different institutions, have jeopardized in the past the constitution of homogeneous groups with the strength required to lead the development of complex instruments at international level.

To solve these problems and minimize the negative effects of this geographical and administrative spread, the government of *Comunidad de Madrid* has funded in the last years the activities of several networks constituted by some of the different groups and industries: ASTRID and AstroCAM (2006-2009), and presently AstroMadrid (2010-2013). The main objective of these networks was to constitute multidisciplinary teams that would benefit from the synergies originated by each individual group to optimize the development of astronomical instruments. The complementarity of skills and know-how of the different participating groups has allowed to optimize ongoing and future developments by sharing facilities, tools and expertise:

Moreover, this activity benefits and will benefit directly from the close collaboration already established with the aerospace companies located in *Comunidad de Madrid*. Most of the ongoing projects are being performed in collaboration between the research centers and the industries. The development of astronomical instrumentation is indeed a field where close coordination between public institutions and private companies has been in place for many years, as it has been officially recognized at national level.

Acting as a coordinated, single entity, the pool of research groups and specialized industries in the *Comunidad de Madrid* constitute already one of the leading actors at European level in the field of Astrophysical research and instrumentation, developing state of the art technologies. In this dossier we compile the basic information of the research groups and industries involved in Astronomy and Astrophysics, and associated technological development, in *Comunidad de Madrid*. Its main objective is to provide homogeneous information and to foster further coordination in the future, establishing the starting point for the constitution of the future Madrid Astrophysics Network, an entity that would have the scientific and technological strength required to lead the future development of complex instruments at international level.

Research Groups

Universidad Complutense de Madrid.
Department of Earth Physics, Astronomy and Astrophysics II.
Extragalactic Astrophysics.

Contact information:

Affiliation & Address: Departamento de Astrofísica y Ciencias de la Atmósfera, Facultad CC. Físicas, Universidad Complutense de Madrid. 28040 Madrid (Spain).

Contact persons: Jesús Gallego, Jaime Zamorano

Website: <http://guaix.fis.ucm.es/>

Staff researchers: 5

Postdoctoral/contracted researchers: 3

Areas of expertise and capabilities:

Keywords: Early type galaxies; star-forming galaxies; deep surveys; galaxy evolution; extragalactic databases.

Description of activity and achievements

The UCM group for Extragalactic Astrophysics and Astronomical Instrumentation (GUAIX, from the acronym in Spanish) was created in 2007 with the goal to join the efforts of the Star-forming Galaxies group, the Elliptical Galaxies group and the Astronomical Instrumentation group. At this moment, the group is composed of a grand total of 20 researchers: six full professors (J. Zamorano, J. Gorgas, J. Gallego, N. Cardiel, P.G. Pérez González and A. Gil de Paz), one assistant professor (Á. Castillo), two postdoctoral researchers (S. Pascual, C. Eliche) and eight Ph. D. students. This group is considered with the code 921317 in the catalog of research groups of the UCM.

The group relies on the UCM workshops and laboratories, including several technical centers for support to the research (Centros de Apoyo a la Investigación, CAIs). The group has also created a top-level laboratory for advanced instrumentation (LICA; from the acronym in Spanish; P.I. J. Zamorano; <http://guaix.fis.ucm.es/lica/>) which is one of the strategic initiatives of the International Campus Moncloa of Excellence (<http://www.campusmoncloa.es/>) created by Universidad Complutense and Universidad Politécnica de Madrid. This laboratory is specialized in characterization of detectors and all kind of optical components in the optical and near-infrared.

Main lines of research are both early and star-forming galaxies at different redshifts. The group leads the ESO/GTC large program SHARDS (Survey for High-z Absorption Red and Dead Sources; P.I. Pérez-González; <http://guaix.fis.ucm.es/~pgperez/SHARDS/>) and belongs to several international projects.

Scientific publications of the group in journals with referee: 2005: 21; 2006: 19; 2007: 26; 2008: 41; 2009: 30; 2010: 83; 2011: 64. Citations grand total about 10,000.

Average contributions per year to meetings: 11 at national level and 25 at International level.

Stable international collaborations

SHARDS (Survey for High-z Absorption Red and Dead Sources). P.I. P.G. Pérez-González.
<http://guaix.fis.ucm.es/~pgperez/SHARDS/>

Long term ESO/GTC program approved in 2009A carried out during 20 nights in 2010-2013. It consists in imaging observations of the entire GOODS-North region in 25 medium-band different filters with GTC/OSIRIS covering the wavelength range between 500 and 950 nm with contiguous passbands. The depth of the survey is at least 26.5 mag at the 3σ level in all filters. The main scientific goal of SHARDS is carrying out an unbiased spectro-photometric survey of passively evolving galaxies at $1.0 < z < 2.5$ and measuring stellar population ages through the direct measurement of the Mg(UV) absorption index.

AEGIS (All-wavelength Extended Groth International Survey). P.I. S. Faber; J. Gallego core member.
<http://aegis.ucolick.org>

International collaboration led by the extragalactic group of Lick Observatory to carry out all kind of extragalactic surveys and studies in the main cosmological surveys. UCM is the only Spanish group participant.

GOYA (Galaxy origins and young assembly). P.I. R. Guzmán; J. Gallego core member.
<http://www.astro.ufl.edu/GOYA/home.html>

The GOYA Project studies the structure, dynamic, gas content, and stellar population of galaxies at high redshift. The foundation of the GOYA Project is a near-IR spectroscopic survey of 2500 galaxies at $z > 1$ using 30 guaranteed nights with EMIR, a cryogenic near-IR multi-slit spectrograph at the 10.4-m Gran Telescopio Canarias (GTC).

MILES. N. Cardiel and J. Gorgas core members.
<http://miles.iac.es/>

A new stellar library developed for stellar population synthesis models for the study of stars and galaxies, and their evolution. The library consists of ~ 1000 stars spanning a large range in atmospheric parameters.

Fireball, meteor and Light Pollution group of Universidad Complutense de Madrid. P.I. Zamorano.
<https://guaix.fis.ucm.es/>

The group studies the effects of light pollution in Spain and works to reduce its impact by promoting a more efficient public lighting.

Universidad Complutense de Madrid.
Department of Earth Physics, Astronomy and Astrophysics II.
Stellar Astrophysics.

Contact information:

Affiliation & Address: Depto. de Astrofísica y Ciencias de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid. 28040 Madrid (Spain).

Contact person: David Montes, María José Fernández-Figueroa

Website: <http://www.ucm.es/info/Astrof/invest/actividad/actividad.html>

Staff researchers: 5

Postdoctoral/contracted researchers: 3

Areas of expertise and capabilities:

Keywords: Cool stars; stellar activity; chromosphere; corona; high-resolution spectroscopy; X-ray observations; stellar spectral libraries; stellar clusters; kinematics; stellar kinematic groups; young associations; young stars; pre-main sequence stars; star-forming regions; stellar atmospheres; stellar parameters; abundances; ages; radial velocities; rotation; flare stars; binary systems; chromospherically active binaries; common proper motion stars; very low mass stars; substellar objects; brown dwarfs; planetary mass objects; exoplanets.

Description of activity and achievements:

The group has a strong track record in the spectroscopic analysis of cool stars: spectral classification, radial and rotational velocity determinations, Li abundance, and analysis of the optical chromospheric activity indicators. The group has been working during the last years in different kind of cool stars including pre-main sequence stars, members of young open clusters, single young rapid rotators, flare stars and chromospherically active binaries. As result of this work the group compiled several libraries of high and mid-resolution optical spectra of late-type stars (F, G, K and M field stars, from dwarfs to giants) that are available at the World Wide Web. In addition, the group has been working in the spectroscopic characterization of late-type stars members of young stellar kinematic groups. These nearby and young stars result to be good search targets for direct imaging detection of substellar companions (brown dwarfs and giant exoplanets).

During the last years the group was involved in the spectroscopic characterization of the cool stars (FGK spectral types) in the solar neighborhood using high resolution optical spectroscopy and in the analysis of the stellar populations in accessible star-forming regions from the more massive objects (O-type stars) to the less massive M stars and brown dwarfs using their X-rays, optical and infrared properties.

Large part of the group is also actively involved in instrumental projects like CARMENES (Calar Alto High-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs) a next-generation instrument being built for the 3.5m telescope at the Calar Alto Observatory by a consortium of German and Spanish institutions. Other part of the group is involved in the ultraviolet space mission WSO-UV (World Space Observatory-Ultraviolet).

Several students and postdocs are working now in the science preparation of the M-dwarf sample that will be observed with CARMENES and preparing the M dwarf database CARMENCITA (CARMENES Cool star Information and daTa Archive) from where the best target sample will be chosen.

More recently, part of the group is participating in the science preparation activities for the Gaia mission at the Spanish level in the REG (Red para la Explotación Científica de Gaia) and at international level in GES (Gaia-ESO Spectroscopic Survey) where the group is involved in the stellar parameters and abundances determination for the FGK stars and pre-main sequence stars working groups.

Stable international collaborations

CARMENES (Calar Alto High-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs) consortium.

GES (Gaia-ESO Spectroscopic Survey) a public spectroscopic survey, targeting $\geq 10^5$ stars, systematically covering all major components of the MilkyWay, from halo to star forming regions, providing the first homogeneous overview of the distributions of kinematics and elemental abundances.

WSO (World Space Observatory-Ultraviolet).

Herschel Open Time Key Programme DUNES (DUst disks around NEarby Stars) “A Search for Edgeworth-Kuiper Belt analogues” (IP: C. Eiroa) for the spectroscopic characterization of the sample.

Observatoire Astronomique, Université de Strasbourg (P. Guillout, R. Freire-Ferrero) and Osservatorio Astrofisico di Catania (A. Frasca, A. Klutsch) for the analysis of kinematics and young stars.

Instituto de Astrofísica de Canarias, IAC (J.I. González Hernández) and Centro de Astrofísica da Universidade do Porto, CAUP (S. Sousa, N. Santos) for the stellar parameters and abundances determination

Osservatorio Astronomico di Palermo (INAF, Italia) for the X-ray studies of the coronal activity and the star-forming regions.

Universidad Complutense de Madrid.
Department of Earth Physics, Astronomy and Astrophysics II.
Instrumentation.

Contact information:

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Website: <http://guaix.fis.ucm.es/>

Staff researchers: 2

Postdoctoral/contracted researchers: 3

Areas of expertise and capabilities:

Keywords: astronomical instrumentation; control systems; data processing; spectroscopy; integral-field units

Description of activity and achievements:

The UCM-Instrumentation AstroMadrid group is part of the "UCM Group of Extragalactic Astrophysics and Astronomical Instrumentation (GUAIX)" which also includes the UCM-Extragalactic AstroMadrid group.

Within the UCM-Instrumentation group we have experience in the development of a number of astronomical instruments for major ground-based telescope facilities. Our activities include the definition of requirements and interfaces to the telescope, development of the control systems (both their hardware and software) and all the steps associated to the data processing including the integration of the data pipelines to the hardware and software standards of the telescope facility.

We are currently using most of our resources in the development of all these aspects for the future (Integral-Field and MOS) optical spectrograph for the Spanish 10.4m GTC telescope, MEGARA, which will be working at GTC in 2016. In this instrument our group is responsible for the scientific coordination, management, Control work package (including mechanisms, data acquisition and pipeline processing).

Our group is also responsible for the data reduction pipelines of other GTC instruments, including EMIR, FRIDA or MIRADAS. We are also involve in initiatives for the E-ELT such as the EAGLE instrument.

Stable international collaborations

During the more than a decade of experience of the UCM-Instrumentation and GUAIX groups we have established a significant number of international collaborations both in the fields of astronomical instrumentation and astronomical research in general.

These collaborations include:

Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE, México): Partners in the MEGARA Consortium where they are responsible of the Optics manufacturing and Cryostat Design and

Construction. A total of 16 INAOE researchers are part of the MEGARA Science Team whose coordination our group is responsible for.

Observatoire Astronomique de Marseille Provence (OAMP, France): Members of the UCM-Instrumentation group have a long story of collaboration with researchers of the OAMP since we worked together on the NASA's Galaxy Evolution Explorer (GALEX) project. We worked together in defining some of the most productive explorations of the mission, such as the GALEX Nearby Galaxy Survey.

National Radio-Astronomy Observatory (NRAO, USA): As members of the Spitzer Survey of Stellar Structures in Galaxies (S4G), a legacy project of NASA's Spitzer satellite, we have closely collaborated with NRAO researchers K. Sheth and J. C. Muñoz-Mateos.

Observatories of the Carnegie Institution of Science (Carnegie Observatories, USA): Since year 2000, where the NASA GALEX mission preparatory activities started to take shape, we have closely collaborated with Carnegie scientist Dr. Barry F. Madore, principal investigator of the wide-field Integral-Field Spectroscopy project TYPHOON at the 2.5m duPont telescope at Las Campanas Observatory (Chile).

University of Florida (UF, USA): We have collaborated extensively in astronomical research related with key science cases of Gemini/FLAMINGOS-II (ULIRGs) in the last decade. More recently, we are involved in the development of the data reduction pipeline of MIRADAS, a third-generation instrument for GTC led by UF.

Universidad Autónoma de México (UNAM, Mexico): We are also involved in the international consortium for the development of FRIDA, another forthcoming instrument for GTC.

Universidad Complutense de Madrid.
Department of Atomic, Molecular and Nuclear Physics.
Astroparticle Physics.

Contact information:

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Contact persons: Juan Abel Barrio (barrio@gae.ucm.es)

Website: <http://www.gae.ucm.es>

Acronym & UCM reference code: UCM-GAE, 910600

Staff researchers: 6.

Postdoctoral/contracted researchers: 10.

Areas of expertise and capabilities:

Keywords: Astroparticle Physics; Gamma Ray Astronomy; High Energy Astrophysics; Cosmic Rays; Medical Physics; Atomic Physics; Particle Detectors

Description of activity and achievements:

The Group of High Energy Physics at the Universidad Complutense of Madrid (UCM-GAE) was born in the late eighties. It began working in the fields of High Energy Physics (in experiments at CERN) and Astroparticle Physics. The group also includes researchers from the laboratory of Atomic and Molecular Spectroscopy of UCM and participates in Medical Physics activities.

The UCM-GAE is a research group recognized by the UCM and the Comunidad Autónoma of Madrid (CAM). Its current field of research focuses mainly on two aspects within the field of Astroparticle Physics, namely the Physics of High Energy Cosmic Rays, via the participation in the AUGER experiment, and the Astrophysics of High Energy Gamma Rays using Imaging Atmospheric Cherenkov Telescopes (IACTs), through contributions to the MAGIC and CTA experiments.

Projects:

The group participates in three major international projects, all within the field of ground-based Astroparticle Physics, namely the AUGER, MAGIC and CTA experiments. The participation in these projects is regularly funded by MICINN/MINECO projects within the FPA (Particle Physics and Accelerators) area.

Additionally, the group has joined a number of national projects and research networks: first, it belongs to two Consolider projects, CPAN (aiming to structure the field of Particle, Astroparticle and Nuclear Physics in Spain) and MultiDark (joining the efforts of several Spanish groups in the quest for dark matter). Additionally, it is part of the Astromadrid research project funded by CAM. Moreover, the group has recently joined an effort, along with other Astrophysics groups in Madrid, to reinforce the Laboratorio de Instrumentación Científica Avanzada (LICA), one of the thematic activities of the Campus de Excelencia Internacional – Moncloa. Finally, it is worth mentioning that there exists an agreement of cooperation with the INSA aerospace company (now part of ISDEFE) by which some members of the company work on the CTA project.

Scientific production:

High Energy Astrophysics with ground-based detectors is a rapidly developing field that is opening a new window in the electromagnetic spectrum for viewing the universe. As a result, new phenomena are being discovered and a new understanding of the non-thermal processes in the universe is being achieved. This is reflected in the pace and impact of the publications of the MAGIC experiment, which has published, over the last 5 years, more than 70 articles in international journals, 4 of them in the journal *Science*, with a large impact factor. Full list of articles: <http://magic.mppmu.mpg.de/publications/articles>

In a similar manner, experiments like AUGER are decisively contributing to the study of the non-thermal universe by precisely characterizing the Physics of the Highest Energy Cosmic Rays. In this sense, the AUGER collaboration has published over 40 articles in international journals, one of them in the journal *Science*. The full list of articles can be found in: http://www.auger.org/technical_info.

Doctoral programs and PhD dissertations:

The UCM-GAE group actively participates in the doctoral programs of Physics and Astrophysics of UCM, both with an indication of quality. In the framework of these programs, the group contributes to three master programs, namely Astrophysics, Theoretical Physics and Biomedical Physics. Additionally, 7 PhD theses have been defended within the group during the last 5 years.

Stable international collaborations:

MAGIC is a ground-based gamma ray observatory, composed of two IACTs located in the Observatory Roque de los Muchachos on the Canary Island of La Palma. This is one of the world's largest facilities of its kind. The UCM-GAE joined the experiment in its early design phase in 1996. More information on MAGIC can be found in: <http://magic.mppmu.mpg.de>

The **Pierre AUGER Observatory** is the world's leading experiment to study Highest Energy cosmic rays, above 10^{18} eV. The observatory is placed in Argentina and operated by an international collaboration of 13 countries, which the UCM-GAE group joined at the beginning of the construction phase in 2002. More details can be found in: <http://www.auger.org>

CTA is the project to build an open International Observatory for ground-based gamma ray astronomy (based on the next generation of IACTs). It will be formed by two observatories (one in each hemisphere). The Spanish Astroparticle Physics community has set-up a proposal for the northern observatory to be built in the Tenerife Island. The first telescopes of the observatory are expected to start operation in 2016. More information on the project can be found in: <http://www.cta-observatory.org>

Additionally, the group maintains, in the context of MAGIC and CTA projects, stable collaborations with foreign institutions at the Max-Planck Institute for Physics (Munich), with Italian IFNF (at Padova and Pisa), and with French IN2P3 (at LAPP-Annecy). In the context of AUGER, the group collaborates with Argentinian (at La Plata University), American (at Chicago University) and Italian (at Roma Tor Vergata University) groups.

Universidad Complutense de Madrid.
Department of Earth Physics, Astronomy and Astrophysics I.
Astronomy and Geodesy.
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Website: <http://www.mat.ucm.es/~aegora>

Contact person / Group Director: Ana Inés Gómez de Castro

Staff researchers: 4

Postdoctoral or contracted researchers: 5

Areas of expertise and capabilities

Keywords: Ultraviolet Astronomy; Astrophysical Plasmas; Star Formation; Cool Stars; Optimization and Data Mining; Numerical Simulations; Astronomical Instrumentation; Outreach and Education in Astronomy.

Description of activity and achievements

1.- WSO-UV (www.wso-uv.es):

Our group is the scientific responsible of the Spanish contribution to the Russian space mission named World Space Observatory - Ultraviolet (WSO-UV), an ultraviolet space telescope that will be launched in 2017. The Spanish participation is divided in two main parts:

The development of the UV camera for the telescope: the Imaging and Slitless Spectroscopy Instrument (ISSIS). ISSIS has two channels equipped with MCP detectors covering the range 1150-3200 Angstroms, a field of view of 70 arcsec and resolution of 0.036 arcsec/pixel. Moreover, it is equipped with gratings for slitless spectroscopy with spectral resolution of 500.

The ground control of WSO-UV will be shared by Russia and Spain and UCM will host the Spanish Science and Mission Operation Centre. The WSO-UV Ground Segment includes all the infrastructure and facilities involved in the preparation and execution of the WSO-UV mission operations, which typically encompass real-time monitoring and controlling of the spacecraft, as well as reception, processing and storage of the scientific data.

Our group activities are concentrated in the development of ISSIS and the Spanish Ground Segment, but we also assist and coordinate the Spanish astronomical community in the preparation of the core programme, including the development of specific tools that guarantee the maximum scientific return of the WSO-UV mission.

2.- NUVA (www.nuva.eu):

Our group coordinates the pan-European Network for Ultraviolet Astronomy (NUVA) which coordinates the UV community and promotes the development and utilization of space infrastructures for UV Astronomy.

3.- HOU (www.houspain.com):

Our group coordinates the Spanish node of the educational project Hands-On Universe that enables students to investigate the Universe while applying tools and concepts from science and technology.

4.- Astronomy/Astrophysics:

Research lines in our group are associated with Ultraviolet Astronomy, focusing mainly in the study of star-forming regions and young stars. We are investigating the physical properties of T-Tauri stars. We are also using data from the GALEX mission (complemented with other surveys and catalogues) to study the UV properties of point and extended sources in different star-forming regions. We are analysing the stellar content of different molecular clouds, searching for extended weak structures (shells, filaments) through segmentation algorithms. Pre-Main Sequence stars, disks, jets, and the interactions of winds and outflows with the environments are some of the issues we are addressing from both the observational and the numerical points of views. This studies will allow us, among other things, to define and prepare the core program for the camera ISSIS of the WSO-UV telescope.

Stable international collaborations

Institute of Astronomy of the Russian Academy of Sciences, Russia
University of Colorado Boulder
Institute d'Astrophysique de Paris, France
Tel Aviv University, Israel
European Space Astronomy Center (ESAC)
University of Leicester, United Kingdom
Midi Pyrenees Observatory, France
Italian National Institute of Astrophysics, Italy
Universidad de Medellín, Colombia
Global and European Hands on Universe Consortia

Universidad Autónoma de Madrid.
Department of Theoretical Physics.
Astrophysics Group

Contact information:

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Contact person: Gustavo Yepes (gustavo.yepes@uam.es)

Website: <http://astro.ft.uam.es>

Staff researchers: 4 permanent. (2 full professors + 2 associate professors)

Postdoctoral/contracted researchers: 9 postdocs + 6 Ramon y Cajal Fellows

Areas of expertise and capabilities:

Keywords: Cosmology, dark matter, dark energy, Large Scale Structure, Galaxy formation, N-body Simulations, hydrodynamical simulations,, High Performance computing, Galaxy Clusters, Extragalactic Astronomy, Galactic Astronomy, Local Group, dwarf galaxies, Interestelar medium, star formation, stellar evolution, spectroscopic techniques, element abundances, planetary systems, protoplanetary disks, circumstellar matter, astroparticle physics.

Description of activity and achievements

The Astrophysics Group at UAM was formed more than 30 years ago as an stable group investigating in the area of cosmology and extragalactic astrophysics that later grew up with two more permanent positions and extending their expertise to the area of stellar and planet formation and evolution. At present the group consists of two full professors and two associate professors , 6 tenure track Ramon y Cajal Fellows and more than 20 postdoctoral researchers and PhD students. There are also strong interactions between members of the astrophysics group and members of the Instituto de Física Teórica (IFT-UAM/CSIC) in the areas of Cosmology, Large Scale Structure formation in the Universe and astroparticle physics. The group members have published more than 650 articles in the past 5 years (2008-2013) that have got more than 1100 citations. The main research activities of the group members can be divided into these categories:

Star formation and exoplanets

Star formation, planetary systems and planet are all links in the same chain: the gravititory collapse of a fragment of a molecular cloud, which leads to star formation and then to circumstellar disks where the planets will be formed. There are several running projects regarding this evolutive chain: i) Proto-stars and young star objects; ii) Evolution of protoplanetary disks into planetary disks; iii) Kuiper belts and exozodiacal light in mature stars of the solar vicinity; iv) Detection and characterization of earth-like planets in near stars.

Stable international collaborations:

This departmental research takes place in the framework of large international consortia (i.e. DUNES and GASPS related to the space telescope Herschel or ARENA).

Extragalactic Astrophysics

It has been understood that the chemical evolution of the different systems in the Universe provide key elements to identify the processes leading to galaxy formation. The subgroup of extragalactic astrophysics studies these processes, both from a theoretical -modelling- point of view and through observations, devising methodologies for the determination of chemical abundances in the interstellar gas and in star populations. The team also studies the “activity” (high-energy radiation emission) in galaxy nuclei and its connection with violent star formation. This group is leader in the study of star formation in that type of environments.

Stable International Collaborations:

INAOE, Cambridge, IAA, IAC, Lancaster, Oxford, Nottingham, Australia.

Computational Astrophysics

This subgroup develops simulations of visible structures in the Universe at different astronomical scales: from the largest – of order of billion light-years -, to the smallest, e.g. galaxies such as the Milky Way. The gravitational effects of the dark matter and dark energy components are taken into account and explored, as well as gas-dynamic effects. These simulations are a virtual laboratory which serves to test and verify theories and astrophysical and cosmological models; it is also a tool to design future observational and instrumental strategies. The team not only performs simulations in-house but also participates in large international collaborations, and some of their simulations are in fact the biggest ones in the world that simultaneously include gas, star formation and dark matter.

Stable international collaborations and projects:

CLUES Project: (Potsdam, Jerusalem, New Mexico,) (<http://www.clues-project.org>)

MUSIC Project: (La Sapienza Roma, AIP Potsdam, Bologna, Trieste) (<http://music.ft.uam.es>)

JUBILEE (Sussex, Potsdam, IFCA) (<http://www.jubilee-project.org>)

CURIEHZ (Potsdam, Colombia, IFT) (<http://curiehz.ft.uam.es>)

MULTIDARK (IFT, Potsdam, New Mexico; BOSS Collab.) (<http://www.multidark.org>)

SSimPL (Australia) (<http://www.astronomy.swin.edu.au/SSimPL/>)

Astroparticle Physics and Cosmology

This line deals with the origin and composition of the Universe and spans research in astroparticle physics and cosmology. Both fields are undergoing a tantalizing transformation as a consequence of the many running experiments which provide precise results about the universe at its largest scales. Data of deep impact is expected to be available very soon, such as that from the PLANCK satellite or from dark matter experiments e.g. XENON. The collaboration and coordination in this field between IFT members (with PE10-13 rating in this area of 5/5 inside CSIC y 4/5 at an international level) and the extremely active and consolidated astrophysics group of the Department is very positive.

Stable International Collaborations:

FERMI, XENON, PLANCK, CDMS.

Universidad de Alcalá.

Space Plasmas & Astroparticle Group.

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Contact person: M. D. Rodriguez Frias

Website: <http://spas.uah.es>; <http://spas.uah.es/jemeuso/>

Acronym: SPAS UAH

Staff researchers: 2

Postdoctoral/contracted researchers: 6

Areas of expertise and capabilities:

Keywords: Cosmic Radiation; Cherenkov and Fluorescence Radiation; Space Research; Astroparticle Physics; Solar Energetic Particles

Description of activity and achievements

The SPAS and ASTroparticle group (SPAS) is involved in two international projects of Astroparticle Physics with a common goal: the study of Ultra High Energy Cosmic Rays reaching the Earth with energies higher than 10^{17} eV from the Earth surface with the Pierre Auger project and from the space with the JEM-EUSO space mission.

PIERRE AUGER OBSERVATORY

The SPAS group is involved in the Pierre Auger Observatory since 2003. This observatory is devoted to the study of ultra-high energy cosmic rays. Around 17 countries and more than 400 scientists participate in this project whose main objectives are the determination of the energy spectrum, composition and the search of anisotropies in the arrival direction of these cosmic rays, and eventually, the astrophysical sources where they are accelerated.

THE JEM-EUSO SPACE MISSION

The Japanese Experiment Module (JEM) Extreme Universe Space Observatory (EUSO) will be launched and attached to the Japanese module of the International Space Station (ISS) in 2016. Its aim is to observe UV photon tracks produced by Ultra High Energy Cosmic Rays (UHECR) developing in the atmosphere and producing Extensive Air Showers (EAS).

The SPAS group is a key member of the JEM-EUSO collaboration, very active in the development of the atmospheric monitoring system, mainly the Infrared camera (both for the main mission and the EUSO Balloon). It participates in developing simulations of the JEM-EUSO Atmospheric Monitoring System (AMS), particularly on the role of clouds in the performance of the mission and on how the atmospheric scene can be detected with the Infrared Camera.

The AMS plays a fundamental role in our understanding of the atmospheric conditions in the Field of View (FoV) of the telescope and will include an IRCamera for cloud coverage and cloud top height detection. The monitoring of the cloud coverage by JEM-EUSO AMS is crucial to estimate the effective exposure with high accuracy and to increase the confidence level in the UHECRs events just above the threshold energy of the telescope. Therefore, the JEM-EUSO mission has implemented the AMS as far

as the impact onto mass and power budget is insignificant. It consists of 1) Infrared Camera (IRCAM), 2) LIDAR, 3) Slow data of the JEM-EUSO telescope.

The IRCAM is able to detect infrared radiation of the target with emissivity (ϵ) greater than 0,6 and lower than 1 and estimates the temperature of the target under investigation with accuracy better than 3K. The IRCamera instrument is an independent payload of the JEM-EUSO telescope and has its own calibration unit with 2 black bodies. This strategy will help to achieve the required performance.

Stable international collaborations:

The Tübingen Department of High energy Astrophysics, a key member of the JEM-EUSO collaboration, contributes significantly to the JEM-EUSO simulations, the development of the trigger electronics and the overall design of the mission. They lead the development of the JEM-EUSO simulation software based on ESAF (*EUSO Simulation and Analysis Framework*). They are active in the development and debugging of the ESAF software, specifically on the angular, energy and Xmax reconstruction, on the trigger algorithms development of the JEM-EUSO software and to the assessment of the mission performances. They also work on the development of the trigger electronics scheme of the JEM-EUSO instrument. They collaborate in developing the cluster control board of the JEM-EUSO mission. The simulation studies are therefore a perfect match between the activities of the two groups, with long collaboration stays in both institutions. This brings great advantage to the JEM-EUSO mission. Future collaboration activities will aim at a deeper understanding of the JEM-EUSO performances given the complex atmospheric conditions of the JEM-EUSO viewing scene. The presently developed clear sky performance studies will be therefore extended to the cloudy conditions and to more realistic atmospheric conditions. This is key for a full understanding of the JEM-EUSO performances.

Since 2007 the SPAS group is in close contact with the RIKEN Institute in Japan, developing an exchange program of predoctoral students in the frame of the JEM-EUSO international Project.

The SPAS group started its relationship with researchers from the Institute of Nuclear Sciences of the National Autonomous University of Mexico in 2006 (especially with Dr. G. Medina Tanco). Since then, both groups have jointly participated in several research projects funded by Spanish and Mexican institutions. Initially the work was devoted on the study of new methods for the determination of the energy and composition of cosmic rays of ultra-high energy in the context of the international collaboration Pierre Auger Observatory. The research has focused later on the search of more efficient methods to detect primary photons in the ultra-high energy cosmic ray flux. In parallel, the SPAS group have participated in the development of the BATATA experiment (Buried Array Telescope AT Auger) led by Medina Tanco. The SPAS group has participated in the installation, the estimation of the energy requirements for operation, data acquisition software and data are currently under analysis.

Regarding the SPAS relationship with Argentinean groups, we collaborate with the Institute of Technology in Detection and Astroparticle (CNEA, CONICET, UNSAM), mainly with Dr. A. Etchegoyen since 2009, mainly in the development of the experiment called AMIGA (Auger muon ground infill array) that is already collecting data. Its main objective is to measure the muon content of the cascades initiated by cosmic rays of ultra-high energy within the Auger experiment. This result will significantly improve the composition results from Auger. In addition, the SPAS group is working with Dr. A. D. Supanitsky since 2010, who belongs to the Institute of Astronomy and Space Physics of the University of Buenos Aires (UBA IAFE-CONICET). The research is related with the development of new methods to identify primary photons in the ultra-high energy cosmic ray flux.

Universidad de Alcalá. Space Research Group (SRG-UAH).

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Website: Principal: www.srg.uah.es

EPD-Solar Orbiter: <http://www.sorbete.srg.uah.es>

Space Weather: <http://spaceweather.uah.es>

HUMSAT: <http://www.humsat-uah.org>

CaLMa: www.calmanm.es

Melibea: <http://www.sorbete.srg.uah.es/e-Callisto>

Master: <http://pie.uah.es>

Staff researchers: 16

Postdoctoral/contracted researchers: 4 postdoctoral researchers and 16 contracted engineers.

Areas of expertise and capabilities:

Keywords: Solar Energetic Particles; Cosmic Rays; Solar wind; radiation environment; Sun-Earth connection; space weather; space instrumentation; on-board computers; aerospace engineering; real-time control software; optimal control; non-linear and systems.

Activities and achievements

- CDPU of CEPAC instrument on-board SOHO mission.
- Piship of the EPD (Energetic Particle Detector) instrument on-board Solar Orbiter mission.
- Instrument Control Unit (ICU) for EPD on-board Solar Orbiter.
- Instrument Control Unit for NISP on-board Euclid.
- PESCA cosmic ions instrument for satellites.
- An identification method for energetic cosmic ions.
- Study of Solar Energetic Particles events and solar cycle modulation using space based data.
- A Solar Magnetic Cloud model.
- A Solar Current Sheet model.
- UAH-SWS. The first Spanish warning space weather service including: the first warning system of severe geomagnetic disturbances based on the interplanetary magnetic field only, and a theoretical model for the recovery of the magnetosphere after an intense geomagnetic storm, able to reproduce even superstorms.
- Component Based Software Engineering (CBSE).
- Automatic code generation.
- Innovative technological solutions for optimal control and planning.
- Data acquisition systems for nuclear instrumentation.
- HUMSAT: initiative supported by the UN and ESA for the construction of a 3U cubesat and an amateur radio satellite ground station.
- CaLMa: the only Neutron Monitor that studies the cosmic environment around the Earth that is working in Spain. Integrated in the Neutron Monitor Database (NMDB).
- Melibea: the only Solar Radio Telescope in Spain included in the International Network of Solar Radio Spectrometers e-Callisto.

- Master of Science and Technology from Space.
- Doctorate Programme in Space Research.

Stable international collaborations

- University of Turku (Finland)
- University of Kiel (Germany)
- Applied Physics Laboratory/Johns Hopkins University (USA)
- V.N. Karazin Kharkiv National University, Kharkiv (Ukraine)
- Goddard Space Flight Center of NASA (USA)
- European Space Research and Technology Centre (ESTEC) of ESA (Netherlands)
- EADS Astrium (France)
- Rapita Systems (UK)
- Instituto de Pesquisas Espaciaes (Brazil)
- Universidad Tecnológica Nacional-Facultad Regional Mendoza (Argentina)
- Instituto de Astronomía y Física del Espacio, Buenos Aires (Argentina)
- Observatoire de Paris (France)
- Université Versailles St-Quentin, LATMOS-IPSL (France)
- Solar–Terrestrial Center of Excellence–SIDC (Belgium)
- UJF-Grenoble 1/CNRS-INSU, Institut de Planétologie et d’Astrophysique de Grenoble (France)

Universidad Politécnica de Madrid.
Faculty of Computing Sciences.
Collaborative Learning Group Ciclope.

Contact information:

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Contact persons: Francisco SANCHEZ, Raquel CEDAZO

Website: <http://ciclope.info>

Staff researchers: 4

Postdoctoral/contracted researchers: 2

Areas of expertise and capabilities:

Keywords: Collective Intelligence, Citizen Science, Web Learning, Web Technology, Ubiquitous Computing, Robotic Telescope, Astronomy

Description of activity and achievements:

The UPM group counts with ten years of expertise in Collective Intelligence. It has created the Montegancedo Astronomical Observatory. One of the first web free Access Astronomical observatory of the world (<http://om.fi.upm.es/>) and the first social network for researching astronomy with access to a real telescope.

Our group develops software for web interfaces and mobiles phones mainly for allowing the interaction and the participation of hundreds, thousands or millions of people. This kind of software is being used lately for Citizen Science, especially in Astronomy, with projects like Galaxy Zoo (<http://zoouniverse.org>) or NASA Start Dust (<http://stardust.jpl.nasa.gov/>).

Our main field of application for our software is Astronomy Science and we collaborate with several projects with Astronomers in Spain and all around the world.

Stable international collaborations

The UPM group is participating now in two projects:

1. GLORIA european project (<http://gloria-project.eu>), where we are coordinators. It has a total budget of 2,5 M€ and 12 partners. GLORIA intends to become the first global network of robotic telescopes for researching and learning Astronomy. The Montegancedo Observatory is currently integrated in GLORIA network. Every person who had a robotic telescope can connect it to GLORIA in order to share the observing time with other locations and timings.
2. MEGARA instrument (Multi-Espectrógrafo en GTC de Alta Resolución para Astronomía), which is an optical Integral-Field Unit (IFU) and Multi-Object Spectrograph (MOS) designed for the GTC 10.4m telescope in La Palma. (<http://guaix.fis.ucm.es/megara>). UPM group is in charge of the control software.

Centro de Astrobiología (CSIC-INTA).

Department of Astrophysics.

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Website: <http://www.cab.inta-csic.es/es/departamentos/2/departamento-de-astrofisica>

Acronym: CAB-ASTRO

Staff researchers: 18

Postdoctoral/contracted researchers: 50

Areas of expertise and capabilities:

Keywords: Formation and Evolution of galaxies; Astrochemistry; Molecular Spectroscopy; Molecular Clouds; Dust Grains properties; Chemical Reactions and Chemical Models; Radio Astronomy; Radio Interferometry; Infrared Astronomy; Laboratory Simulations of ISM conditions; Planetary atmospheres; Star formation; Stellar evolution; Initial Mass Function; Formation and evolution of high and low-mass stars; brown dwarfs and planets; circumstellar disks; protoplanetary disks; transitional disks; debris disks; Edgeworth-Kuiper belts; Exoplanets; Telluric planets; Earth-like planets; Planetary systems; Habitability zone.

Description of activity and achievements

Research at CAB-ASTRO is organized along the following groups:

Formation and Evolution of Galaxies

The group is specialized in the Astrophysics area of "Formation and Evolution of Galaxies".

The main focus is the study of different galaxy types observed across the history of the Universe. This research is based on data obtained with ground based and spatial telescopes, optimized in X rays, optical, infrared and millimetric. The group also have an important implication in technological projects of astronomical instrumentation, both spatial and ground based.

Molecular Astrophysics Group

This is a multidisciplinary group providing strong connection between Astrophysics, Chemical Physics, Laboratory experiments, Materials Science and astronomical instrumentation for ground and space observatories. The activities of the group include astronomical observations, computational modelling and laboratory experiments of the interstellar and circumstellar media physics and chemistry, development of superconducting detectors, spectroscopic tools for data cube analysis and molecular spectroscopy line catalogues for the detection of new chemical species in Space.

Formation and Evolution of Stars, Brown Dwarfs and Planets

Researchers in this group work on activities related to the observation, study, and modeling of the various phases and processes associated with the formation and evolution of stars, brown dwarfs and extrasolar planets, aiming to characterize their physical properties.

Researchers at CAB-ASTRO have contributed to more than 1.000 international publications since 2009, when the department was created, including more than 600 publications in refereed journals.

Research in Astrophysics has been combined with contributions to the development of astronomical instrumentation, both on ground and in space, including the following projects:

- INTEGRAL-OMC (ESA)
- GAIA (ESA)
- Bepi Colombo-MIXS (ESA)
- JWST-MIRI+NIRSPEC (NASA)
- PLATO and EChO (ESA)
- SPICA-Safari (ESA)
- Robledo DSS54 (NASA)
- ALMA (ESO) -
- CARMENES (CAHA)
- VLT-Espresso (ESO)
- E-ELT-Harmoni (ESO)
- Development of Far Infrared superconducting detectors

Stable international collaborations

- University of Hertfordshire, Hatfield, UK.
- Institute of Astronomy, University of Cambridge
- European Southern Observatory
- Spitzer Science Center, California Institute of Technology, Pasadena, USA)
- INAF - Osservatorio Astronomico di Palermo, Italy
- Max-Planck-Institut für Astronomie, Heidelberg, Germany
- Université Joseph Fourier/CNRS, Laboratoire d'Astrophysique de Grenoble, France
- Institut d'Astrophysique de Paris, France
- Stockholm University, Department of Astrophysics, Sweden
- University of Leicester, UK
- Observatoire de Paris, France

Centro de Astrobiología (CSIC-INTA).
Department of Astrophysics.
Virtual Observatory.

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Website: <http://svo.cab.inta-csic.es>

Twitter: @ObsVirtEsp

Staff researchers: 1

Postdoctoral/contracted researchers: 7

Areas of expertise and capabilities:

Keywords: Virtual Observatory; astronomical databases; data mining; stars: Hot subdwarfs; stars: AGB and post-AGB; stars: Low-mass; brown dwarfs; stars: Pulsating variables; solar system: Asteroids.

Description of activity and achievements

The main objective of the Virtual Observatory (VO) is to guarantee an easy and efficient access and analysis of the information hosted in astronomical archives and services. The VO concept goes one step further than just giving access to distributed computational resources or to the data. It also permits operations on the data and returns results. VO is opening new lines in the astronomical research and it is considered both from the technical and scientific point of view the framework where to settle the astronomical archive-related activities.

The Spanish Virtual Observatory (SVO) is a project led by the Centro de Astrobiología that, since 2004, coordinates and collaborates with the Spanish astronomical groups with interest in the VO and acts as the national contact point for the international VO initiatives, in particular the International Virtual Observatory Alliance (IVOA) and the Euro-VO project.

Five are our major lines of work:

1.- Development of VO-compliant scientific data centres: Having an archive perfectly integrated in the Virtual Observatory framework, constitutes an added value of enormous importance for an astronomical project. The full list of archives managed by the SVO at Centro de Astrobiología can be found at: <http://sdc.cab.inta-csic.es/>. Among others, we are responsible for the GTC (the largest telescope in the world) and Calar Alto (the largest observatory in continental Europe) VO-compliant archives.

2.- Development of science cases using a VO methodology: The Virtual Observatory project was driven by science and it is becoming a science driver. After several years, VO is now mature enough to be used as a research tool for the astronomical community.

The Spanish Virtual Observatory collaborates with research groups having science cases that could benefit from using a VO methodology. The SVO role in the collaboration is to evaluate the science case from the VO point of view, to provide information and support about the existing tools to tackle the scientific problem and, if necessary, to develop new analysis tools. VOSA (<http://svo2.cab.inta->

csic.es/theory/vosa/) and VOSED (<http://svo.cab.inta-csic.es/vosed>) are excellent examples of general-purpose VO-tools that were developed in these collaborations. This is a very successful activity as demonstrated by the fact that almost a third of the VO-papers published in the last three years belong to members of the Spanish Virtual Observatory.

3.- Development of VO standards: Standardization represents the first level in the bottom-up VO roadmap. The implementation of the interoperability standards (the interoperability layer) on top of the data repositories permits operations such as data aggregation and combination, which are essential for the full scientific exploitation of the data infrastructure. The Spanish VO is playing an important role at international level in this field, in particular in the definition of access protocols for theoretical models and in the development of data models for photometry, time series and asteroseismology.

4.- Development of data mining tools: Efficient handling of the vast amount of data that is available in the VO framework is only possible if Artificial Intelligence (e.g. Data Mining) techniques are considered. Supervised/unsupervised classification or knowledge discovery projects represent our main lines of work in this field.

5.- Education and Outreach: The new possibilities that the Virtual Observatory offers will definitely have an impact on the astronomical outreach and education activities. SVO develops resources and applications to facilitate the use of the Virtual Observatory by the educational community, amateur astronomers and the public in general.

Stable international collaborations

The Spanish VO has participated since 2006 in Euro-VO (an initiative to coordinate the VO activities at European level) as partner in the following projects:

- CoSADIE: Collaborative and Sustainable Astronomical Data Infrastructure for Europe. September 2012 – August 2014. EU/FP7.
- AIDA: Astronomical Infrastructure for Data Access. February 2008 – July 2010. EU/FP7
- DCA: Data Center Alliance. September 2006 – December 2008. EU/FP6.

SVO is, since 2004, member of IVOA (International Virtual Observatory Alliance: <http://www.ivoa.net>), an organisation that debates and agrees the technical standards that are needed to make the VO possible. It also acts as a focus for VO aspirations, a framework for discussing and sharing VO ideas and technology, and body for promoting and publicising the VO.

Centro de Astrobiología (CSIC-INTA). Department of Instrumentation.

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Contact person: José Antonio Rodríguez-Manfredi (head); Javier Martín Soler

Website:

<https://www.cab.inta-csic.es/es/departamentos/5/departamento-de-instrumentacion-avanzada>

Staff researchers: 14 researchers and engineers

Postdoctoral/contracted researchers: 20

Areas of expertise and capabilities:

Keywords: Instrumentation for planetary exploration missions; Instrumentation for astrophysics missions; Simulation chambers for reproducing planetary and space environments; Nanotechnology

Description of activity and achievements

Centro de Astrobiología's Department of Advanced Instrumentation focuses on design, development and deployment of advanced technology instrumentation and solutions for space exploration, covering all related aspects: from conceptualizing and prototyping of innovative ideas, to management and operation of instrumentation onboard space missions (planetary exploration or astrophysics missions).

The Department of Advanced Instrumentation's expertise also includes the areas of nanotechnology as well as the design, development and exploitation of simulation chambers, where planetary and space environments are reproduced in order to test, calibrate or analyzed the developed technology.

Over the last decade, the Department of Advanced Instrumentation has applied its expertise to develop space instrumentation such as the REMS instrument onboard Curiosity, the NASA's Mars Science Laboratory Mission (together with EADS Astrium CRISA); the TWINS instrument, which is the Spanish contribution to the NASA's InSight Mission to be launched on 2016; the RLS Raman spectrometer for the ESA's Exomars Mission; and some few other next generation instruments that will be in readiness for space exploration shortly.

When appropriate, the Centro de Astrobiología's Department of Advanced Instrumentation works with industrial partners to successfully complete space developments.

Stable international collaborations

JPL
NASA Ames
CNES
CNRS

Instituto Nacional de Técnica Aeroespacial (INTA).

Department of Space Programs & Systems.

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Affiliation:

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Contact persons:

Head of Department: Fernando González García (gonzalezgf@inta.es)

Head of Ground Segment: Eduardo Quintas Ripoll (quintasre@inta.es)

Head of Flight Segment: César Martínez Fernández (martinefc@inta.es)

Staff researchers: 34

Postdoctoral/contracted researchers: 7

Areas of expertise and capabilities:

Keywords: Flight Segment; Ground Segment; Platforms; Subsystems; Management; Systems Engineering; AIV; AIT; On Board Software; Space Weather; SSA; Radiation; Procurement.

Description of activity and achievements:

The activities of the Department cover a wide range of tasks related with Space Programs:

Program Management: Due to the complexity of the Space related programs, a deep knowledge of technical management, people management, risk control, configuration & documentation control, ESA procedures and others is needed. The experience accumulated in the last 20 years allows our team to face complex scientific programs.

Systems Engineering: Turning of scientific needs into technical requirements, interfaces control, technical budgets (mass, data, power, link...) Integration and verification activities, running from plans and procedures edition to execution of tests and edition of reports. Support to engineering design: power, attitude control, thermal, electrical, communications...

Software Development & Operation Definition: On board software and ground software development including applications to control and operate scientific instruments. Collaboration with scientific groups in the definition of instruments operation. Edition of operation procedures.

SSA: Activities related with Space Weather, in particular, radiation issues. Space environment analysis.

Ground Segment: Definition of requirements and development of Ground Control stations and TTC stations. Management of all activities related with the daily routine of Ground Stations including equipments and facilities maintenance.

Components Procurement: tasks include technical assessment and specification, purchasing, reception and verification and storage in controlled areas.

Stable international collaborations

University of Florida: Space Platforms

NASA: operation of Ground Segments

Instituto Nacional de Tecnología Aeroespacial (INTA).

Department of Space Sciences and Electronical Technologies.

Contact information:

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Contact person: Lola Sabau-Graziati Director of Payloads and Space Sciences Department.

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Website: <http://www.inta.es/>

Staff researchers: 16 (8 doctors, 8 graduates)

Postdoctoral/contracted researchers: 10 (1 doctor, 9 graduates)

Areas of expertise and capabilities:

Keywords: Payloads; Space Optics; Optoelectronic; optical instrumentation; Space Magnetism; Magnetometers; Gradiometers; Magnetic Cleanliness; Magnetic Signature; Planetary Magnetic Mineralogy; Electronics for Payloads; Space Radiation Environment; Radiation Effects; COTS; Radiation test; Thermal control for Space systems; cryogenic; Payloads Mechanical Test; Space Mechanisms; Payloads Mechanical Integration; Thermal Analysis; Payloads Mechanical Design; Space engineering; Space Electronic design;

Description of activity and achievements

Payloads Design, development, manufacturing, integration and test for INTA minisatellites: MINISAT 01, Nanosat-01, Nanosat-1B and OPTOS, as well as others satellites external to INTA: INTEGRAL, OSIRIS/Rosetta, MXGS/ASIM, Foton-M3, SEOSAT/Ingenio, Mars METNET, Exomars 2016-EDM, IMaX, SO/PHI (Solar orbiter), WSO, RAMAN, JEM-EUSO, ECHO.

Calibration and Data exploitation of the payloads developed at INTA

Design, integration and characterization of optical instrumentation and sensors.

Characterization of new nanostructured materials.

Mechanical design and test.

Design and development of ACS sensors and Optical Wireless Links for intra-satellites Communications (OWLS)

Thermal control design

Tests and applied research activities that are performed in the Microgravity Tower

Space Radiation Environment. Radiation tests on Components, Materials and New technologies for Space. More than 30 Radiation Test: Total Ionizing Dose (TID), single Event Effects (SEE) and Displacement Damage (DD) performed on more than 100 devices in National and international Facilities. Development of Radiation Monitors for Space.

Development of magnetometers and gradiometers for space applications. Magnetic Cleanliness and magnetic signature testing. Magnetic mineralogy.

Stable international collaborations

European Space Agency

National Aeronautics and Space Administration (NASA)

Agency Japan Aerospace Exploration (JAXA)

Italian Space Agency (ASI)

Russian Space Agency (Roscosmos, RKA).

Russian Academy of Sciences

Carnegie Mellon University, (EEUU)

University of Trier (Germany)

The Proton Irradiation Facility at the Paul Scherrer Institute (Switzerland)

Université Catholique de Louvain. CYClotron of LOuvain la NEuve (CYCLONE) Test Facility. (Belgium)

University of Jyväskylä, Finland (JYFL). RADiation Effects Facility (RADEF).

Max Planck Institute. (Germany)

Rutherford Appleton Laboratory. (England).

Technical University of Denmark.

Faculdade de Ciencias (FCUL), Universidade de Lisboa (Portugal).

Istituto di Astrofisica Spaziale e Fisica Cosmica (Italy)

Observatorio Astronómico Nacional (OAN).

Contact information:

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Contact person: Director Rafael Bachiller

Website: <http://www.oan.es/>

Staff researchers: 30

Postdoctoral/contracted researchers: 5

Areas of expertise and capabilities:

Keywords: Radioastronomy, star formation, evolved stars and planetary nebulae, galaxies, interstellar molecules.

Description of activity and achievements

During the last 3 decades, astronomers and engineers at OAN and Yebes have equipped and put into operation the 14-m and 40-m radio telescopes in the Yebes Observatory (a recognized Spanish Large Scientific Infrastructure or ICTS), and have collaborated in the foundations of other large radioastronomy facilities. In particular, a collaboration of IGN with French CNRS and German MPG developed the Instituto de Radioastronomía Milimétrica (IRAM), which operates the two major mm-wave observatories world-wide (in Pico Veleta and Plateau de Bure) until the advent of ALMA. On the other hand, the 40-m radiotelescope in Yebes has become one of the major elements of the European VLBI Network (EVN).

OAN astronomers played a crucial role promoting the incorporation of Spain in the ALMA project through tight collaboration with ESO. This collaboration was culminated by the full incorporation of Spain as full-member of ESO in 2006. OAN astronomers are currently among the major ALMA users in Spain.

OAN also contributed significantly to the definition, construction and scientific exploitation of ESA space infrared telescope HERSCHEL.

In addition to the highly specialized technological work carried out in their own ICTSs in Yebes and Pico Veleta (IRAM 30-m radiotelescope), the Yebes engineers have become the European leaders in the development of cryogenic IF amplifiers, transferring successfully this technology to the Spanish microwave industry. Flight qualified units for all the bands of the HIFI instruments in the HERSCHEL satellite, compliant with the specifications, were delivered on time and have contributed without any failure to the scientific success of the mission. Under contract with ESO, Yebes also led the development of the cryogenic IF amplifiers for all European receivers in ALMA.

The use of Yebes, IRAM, HERSCHEL, ALMA along with other radio telescopes and interferometers in Europe and America, have allowed the undertaking of cutting edge investigative work that has translated into several hundreds of articles published by OAN astronomers in specialized, international, refereed journals. In fact, over the last five years, almost 300 scientific articles in refereed journals and conferences have been published, and have contributed appreciably to a

greater knowledge of: the physical and chemical processes that take place in the interstellar and circumstellar media, both within our Galaxy as well as external galaxies, and in the processes that relate to the first and last stages of the life of stars.

Stable international collaborations:

OAN maintains collaborations with essentially all major radioastronomy institutes around the world. It has been a very active player in the successive RadioNet projects funded by the EC, and currently holds the chairmanship of its Board. RadioNet is the Network of 22 major radioastronomy institutes in Europe, covering from the cm to the sub-mm ranges.

Other major institutional collaborations, all supported by IGN, include the IRAM institute mentioned above, ESA HERSCHEL, ALMA, EC funded EXPRéS and NEXPRéS projects, SKA related activities, CRAF (ESF Committee on Radioastronomy Frequencies), etc.

CIEMAT. Division of Astroparticle Physics.

Contact information:

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Ignacio Sevilla (ignacio.sevilla@ciemat.es, 914962577)

Website: <http://www.ciemat.es/>

Staff researchers: 8

Postdoctoral/contracted researchers: 5

Areas of expertise and capabilities:

Keywords: galaxies, photometric surveys, detectors, high energy phenomena,

Description of activity and achievements:

CIEMAT participates in a galaxy evolution project (ESTALLIDOS) and in the study of the nature of dark energy (DES and PAU projects). CIEMAT also participates in experiments related with the cosmic rays (AMS experiment in the International Space Station and ground-based gamma-ray astronomy (CTA and MAGIC observatories). Each of these lines is described below:

Cosmic evolution of galaxies (ESTALLIDOS) The aim of the project is the theoretical and observational study of starbursts and their impact on the evolution of the galaxies hosting them. The main science driver is to define the nature and extent of the bursts as a function of metallicity and environment, as well as the mechanisms that allow their feedback leading to new generations of stars and, hence to the cosmic metal enrichment. A wide range of galaxy properties and environments is studied, including from nearby galaxies to the most extreme star forming objects, in order to characterize the physical processes governing massive star formation in galaxies. The research has been structured around three main objectives: i) Study of the massive star formation and chemical enrichment in the local Universe, ii) Analyze the impact of massive starbursts on galaxy evolution and iii) Characterization of extreme starbursts. Relevant science topics addressed under these objectives include: 1) Metallicity enrichment as the imprint of the star formation history of galaxies. 2) Detailed observational studies of star formation and chemical enrichment in local Universe objects. 3) Precise calibration of physically motivated models of massive star formation and chemical evolution of galaxies. 4) Evolution of star forming galaxies as seen from large surveys, and the derivation of new constraints. 5) Extreme starbursts (in mass, metallicity, luminosity, star formation and environmental conditions)

Physics of Accelerating Universe The PAU Survey will study the existence and properties of dark energy from the observations of Redshift Space Distortions and Weak Lensing Magnification from galaxy cross-correlations. The PAU Team is building an imaging instrument, PAUCam, designed to be located at the prime focus of the 4-m diameter William Herschel Telescope (WHT) at La Palma. Using narrow band filters, it is possible to obtain a redshift precision above 0.0035 (1+z) for 70% of the imaged galaxies. The goal is to cover 200 sq.deg. CIEMAT is a key part for the development of the electronics of PAUCam being responsible of the design, validation, production and maintenance of the preamplification boards, and the clock boards. A test station for CCD characterization and for the filter system as the tool for installing the camera at the telescope has been designed and built in CIEMAT, who is also responsible for the mechanical design and cooling of the crates for the electronic boards. In terms of software the team is in charge of developing the scientific quality control

software. It also contributes in the data analysis for weak lensing magnification and redshift space distortions.

Dark Energy Survey: The Dark Energy Survey is a photometric survey aimed directly at understanding the acceleration of the universe. The DES Collaboration has built an extremely red sensitive 500 Megapixel camera (DECam), a 2.2 degree diameter FoV prime focus corrector and the data acquisition system. The system was mounted at the prime focus of the Blanco 4-meter telescope at CTIO, a southern hemisphere NOAO telescope. A 30% of the available time on the telescope on next 5 years will be used to pursue a high precision multi-bandpass wide area survey. The survey g,r,i,z,Y data will cover 5000 sq-degrees. The science goals aims related on the the dark energy study are 1) Cluster counting and spatial distribution at $0.1 < z < 1.3$, 2). The shifting of the galaxy spatial angular power spectra with redshift. 3) Weak lensing measurements to $z \sim 1$, 4) 4000 supernovae at $0.3 < z < 0.8$. The commissioning of the camera and science verification was done during 2012-13 and the survey will start in 2013. The CIEMAT has designed, produced and tested a dedicated electronic Clock Boards (CB) and its transition board (CBT), adapted to the strong requirements of DECam. It also contributes to the development of the quality control software. From the science viewpoint, CIEMAT participates mainly in the analysis of baryon acoustic oscillations, weak lensing magnification and clustering properties of galaxies

The AMS experiment at the International Space Station: The purpose of the AMS project was to install a magnetic spectrometer in space to do a high precision study of cosmic rays up to $Z \leq 26$ measure their energy spectrum up to the TeV range. The assembly and integration of the detector was done at the CERN (Geneva) and NASA installed the detector on the ISS on May 2011. The purpose is to keep the detector operative on the ISS throughout its lifetime. CIEMAT participated in the construction and assembly of the RICH (Ring Imaging Cherenkov). It is also responsible for the RICH simulation and reconstruction software and its integration in the general AMS code. The group also has a very active involvement in many of the data analysis channels of the experiment, such as the alignment, anisotropy measurements, B/C ratio and positron fraction among others.

Gamma ray observatories (CTA/MAGIC). CIEMAT is involved in R&D activities in electronics and mechanics whose main aim is the construction of a large facility (Cherenkov Telescope Array) to detect very high energy gamma rays with a higher sensitivity, an order of magnitude larger than the present observatories in the energetic range between 10 GeV and 100 TeV. It will serve as an open observatory to a wide astrophysics community and will provide a deep insight into the non-thermal high-energy universe. The group also contributes to the scientific work and operations of the MAGIC gamma ray observatory at the Roque de los Muchachos site.

Stable international collaborations:

Australian Astronomical Observatory (Australia), Universidad de Sao Paulo (Brasil), Université Laval (Quebec, Canada), University of Central Lancashire (Reino Unido), AMS Collaboration, DES Collaboration, MAGIC Collaboration, CTA Collaboration.

AstroMadrid Industries

AstroMadrid Industries

CRISA

<http://www.crisa.es/>

The logo for Crisa, featuring the word "Crisa" in a bold, blue, sans-serif font.

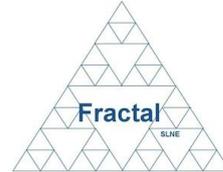
DEIMOS SPACE

<http://www.deimos-space.com/>

The logo for deimos SPACE, with "deimos" in a bold, black, sans-serif font and "SPACE" in a smaller, black, sans-serif font below it. An orange arc is positioned above the "o" in "deimos".

FRACTAL SLNE

<http://www.fractal-es.com/>



GMV

<http://www.gmv.com/en/index.html>

The logo for GMV, featuring the letters "gmv" in a bold, red, sans-serif font. Below it, the tagline "INNOVATING SOLUTIONS" is written in a smaller, black, sans-serif font.

INSA-ISDEFE

<http://www.isdefe.es/>

The logo for INSA, featuring the letters "INSA" in a bold, blue, sans-serif font. Below it, the tagline "INGENIERÍA Y SERVICIOS AEROSPACIALES, S.A." is written in a smaller, black, sans-serif font.

IXION

<http://www.ixion.es/>

The logo for IXION, featuring the word "IXION" in a bold, black, sans-serif font. Below it, the tagline "industry and aerospace" is written in a smaller, black, sans-serif font, with "and" in a green color.

LIDAX

<http://www.lidax.com/en/>

The logo for LIDAX, featuring the word "LIDAX" in a bold, blue, sans-serif font. Below it, the tagline "ingeniería" is written in a smaller, black, sans-serif font, with a blue arrow pointing to the right.

SENER

<http://www.sener.es/inicio/es>



SERCO

<http://www.serco.com/>

The logo for serco, featuring the word "serco" in a bold, black, sans-serif font. A red oval is positioned below the "o".

THALES ALENIA SPACE

<https://www.thalesgroup.com/en/thales-alenia-space>

The logo for ThalesAlenia Space, featuring the words "ThalesAlenia" in a bold, blue, sans-serif font and "Space" in a smaller, blue, sans-serif font below it. A blue arc is positioned above the "Space" text. Below the logo, the tagline "A Thales / Finmeccanica Company" is written in a smaller, black, sans-serif font.

FRACTAL S.L.N.

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Areas of expertise and capabilities:

Keywords: Instrumentation; Software; Astronomy; Optics; Detectors; Opto-mechanics; Management; System Engineering; Consultancy; Training;.

Description of capabilities, activity and achievements

Participation in the following projects Astronomy or I+D+I (we have chosen some representatives projects among the > 50 projects that Fractal have developed in 8 years):

Some Astronomy projects:

MEGARA: the next visible multi-object spectrograph for the Gran Telescopio Canarias (GTC). Fractal is responsible, under UCM (Universidad Complutense de Madrid), of the following services: project management, system engineering, spectrograph design and integration, detector characterization and optical bundles design and integration.

CARMENES: the next double-arm echelle spectrograph for the 3.5m telescope at the Calar Alto Observatory. Fractal is responsible, under LWS (Heidelberg) of the following services: project management, system engineering, and CCD characterization. Fractal has carried out some services for IAA within this project.

Several contract providing software services in Spain (OAN) and Europe (2 contracts with ESO).

Design and development of ARES fiber-fed R=12000 spectrograph and associated fiber Link for the Montsec telescope for the Instituto de Estudios Espaciales de Cataluña (IEEC).

Holographic Gratings for the RAMAN spectrograph on board of the Rover of the ExoMars mission under contract for INTA (Instituto Nacional de Técnica Aeroespacial).

Some I+D+i projects:

VIENTOS project (in collaboration with UCM) for the development of the innovative solutions for pupil elements (2010-2012) co-funded by CDTI (Center for Technological and Industrial Development) under the Industry for Science program (Reference IDC-20101106).

Feasibility study for the design and characterization of high resolution gratings, with the partnership of UCM under the program "Ayudas para el sector aeroespacial de la Comunidad de Madrid (2009)" (Reference 04-AEC-0913-000022/2009).

GMV

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Areas of expertise and capabilities:

Keywords: GMV is providing solutions for instrument system engineering, data processing/archiving/dissemination, proposals handling/planning/scheduling, data exploitation/visualization and analysis tools

Description of capabilities, activity and achievements

GMV has actively participated during the last 20 years in programs related to astrophysics and Astronomy. Along all those years GMV has acquired a great expertise on different thematic such as: Instrument processing and calibration including processing framework tool development, Proposal handling tool development, planning and scheduling: optimal telescopes scheduling and optimal dimension and topology of telescope network, archive/catalogue and dissemination definition and development as well as the development of visualization and analysis tools using a wide range of product formats from FITS to HDF or NetCDF. It is also important to notice that GMV is able to provide solutions and Services in RAMS engineering and as system engineering team provide a whole solution for system definition, specification, design and integration.

Among the most important projects GMV has participated in:

Spectroscopy defining a 3D system platform for data reduction and definition of the algorithms for the reduction of this kind of astronomical data, as for example, the tracing of the spectra in the CCD detector.

Study of the correlation between the optical aerosol thickness obtained from satellite data (SEVIRI, MSG-2) and the astronomical extinction measured in on-ground observations in the Canary Islands.

Defining the entire processing pipeline for OSIRIS instrument at GTC which covers not only the processing framework also the data reduction algorithms.

Defining GAIA Reference Database and Hershel and Plank System Database.

Defining a GS for WSO which is a ultraviolet mission in 100-320nm (UV) wavelength range. GMV has defined both Mission Control Center (MOC) and Science Control Center (SOC).

Defining COROT Mission Centre, which is a mission aimed to investigate asterosystemology and the search of Exo-planets.

For the Infrared Space Observatory (ISO) definition of the entire MOC and SOC including interfaces with instrument pipelines.

LIDAX

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Jesús Aivar (Business Development Manager).
comercial@lidax.com
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FAX: (+34) 91 656 39 01

Company: LIDAX
Address: Av. Cristobal Colón 16, Torrejón de Ardoz (Madrid/(Spain)), PO Box: 28850
Website: <http://www.lidax.com>

Areas of expertise and capabilities:

Keywords: Development of Advanced Mechanical Equipments, following Space Standards:
Opto-Mechanical, Thermal, Mechanical and Testing Engineering Expertise

Description of capabilities, activity and achievements

Cryo OGSE for the Instituto Nacional de Técnica Aeroespacial (INTA)- MIRI Telescope Simulator. Phase A definition & System Engineering and MIRI Telescope Simulator Folding Mirrors. Complete equipment supplier.

Flight equipment for the Centro de Astrobiología (CSIC-INTA)- Focal Plane Assemblies for MIXS-T & MIXS-C Instruments of ESA BEPI COLOMBO satellite as a complete equipment supplier carrying out among other activities the Space Qualification and Tests.

On ground instrument for the Instituto de Astrofísica de Canarias (IAC)- Telescope and Atmosphere simulator for adaptive optics study using FPGA. Complete equipment supplier.

Flight Equipment for the European Space Agency (ESA)- Development of a Family of Dry Lubricated Gearbox Family for Extreme Temperatures (Hot/Cold) +-200°C Complete Building Block Supplier

Flight Equipment for ASTRIUM - Focal Plane Assembly Co- Alignment Sensor of the ATLID Instrument of ESA Earthcare Mission.

SENER Ingeniería y sistemas

Contact information:

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Website: www.sener.es

Areas of expertise and capabilities:

Keywords: Opto-mechanics and mechatronics systems design, implementation and verification.

Description of capabilities, activity and achievements

Space Instrumentation: Rosetta Filter Wheel, Pleiades Shutter Mechanism, ISIS Camera for WSO, Infrared Camera for JEM-EUSO, SEOSAT/INGENIO High Resolution Camera, Solar Orbiter PHI and EPD instruments, MTG 3MI instrument.

Ground Instrumentation: GTC: OSIRIS WSS, EMIR DTU and CSU Electronics & Control, M2 drive systems for GTC, IRAIT and VISTA and M5FU for E-ELT, VLT GRAAL, ALMA Amplitude Calibration System, E-ELT HARMONI Calibration Unit, JPCam Actuator System and CARMENES Opto-mechanics Design.

Madrid Cluster Aeroespacial

Madrid Cluster Aeroespacial

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Fax: (+34) 914 414 155
Website: <http://www.eacp-aero.eu/index.php?id=48>

Areas of expertise and capabilities:

Facts & Figures

Number of companies	144 (in the region): The main firms members are: Airbus, EADS CASA, EADS Astrium Crisa, ITP, CESA and Grupo TAM
Number of employees	20,000 (direct jobs)
Number of research institutes	Forming part of Madrimasd (www.madrimasd.org) there are more than 48 research groups devoted to aerospace related R&D activities
Other cluster members	Madrimasd - R&D (all the Madrid Region Universities and RTOs). New (2009) partners: Hispasat, Deimos, INSA, Mecanizados Escribano, Boeing, Aernova, Aries Ingeniería, etc.

Cluster Management

Organizational form	Association
Financing	Variable multiannual scheme balancing member fees, competitive public funding from regional, national and (expected) EU sources. During the first 4-5 years period, the main financing is being provided by regional funds.

Main Actors

Main industry actors	EADS, Airbus, ITP, CESA, Grupo TAM, Indra, GMV, Deimos, Boeing, Mecanizados Escribano, INSA, Hispasat, Ineco, INSA, Aena, Acatec, Aerlyper, Amper, Aernova, Aries complex, Aries Ingeniería y Sistemas, CT Ingenieros, Hexcel, Iberia Mantenimiento, ITD, Nextel, Ramen, Rodriser, Sener, SMA, Tecnatom, Tecnobit, Dasel, Lidax.
Main research institutes	Madrimasd: INTA, CSIC, UPM, UC3, URJC, UAH, UCM, UAM, Imdea Materiales, Imdea Software, Imdea Nano.

Cluster Competences and Strategy

Strengths & Competences

Integration, engineering and design, engines, equipment and systems, composite materials, space, and maintenance and repairing.

The Madrid Aerospace cluster is part of Madrid Network (www.Madridnetwork.org) which is the Madrid Cluster & Technological Parks association of the Madrid Region. This association takes a great impact on aerospace related activities within the region, e.g: TecnoGetafe is a relevant initiative providing real state and advanced services for firms which focus their activity on aerospace.

Below is a list of some of the leading aerospace companies in Madrid, members of the MPAE cluster:

- Airbus España is the Spanish subsidiary of the European company AIRBUS, which is specialised in the design, development and manufacture of aeronautical composite material components. More than 2,000 people work in the Getafe factory, where different components are built for the aircraft families Airbus A310, A320, A330, A340 and A380. This centre houses the Directorate General of Airbus España.
- CESA is a company that focuses on different activities in the field of aeronautics, e.g. equipment design, engineering, rating and certification, and maintenance, etc. Its specialty is the manufacture of fluid mechanical equipment, such as: landing gear, hydraulic systems and flight control.
- Founded in 1985, CRISA has participated in most of the leading European space programmes, Crisa is currently integrated into Astrium, S.L. Its experience in the space sector covers all kinds of applications, such as Earth observation, space infrastructure, scientific programmes, and telecommunications and navigation.
- EADS CASA, recently transformed in Airbus Military, takes part in numerous aerospace programmes, e.g. the Airbus airplanes, the Eurocopter helicopters, the Eurofighter combat plane, and the European satellite navigation system Galileo.
- EADS-CASA Espacio is a European Composite Material Centre of Excellence that since 1966 has been developing, producing, integrating and qualifying space elements and structural subsystems for thermal control and power distribution of Launchers, Satellites and the International Space Station.
- TAM since the 1980s, is specialised in cutting-edge numerical control technology for the aerospace industry. At present, its core business focuses on engineering-related activities.
- ITP (Industria de Turbopropulsores S.A., is a company in which Sener Aeronáutica and Rolls-Royce hold the controlling shares. Its activities include engineering, R&D, manufacturing and casting, assembly and testing of aeronautical engines and gas turbines, as well as maintenance of engines and aircraft. The ITP Group has eleven work centres located in Europe and America.

Science & Research

Galileo, GMES, Air Traffic Control, Navigation Systems, Advanced manufacturing, Diversification (Tier1), UAVs, energy and greening

International Collaboration

We are part of several European aerospace related networks: e.g.: NEREUS, Clunet and ERA-Star; and we have already signed specific cooperation agreements on cluster policies with advanced regions: Helsinki, [BavAIRia](#), Île de France, Shanghai, Israel, ...

Main Challenges

The main challenge is to keep the leading edge in composite technologies, manufacturing engineering, advanced materials, Satellite Navigation and Air Traffic Systems, and exploit our potential on other emerging activities. Our strategy is based in the assumption of a clear collaborative leadership by the firms, supported both from the scientific/academic sector and the regional administration.