GAIA, THE EUROPEAN SATELLITE THAT IS INVESTIGATING 1.5 MILLION KILOMETRES FROM EARTH

RedIRIS

The Gaia Mission will provide unprecedented data on interstellar space. RedIRIS collaborates in reaching this scientific milestone

Cataloguing the night sky is an essential part of astronomy. Our galaxy is a disk of around one billion stars in a spiral structure that surrounds a central bulb. While most stars were born in the Milky Way, many others originated in small external galaxies that then merged with ours.

Gaia Objectives

Gaia is a satellite, an exceptionally complex space observatory acting at a distance of around 1.5 million kilometres from the Earth in order to create a three-dimensional map of one billion stars -approximately 1% of all the stars in the Milky Way-, so that astronomers from around the world can understand the origin, structure and evolution of our galaxy.

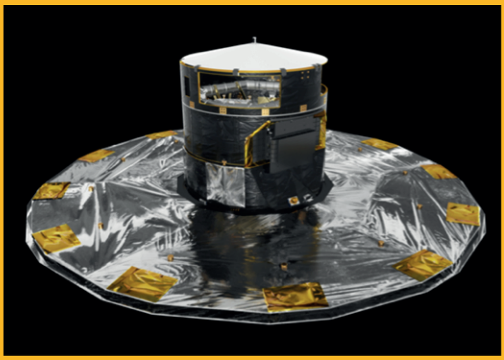
On its orbit around the Sun, Gaia will cover different parts of the sky and over its 5-year Mission the satellite will observe and measure each star an average of 70 times, determining with extraordinary accuracy its position and distance; temperature, composition and mass; and, most importantly, movement. It is also expected to identify the characteristics of over 2,000 asteroids in our Solar System, as well as bodies and phenomena in other galaxies.

Participants and project phases

The Gaia satellite is a pan-European project with over 400 scientific experts and software developers from 24 countries. Construction alone cost €740 million, financed by the European Space Agency (ESA). End responsibility for the Mission lies with the ESA, while the scientists who will create the Gaia Catalogue are responsible for the data.

The Gaia project, approved by the ESA in 2001, is primarily managed by the Governing Body (comprising ESA and scientist representatives), the Scientific Team (research representatives), the Executive Office (coordination unit) and the Data Processing and Analysis Centre (DPAC, responsible for data management).

Gaia comprises various phases: Feasibility studies (2002-2003); Detailed design (2004-2006); Construction (2006-2013); Satellite launched on 19/12/2013 by a Soyuz-STB from the European Spaceport in French Guiana; Scientific operations (2014-2018) and Data analysis and Gaia Catalogue preparation (2014-2022).



GAIA spacecraft

First Soyuz rocket launched from the CSG

Final verification of one of the Gaia primary mirrors

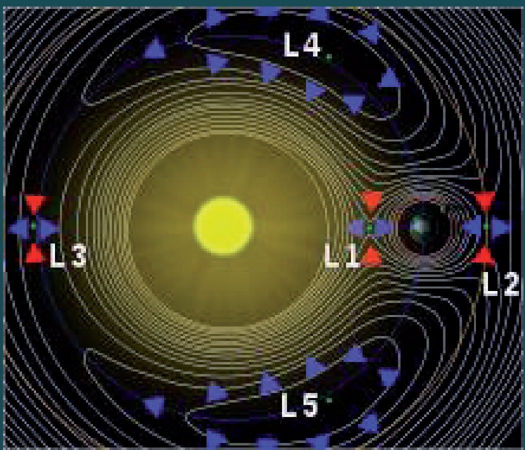
Challenges and significant Spanish participation

Gaia's greatest challenge is the transmission, management, storage and filtering of the prodigious quantity of information produced. Each day, the satellite generates and sends a 50 gigabyte data file to Earth; it is received from three antenna located in New Norcia (Australia), Cebreros (Ávila) and Malagüe (Argentina), while scientific operations are conducted at the European Space Astronomy Centre (ESAC), in Villafranca del Castillo (Madrid). By the end of the Mission this will generate 1 petabyte of data, equivalent to 200,000 DVDs.

In addition to the above duties, Spain is jointly responsible for two of the project's nine working units: simulations and creating the public data archive. These tasks are undertaken by the team from the University of Barcelona (UB), formed by engineers and scientists from the Institute Cosmos Sciences (ICCUB), the Institute of Space Studies of Catalonia (IEEC) and the Astronomy and Meteorology department. This team, a part of the Mission from the outset, has contributed to defining some of the satellite's instrumental elements and the software for processing and updating data. The UB has received the valuable collaboration of the Consortium of University Services of Catalonia (CSUC) and the Barcelona Supercomputing Centre (BSC).

Other Spanish participants include the University of A Coruña and the Laboratory for Space Astrophysics and Fundamental Physics (LAEFF) -which depends on the National Institute of Aerospace Technology (INTA)-, plus a series of aeronautical companies.

In this complex, far-reaching project, the participation of the Spanish Academic and Scientific Network RedIRIS is essential; it provides its fibre optic core network infrastructure, interconnected to the GÉANT pan-European academic network, which allows the global transmission of all information generated by the project with maximum quality and security guarantees. RedIRIS offers its powerful infrastructure to the ESAC cost-free, with 10 Gbps redundant connections to RedIRIS, and the other Spanish academic and scientific bodies involved in this project also have very high speed connections to RedIRIS.



Potential balance points between the Earth and the Sun deduced by Lagrange

Greek astronomer Hipparchus (190-120 BC) created the first Catalogue of stars, identifying 850. Much later, before the invention of the telescope, the great Danish astronomer Tycho Brahe (1546-1601) developed the Tycho Catalogue with a census of one thousand stars. Several centuries later, in 1989, the ESA launched the Hipparcos (HIgh Precision PARAllax COllecting Satellite) into space, the first satellite dedicated to astrometry. This lead to the Hipparcos Catalogue (1997), a list with almost 120,000 stars and more accurate data than any previous measure. In 2022, the Gaia Catalogue will contain detailed information on one billion stars.

The Gaia satellite is orbiting 1.5 million kilometres from the Earth in the opposite direction of the Sun, exactly at the Lagrange L2 point, which is named in honour of its discoverer Joseph Louis Lagrange (1736-1813). At L2, the gravitational forces of the Sun, the Earth and Moon are aligned, making it possible for the satellite to observe the full celestial sphere without interruption, while it will take a year to travel around the Sun, similar to the Earth.

Gaia instruments

The Gaia satellite comprises two 3.5 m telescopes that operate jointly in space, and 10 mirrors that direct light towards three detection instruments: the astrometer (the main instrument), which can calculate the positions and movements of stars; the photometer, which provides information on the star's brightness and colour (to determine its intrinsic characteristics); and the spectrometer, which provides three-dimensional measurements of the stars. Measurements are so accurate that they can identify a shirt button on the moon thanks to the enormous focal plane, with one billion pixels!

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