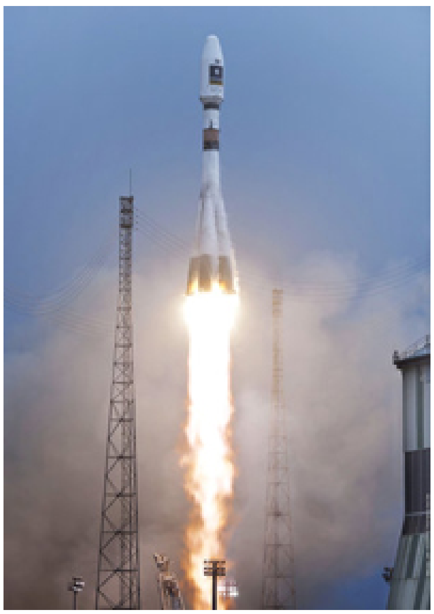
Gaia on a mission to map billions of stars in the Milky Way

December 16 2013, by Erik Høg



Gaia is scheduled for launch on the 19th of December with a Soyuz rocket from Arianespace in French Guyana in South America. Credit: ESA

On the 19th of December, the Gaia satellite will be launched and it will make the most precise measurements of the billions of stars in the Milky Way to date. Gaia is an astronomical satellite that measures the positions, distances and movement of stars. Behind the European ESA project is the Danish astronomer from the Niels Bohr Institute, Erik Høg, who has played a key role in developing the design of the new satellite, which will be a million times more efficient than its predecessor, the Hipparcos satellite.

Astrometry is the branch of astronomy that measures the positions of stars and the distances to them. By following them over time, you can also determine their movements in the galaxy. Astrometry is 'surveying' the sky like mapping a landscape.

Even using the most accurate telescopes on Earth, measurements of stellar positions are unreliable due to turbulence that arises when light has passed through the atmosphere. For this reason, the European Space Agency, ESA, sent up the first astrometric satellite, Hipparcos, in 1989. This satellite was designed to measure stellar positions more accurately than had previously been done. Erik Høg was involved with inventing and designing the satellite Hipparcos. The observations exceeded all expectations, both in terms of accuracy of measurements and the number of stars measured. The results were a catalogue of 2.5 million stars to be used for astronomical observations and for controlling the movement of satellites.

Plans for a new satellite

But even then he had an idea for a new astrometric satellite. "In 1992, I proposed a new astrometric satellite Roemer (after the famous Danish astronomer Ole Rømer) as the successor to Hipparcos, which was then in the middle of the mission. This proposal started the work on Gaia, even though everyone else was fully occupied with the analysis of data from Hipparcos," explains Erik Høg.

The reason that Hipparcos was a success was that there were many in Europe who had experience with astrometry and had good ideas. Something similar could not be found anywhere else in the world. Attempts were made in the USSR, USA and Japan, but were short-lived, there was not a big enough scientific and economic basis. A satellite mission is very expensive. The cost of Hipparcos and Gaia is about the same as the Farø Bridges and the Sydney Opera House, and can only be managed by the ESA's scientific budget for a large mission.

Gaia in roundabout way

Gaia weighs 2,100 kg, it is 3.5 meter high and has a diameter of 10 meters. The instruments are placed on a hexagonal optical bench. At the bottom are solar panels that supply the satellite with 2,000 watts of power. Credit: ESA

But the road to Gaia was long and tortuous. The mission was named GAIA (Global Astrometric Interferometer for Astrophysics), where the 'I' stands for interferometry because ESA proposed the use of interferometric techniques in 1993. This means that the light from the stars is picked by two telescopes, whose light is brought to interference, causing streaks in the image of each star, which you then measure the position of.

ESA had chosen interferometry from space as a cornerstone in the concept for a new satellite, but after several years of careful study, it was found that technique was not suitable for astrometry. The optical and mechanical components had to be held in place with such great accuracy that had never been tried before and there was not enough room in the satellite for the special telescopes, so you get less light in and thus lose astrometric accuracy.

Back to the Roemer concept

In 1998, ESA and the GAIA study group rejected interferometry and returned to another system with direct measurement of the stars on the CCDs. They actually returned to Erik Høg's proposal for a 'big Roemer'.

A 'big Roemer' is simply a satellite with large mirrors instead of the small mirrors in Erik Høg's first proposal from 1992.

"Because it was obvious that you could achieve the desired accuracy just by having a larger opening of the telescopes. That is why in 1994 I proposed a 'large Roemer' with mirrors that were 70 cm in diameter. Then more light is gathered and this gives greater accuracy. So the satellite was actually a 'big Roemer', but the name GAIA stuck," explains Erik Høg, who is now emeritus, but worked on the project until 2007.

Gaia was developed by the European consortium Astrium in collaboration with ESA's team and the Gaia Science Team. The position of the stars is measured on-dimensionally along a large circle. Each star is measured approx. 70 times over a few years and when the measurements are combined you can calculate both the position of the star in the sky and the movement of the star, including its distance. It was a Swedish astronomer, Lennart Lindegren, who developed the mathematical calculation method for Hipparcos in 1976 and he has also led this task for Gaia.

The sky mapped efficiently

Gaia will be a million times more efficient than Hipparcos. This is because the mirrors in Gaia are much larger and because Gaia measures by detectors that utilize light ten times better and furthermore because it measures thousands of stars simultaneously, while Hipparcos measured only one star at a time. Gaia measures with 106 CCD chips each with 10 million pixels. The amount of data will be enormous and more than 400 people in 20 countries will be working with the very complicated calculations. The mission is scheduled to last for five years but may be extended by 1-2 years.

The results will by used in cosmology and astronomy to map the entire sky with billions of stars in our galaxy, the Milky Way and nearby galaxies, locate quasars, binary stars, stars with planetary systems and interstellar clouds. They will determine stellar distances and movements and map the distribution of dark matter in our galaxy. It is expected that the first results will be published in 2015 based on more than a year of observations.

Provided by University of Copenhagen

Citation: Gaia on a mission to map billions of stars in the Milky Way (2013, December 16) retrieved 20 April 2024 from
https://phys.org/news/2013-12-gaia-mission-billions-stars-milky.html