One year and 272 billion measurements later, Gaia team celebrates first anniversary of observations

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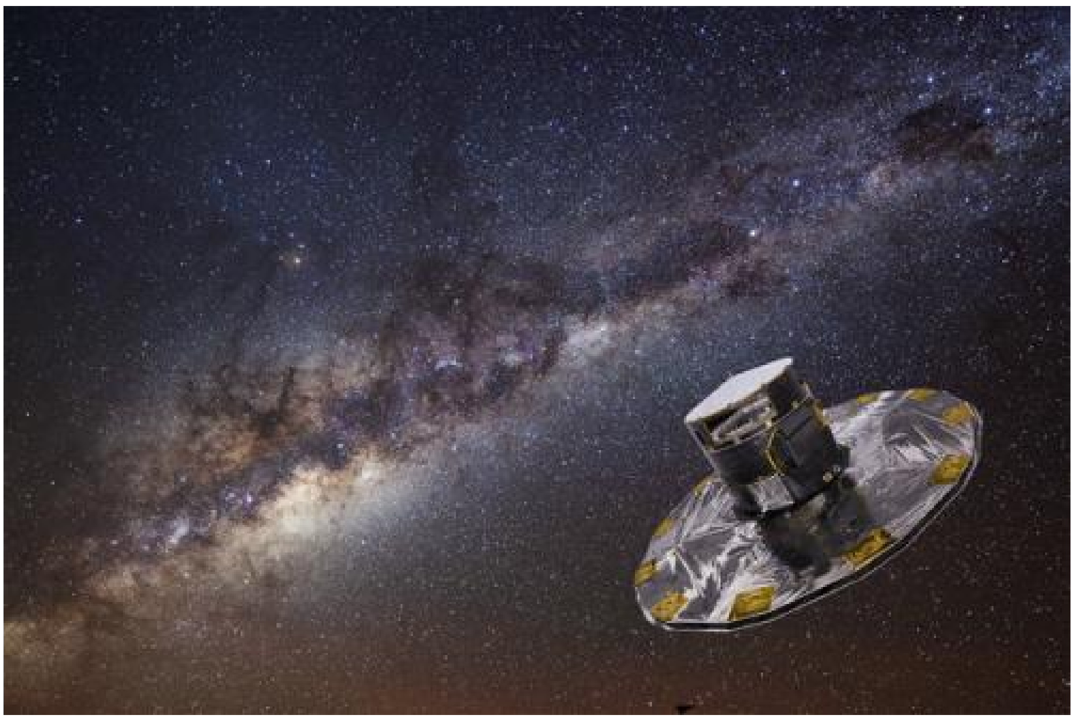

Gaia mapping the stars of the milky way. Credit: ESA/ATG medialab; background: ESO/S. Brunier

A space mission to create the largest, most-accurate, three-dimensional map of the Milky Way is celebrating its first completed year of observations.

The Gaia satellite, which orbits the sun at a distance of 1.5million km from the earth, was launched by the European Space Agency in December 2013 with the aim of observing a billion stars and revolutionising our understanding of the Milky Way.

The unique mission is reliant on the work of Cambridge researchers who collect the vast quantities of data transmitted by Gaia to a data processing centre at the university, overseen by a team at the Institute of Astronomy.

Since the start of its observations in August 2014, Gaia has recorded 272 billion positional (or astrometric) measurements and 54.4 billion brightness (or photometric) data points.

Gaia surveys stars and many other astronomical objects as it spins, observing circular swathes of the sky. By repeatedly measuring the positions of the stars with extraordinary accuracy, Gaia can tease out their distances and motions throughout the Milky Way galaxy.

Dr Francesca de Angeli, lead scientist at the Cambridge data centre, said: "The huge Gaia photometric data flow is being processed successfully into scientific information at our processing centre and has already led to many exciting discoveries."

The Gaia team have spent a busy year processing and analysing data, with the aim of developing enormous public catalogues of the positions, distances, motions and other properties of more than a billion stars. Because of the immense volumes of data and their complex nature, this requires a huge effort from expert scientists and software developers distributed across Europe, combined in Gaia's Data Processing and Analysis Consortium (DPAC).

"The past twelve months have been very intense, but we are getting to grips with the data, and are looking forward to the next four years of operations," said Timo Prusti, Gaia project scientist at ESA.

"We are just a year away from Gaia's first scheduled data release, an intermediate catalogue planned for the summer of 2016. With the first year of data in our hands, we are now halfway to this milestone, and we're able to present a few preliminary snapshots to show that the spacecraft is working well and that the data processing is on the right track."

As Gaia has been conducting its repeated scans of the sky to measure the motions of stars, it has also been able to detect whether any of them have changed their brightness, and in doing so, has started to discover some very interesting astronomical objects.

Gaia has detected hundreds of transient sources so far, with a supernova being the very first on August 30, 2014. These detections are routinely shared with the community at large as soon as they are spotted in the form of 'Science Alerts', enabling rapid follow-up observations to be made using ground-based telescopes in order to determine their nature.

One transient source was seen undergoing a sudden and dramatic outburst that increased its brightness by a factor of five. It turned out that Gaia had discovered a so-called 'cataclysmic variable', a system of two stars in which one, a hot white dwarf, is devouring mass from a normal stellar companion, leading to outbursts of light as the material is swallowed. The system also turned out to be an eclipsing binary, in which the relatively larger normal star passes directly in front of the smaller, but brighter white dwarf, periodically obscuring the latter from view as seen from Earth.

Unusually, both stars in this system seem to have plenty of helium and little hydrogen. Gaia's discovery data and follow-up observations may help astronomers to understand how the two stars lost their hydrogen.

Gaia has also discovered a multitude of stars whose brightness undergoes more regular changes over time. Many of these discoveries were made between July and August 2014, as Gaia performed many subsequent observations of a few patches of the sky.

Closer to home, Gaia has detected a wealth of asteroids, the small rocky bodies that populate our solar system, mainly between the orbits of Mars and Jupiter. Because they are relatively nearby and orbiting the Sun, asteroids appear to move against the stars in astronomical images, appearing in one snapshot of a given field, but not in images of the same field taken at later times.

Gaia scientists have developed special software to look for these 'outliers', matching them with the orbits of known asteroids in order to remove them from the data being used to study stars. But in turn, this information will be used to characterise known asteroids and to discover thousands of new ones.

Gerry Gilmour, Professor of Experimental Philosophy, and the Gaia UK Principal Investigator, said: "The early science from Gaia is already supporting major education activity involving UK school children and amateur astronomers across Europe and has established the huge discovery potential of Gaia's data.

"We are entering a new era of big-data astrophysics, with a revolution in our knowledge of what we see in the sky. We are moving beyond just seeing to knowing about the galaxy in which we live."

Provided by University of Cambridge