SPACE

Billion-star map set to transform astronomy

European Gaia mission releases most detailed 3D chart yet of Milky Way.

BY DAVIDE CASTELVECCHI

After a feverish wait, astronomers around the world have an ocean of new information to explore. On 25 April, the European Space Agency's (ESA) Gaia mission published its first fully 3D map of the Milky Way.

The data haul includes the positions of nearly 1.7 billion stars, and the distances, colours, velocities and directions of motion of about 1.3 billion of them. Together, they form an unprecedented live video of the sky, covering a volume of space 1,000 times larger than that captured by any previous survey (see 'Gaia's gold'). "In my professional opinion, this is crazy awesome," says Megan Bedell of the Center for Computational Astrophysics in New York City, one of the many astronomers who are already conducting studies based on the data set. "We're very curious to see what the community will do with it," says Anthony Brown, an astronomer at the Leiden Observatory in the Netherlands who chairs Gaia's data-processing collaboration.

At an event at the Royal Astronomical Society in London to present the Gaia catalogue, astronomer Gerry Gilmore of the University of Cambridge, UK, showed a striking video that extrapolated from the Gaia data to simulate the future motions of millions of stars. "Everything moves," he said.

The 2-tonne Gaia spacecraft, part of a €1-billion (US$1.2-billion) mission, launched in late 2013 and began collecting scientific data in July 2014. Gaia is in a stable orbit that remains fixed relative to both the Sun and Earth, and makes repeated measurements to estimate the distances to stars — and other celestial objects — using a technique called parallax.

Alongside its 551-gigabyte database, the Gaia team also released a number of scientific papers. The goal of these was to describe quality checks the researchers did on the data and demonstrate how those data can be used; the mission's policy is to make the catalogue immediately available to the community, rather than to reserve it for the team's own science studies first.

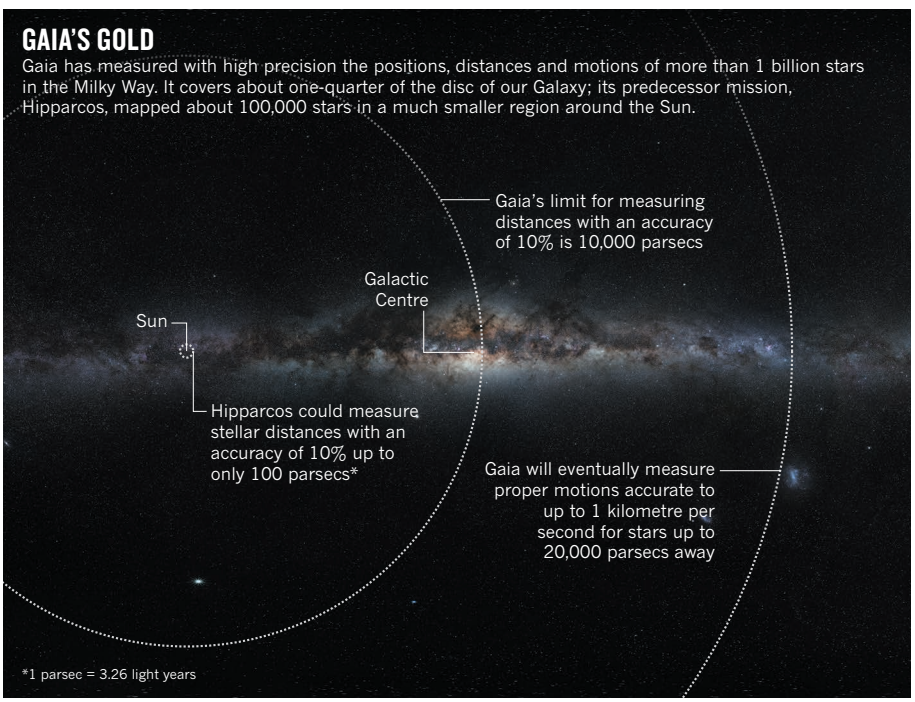
Still, the Gaia papers describe a wealth of original findings, said Floor van Leeuwen, another senior Gaia scientist at Cambridge, at the press briefing. He showed, for example, how Gaia proved for the first time that certain star clusters puff up at the same time as large stars sink to their centres. "We weren't allowed to make discoveries, but we couldn't avoid making them," he said.

One of those findings has implications far beyond the Milky Way. Some astronomers are eager to see Gaia's measurements of certain types of variable star that are used as 'standard candles' of cosmology. Knowing the precise distances to these stars in the Milky Way makes them useful as yardsticks for measuring distances to galaxies much farther away. In particular, astronomers use standard candles to estimate how fast the Universe is expanding, but in recent years, measurements based on this technique have been in apparent contradiction with predictions made using maps of the cosmic microwave background, the afterglow of the Big Bang. A preliminary look at the data shows that Gaia has improved the precision of the standard-candle measurements, Gilmore said at the press briefing. But, he adds, "at face value, the tension is still there".

Dozens of preprints appeared in the days that followed, as teams around the world downloaded Gaia data and ran them through algorithms honed for years in preparation. For example, researchers are now able to test models of how the Milky Way formed through mergers of smaller galaxies and measure the distribution of dark matter.

Gaia released a preliminary catalogue in 2016, but at that time, it had not yet gathered enough data to directly measure the distances to many stars. Further data releases will contain more information and will enable entirely new kinds of studies; the next release will be in 2020. The probe also monitors asteroids and will help scientists to track bodies that look to be on a collision trajectory with Earth.

Gaia has enough fuel to keep operating until 2024, if nothing breaks down and ESA extends the mission beyond its current 2019 end date, says project scientist Timo Prusti at ESA's space-research and technology centre in Noordwijk, the Netherlands. The probe is in overall good health, he says. ■



CORRECTION

The News Feature 'The cells that sparked a revolution' (*Nature* **555**, 428–430; 2018) incorrectly stated that ViaCyte had restarted a 2014 clinical trial after redesigning its encapsulation technology. It had in fact paused enrolment on one trial and started another.