New GAIA data reveals mergers in Milky Way

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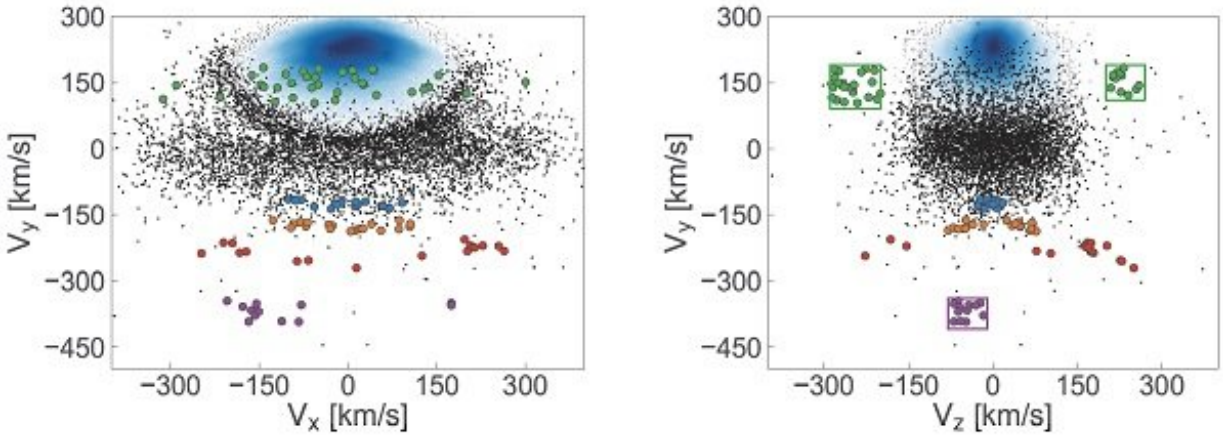

Left panel: different starstreams (coloured dots), the Milky Way disk (blue) and in black the rest of the halo stars, in which the horizontal cigar-shaped blob is visible. Right panel: same data, now seen form a 90 degree rotated angle. Credit: Koppelman et al.

University of Groningen astronomers have discovered relics of merger events in the Milky Way halo. Five small groups of stars appear to represent mergers with smaller galaxies, while a big 'blob' comprising hundreds of stars appears to be the remnant of a large merger event. These results were published in the *Astrophysical Journal Letters* on 12 June.

The study is based on the recent Gaia Data Release 2. This provided the astronomical community with accurate information on the position and movement of millions of stars, mostly in the Milky Way. Ph.D. student Helmer Koppelman is part of the research group of Amina Helmi, professor of dynamics, structure and formation of the Milky Way, who has been involved in the Gaia mission almost from its inception. He started analyzing the data right after the release and published a preprint of the article just eight days later. This has now been officially published.

Halo

"Our aim is to study how the Milky Way has evolved," says Koppelman. The idea is that smaller galaxies merge to form larger ones. "One of the questions is whether a lot of small galaxies merge, or a few large ones." As most stars in the Milky Way's halo—the spherical cloud of stars surrounding the main disk and bulge of our galaxy—are thought to be remnants of merger events, Koppelman and his colleagues focused on halo stars in the Gaia data.

"We collected information from stars within 3,000 light years of the sun, as the accuracy of the position and movement is highest for stars that are near us," Koppelman explains. The first step was to filter out the stars from the Milky Way disk. "These stars move around the centre of the disk, so are easily identified." What remained were about 6,000 halo stars.

Blob

By calculating their trajectory, Koppelman was able to identify stars with a shared origin. "We discovered five small clusters which we believe are remnants of five merger events." However, many of the remaining stars

also appeared to have a shared history. "These stars form a huge "blob" with a retrograde movement compared to the disk. This suggests they are the result of a merger with a large galaxy. In fact, we believe that this merger event must have remodelled the disk in our Milky Way." A more detailed study of the nature of this merger is now underway. "At this point in time, we can say that our Milky Way was shaped by a massive merger event and some smaller mergers."

Koppelman also looked for stars belonging to the "Helmi stream," which is named after his Ph.D. supervisor who identified it back in 1999 as the remnant of a merger event. "Up to now, fewer than 20 stars belonging to the Helmi stream had been identified. The Gaia data has added over 100 new stars." Further analysis should clarify the nature of the galaxy that produced this stream. "We will also be looking at stars beyond 3,000 light-years to discover more members of the different streams we identified. Together with simulations of galaxy evolution, this should give us exciting new insights into the evolution of the Milky Way."

More information: Helmer Koppelman et al. One Large Blob and Many Streams Frosting the nearby Stellar Halo in Gaia DR2, *The Astrophysical Journal* (2018). DOI: 10.3847/2041-8213/aac882

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