Students map Milky Way with dwarf stars

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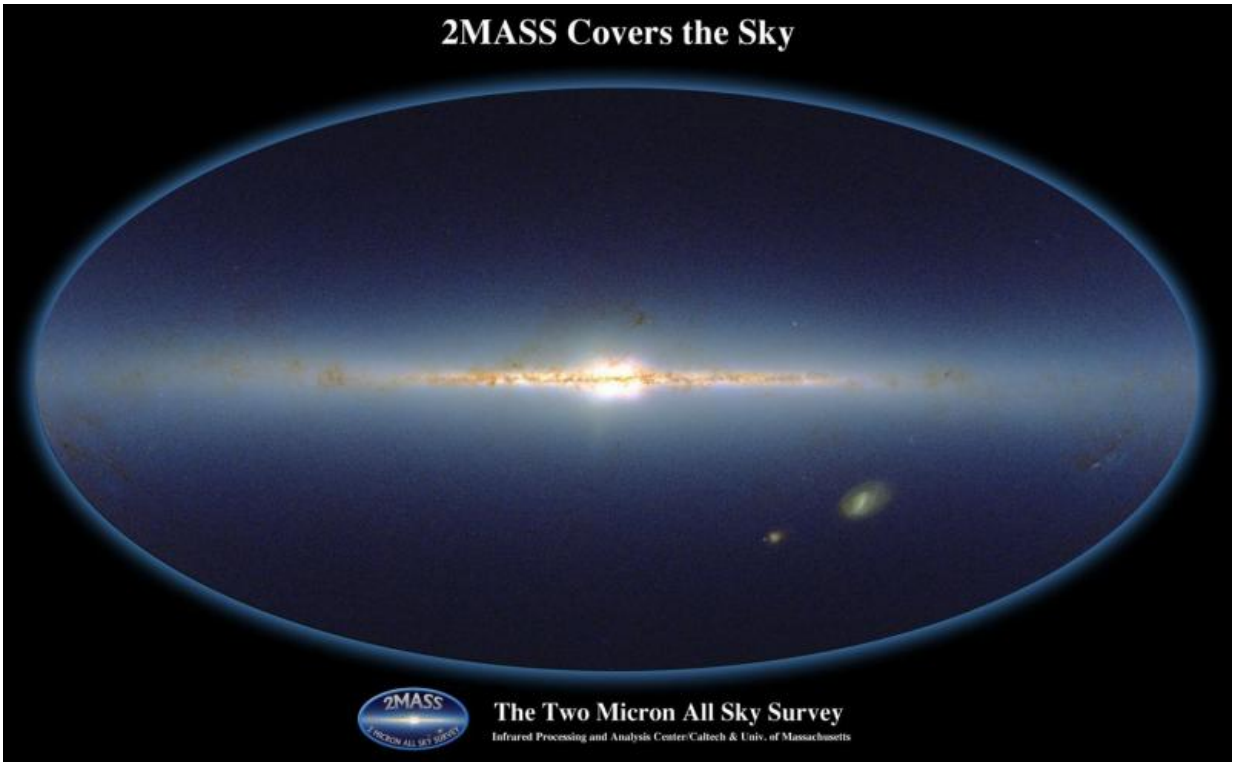


The Milky Way in the 2MASS infrared survey, similar to Hubble observations of the sky colour (near-infrared). Here, the visible stars are mostly bright giant stars. Credit: The Infrared Processing and Analysis Center (IPAC)

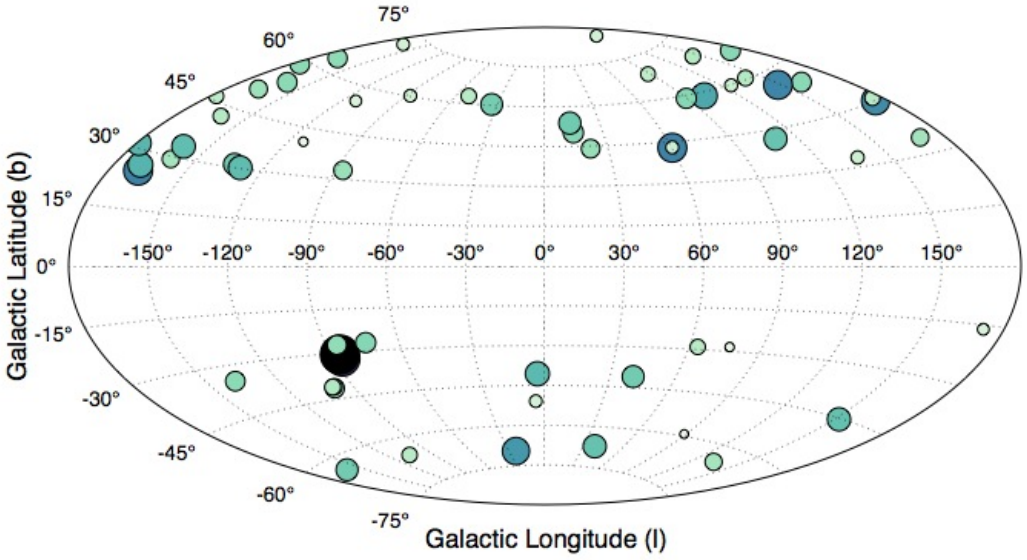
Two astronomy students from Leiden University have mapped the entire Milky Way Galaxy in dwarf stars for the first time. They show that there are a total of 58 billion dwarf stars, of which seven per cent reside in the outer regions of our Galaxy. This result is the most comprehensive

model ever for the distribution of these stars. The findings appear in a new paper in *Monthly Notices of the Royal Astronomical Society*.

The Milky Way, the galaxy we live in, consists of a prominent, relatively flat disc with closely spaced bright stars, and a halo, a sphere of stars with a much lower density around it. Astronomers assume that the halo is the remnant of the first galaxies that fused together to form our Galaxy.

To find out exactly what the Milky Way looks like, astronomers have previously made maps using counts of the stars in the night sky. Leiden Astronomy students Isabel van Vledder and Dieuwertje van der Vlugt used the same technique in their research. Rather than studying bright stars, the two students used Hubble Space Telescope data from 274 dwarf stars, which were serendipitously observed by the orbiting observatory while it was looking for the most distant galaxies in the early Universe. The particular type of star they looked at were red dwarfs of spectral class M.

Dwarf stars are undersized and often have too low a mass to burn hydrogen. As warm, rather than hot objects, they are best viewed with near-infrared cameras. Van Vledder comments: "Astronomers believe that there are very many of these stars. That makes them really quite suitable for mapping the Galaxy even though they are so hard to find."



Fields observed by the Hubble Space Telescope where M-dwarf stars have been found, plotted on a map of the sky with galactic longitude and latitude. In each field, indicated by circles, only a few dwarf stars are identified. However, by combining them, the students could derive an accurate model of the Galaxy. Credit: Leiden Observatory

To find the distribution of the M dwarfs, Van Vledder and Van der Vlugt used three density models that astronomers use to describe the flat disc and halo, both separately and combined. To calculate which model best describes the structure of the Milky Way; the students then applied the Markov Chain Monte Carlo method. Van der Vlugt describes how this works: "You let a computer program test all possible values of each parameter of your model. It then fixes the value which corresponds best with the data."

The model that includes both disk and halo was the perfect match. From the positions of the 274 M dwarfs in their sample, van Vledder and van der Vlugt inferred the existence of 58 billion dwarf stars. They were also

able to accurately estimate the number of dwarfs in the halo, calculating a fraction of 7 per cent, higher than astronomers have previously found for the whole Milky Way.

The results of the students are important for future research with the European Space Agency's Euclid Space Telescope, due for launch in 2020. Like Hubble, Euclid will image the whole sky in near-infrared. Van Vledder adds: "With our research, astronomers can now better assess whether they are dealing with a distant galaxy or a star in our own Galaxy." The students expect Euclid observations to yield an even more accurate picture of the Milky Way.

Van der Vlugt and van Vledder did the research for their bachelor's degree in Astronomy at Leiden University. They worked together with Leiden astronomers Benne Holwerda, Matthew Kenworthy and Rychard Bouwens.

More information: Isabel van Vledder et al. The Size and Shape of the Milky Way Disk and Halo from M-type Brown Dwarfs in the BoRG Survey, *Monthly Notices of the Royal Astronomical Society* (2016). DOI: 10.1093/mnras/stw258

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