Weighing Our Solar Neighborhood

Measuring the acceleration of stellar remnants called pulsars helps researchers map how mass is distributed in our region of the Galaxy.

By **Ryan Wilkinson**

For more than a century, researchers have tried to determine the distribution of mass in the Milky Way. The usual strategy has been to infer the mass distribution from the gravitational acceleration of stars and gas. But that approach usually depends on unrealistic assumptions about the Galaxy, such as that it is in dynamical equilibrium or that it is roughly symmetric around its center. Now Thomas Donlon at the University of Alabama in Huntsville and his colleagues have demonstrated a method that bypasses these assumptions [1].

The researchers' key insight was to use acceleration measurements not of stars and gas but of rapidly rotating neutron stars known as pulsars. Whereas the former measurements can typically be made only indirectly, calling for the Galactic assumptions, the latter ones can be made directly. The team introduced a general procedure for transforming such direct pulsar-acceleration data into a determination of the Galaxy's mass distribution in a very small local region—within just 2 kiloparsecs of the Sun.

Credit: NASA; ESA; Z. Levay/AURA STScI

Donlon and his colleagues applied their technique to the available pulsar-acceleration data, encompassing about 50 pulsars. Their inferred mass distribution was consistent with that of previous analyses. They then combined that distribution with a model for the distribution of visible matter to infer the density of dark matter as a function of distance from the Sun. The result tentatively suggests that dark matter may not be distributed evenly above and below the Galactic disk. However, the team points out that more pulsar data are needed to verify that finding.

Ryan Wilkinson is a Corresponding Editor for *Physics Magazine* based in Durham, UK.

REFERENCES

1. T. Donlon, II *et al.*, "Mean mass density near the Sun from the divergence theorem and pulsar accelerations," **Phys. Rev. D 113, 063033 (2026).**