Distance measurement of a microlensing event

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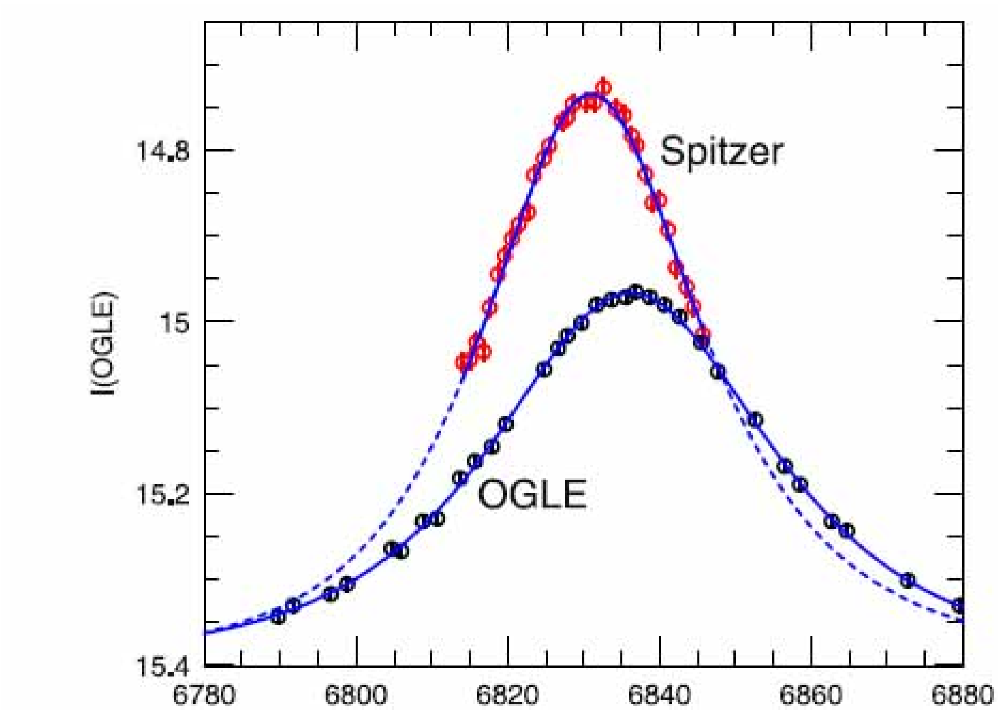

A plot of light intensity (vertical scale in arbitrary units) versus time (horizontal scale in days) for a microlensing event. It shows the changing intensity of light of a very distant background star when it was obstructed by a small, unseen star about ten thousand light-years away that happened to pass across our line-of-sight so that its gravitational field, acting like a lens, then dramatically brightened the star's light. Astronomers watched this event happen from two widely separated locations, the Spitzer Space Telescope and the "OGLE" ground-based observatory. The differences between the two datasets allow for estimates to be made of the dark star's distance and mass. Credit: Spitzer/IRAC; Yee et al.

The distance to celestial objects is key to calculating their intrinsic properties like mass and luminosity. Distance, unfortunately, is also one of the most difficult parameters to measure. The most direct method is called parallax: When a celestial body is viewed from different, widely separated vantage points, its angular position with respect to background stars appears different. Parallax is traditionally used to triangulate the distances to nearby stars by measuring their apparent angles six months apart, at the two opposite sides of the Earth's orbit around the Sun.

Astronomers would like to know the distribution of dark (i.e., unseen) objects in the galaxy, for example free-floating planets or small, dim stars, in order to complete an accurate census of the galaxy. The principle method of detecting these dark objects is through microlensing: the short flash of light produced when the object's gravitational field, acting like a lens (hence the name), changes the intensity of visible light from a more distant, background star when the unseen body happens to pass in front of it. About thirty years ago, scientists predicted that if it ever became possible to observe a microlensing flash from two well-separated vantage points, a parallax measurement would pin down the distance of the dark object.

The Spitzer Space Telescope is currently orbiting the Sun at the distance of the Earth, but trailing the Earth at a location about one-sixth of the way around in its orbital path. CfA astronomer Jennifer Yee led a team of colleagues in a program of parallax microlensing measurements using both Spitzer and ground-based telescopes. When the team got a warning of an imminent flash from ground-based monitors that watch for brightening effects, they quickly arranged to obtain coordinated observations. The flash they measured not only appeared at slightly different times from the two locations, but also had different brightening profiles. The results enabled the scientists to obtain the mass of the dark object, 0.23(+-0.07) solar-masses, as well as its distance, 10,200 (+-1300) light-years. Although Spitzer has previously been used to study microlensing events, this is the first space-based microlens parallax measurement of an isolated star, and demonstrates that this method of probing this dark component of the galaxy is likely to become a very productive one.

More information: "First Space-Based Microlens Parallax Measurement of an Isolated Star: Spitzer Observations of OGLE-2014-BLG-0939," ApJ 802, 76, 2015. arxiv.org/abs/1410.5429

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