Planetary nebula Abell 30 has a binary central star, study suggests

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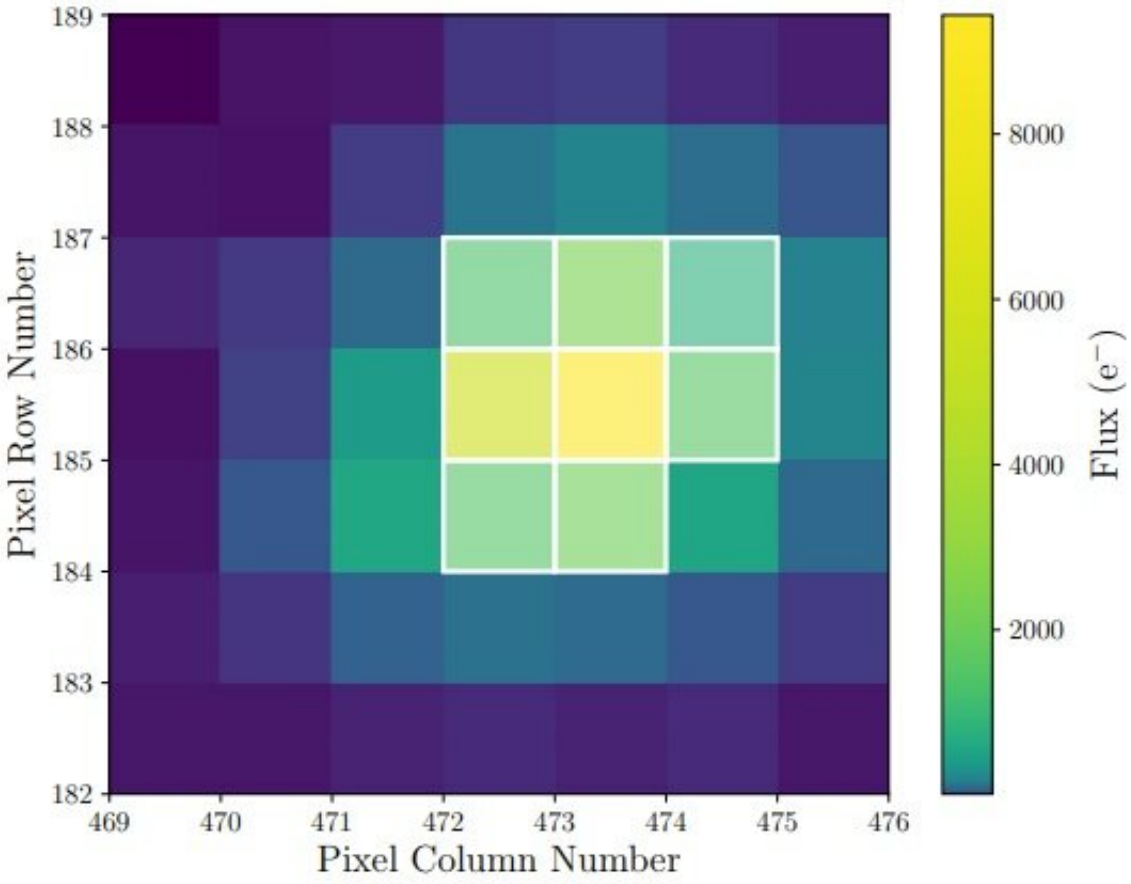

The average K2 target pixel file of the central star of Abell 30 with the pixels included in the photometry aperture outlined in white. Credit: Jacoby et al., 2020.

Using data from NASA's Kepler spacecraft, astronomers have explored a planetary nebula (PN) known as Abell 30. Results of the study suggest that the central star of this nebula is a binary system, which could have implications for our understanding of PN population in general. The finding is detailed in a paper published August 4 on arXiv.org.

Planetary nebulae are expanding shells of gas and dust that have been ejected from a star during the process of its evolution from main sequence star into a red giant or white dwarf. They are relatively rare, but important for astronomers studying the chemical evolution of stars and galaxies.

Of special interest are PNe exhibiting hydrogen-poor material in their central regions. In some cases, the hydrogen-poor material appears as a fan of knots with cometary tails stretched radially from the central star. Detailed investigations of PNe of this type could shed more light on the process of low-mass star evolution.

Abell 30 is the archetype of the so-called "born-again" PNe—identified by low-mass knotty secondary ejecta with nearly no hydrogen. Chemical studies of this PN have shown that it exhibits an extreme abundance discrepancy factor (ADF). One of the theories that may explain such an anomaly is that it is associated with binary star interactions.

However, finding companions to central stars of PNe is challenging for ground-based observatories due to Earth's atmosphere, which limits the performance of these facilities. So a team of astronomers led by George H. Jacoby of the National Optical-Infrared Astronomy Research Laboratory (NOIRLab) in Tucson, Arizona, analyzed the data from Kepler spacecraft's prolonged mission, known as K2, in order to investigate Abell 30 and its central star.

The K2 light curve revealed a strong periodic signal at approximately

1.06 days, with a peak-to-peak-amplitude of about 1.7 percent. The astronomers noted that although such low-amplitude sinusoidal variability could be due to several physical processes, they favor the binary star scenario.

"We report the presence of light curve brightness variations having a period of 1.060 days that are highly suggestive of a binary central star in Abell 30," the researchers concluded.

According to the authors of the paper, Abell 30 has a binary system in which the companion is being irradiated by the hot central star. However, the astronomers were not able to demonstrate a consistent radial velocity variation for the PN, which means that its photometric variability could be also due to a magnetic spot on the central star.

"If a spot is responsible for the observed variability of the central star of Abell 30, then the spot must cover a significant fraction of the stellar surface; otherwise, the brightness would not be changing continuously over the entire period, as seen by the smooth sinusoidal morphology of the light curve," the scientists explained.

They added that further observations, especially high-resolution, time-resolved spectroscopy should be conducted in order to draw final conclusions on the nature of Abell 30's central star.

More information: Jacoby et al., Abell 30—A Binary Central Star Among the Born-Again Planetary Nebulae, arXiv:2008.01488 [astro-ph.SR] arxiv.org/abs/2008.01488

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