Novel method for identifying rings around extrasolar planets

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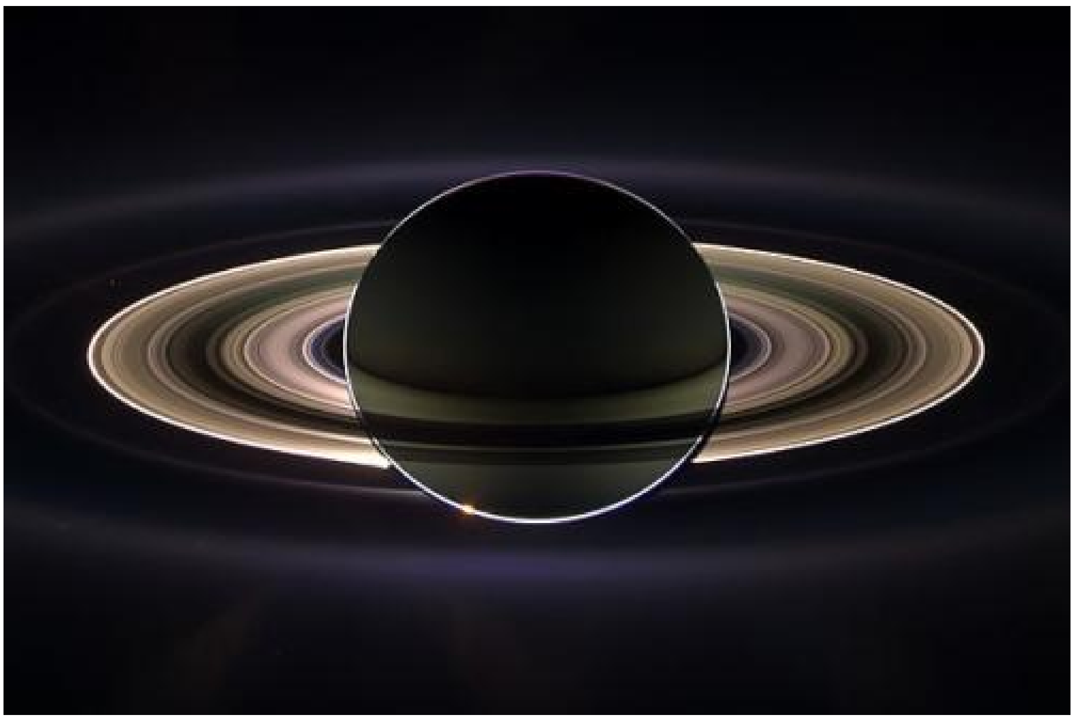


Saturn Eclipsing the Sun as seen from Cassini Spacecraft. Credit: NASA/JPL

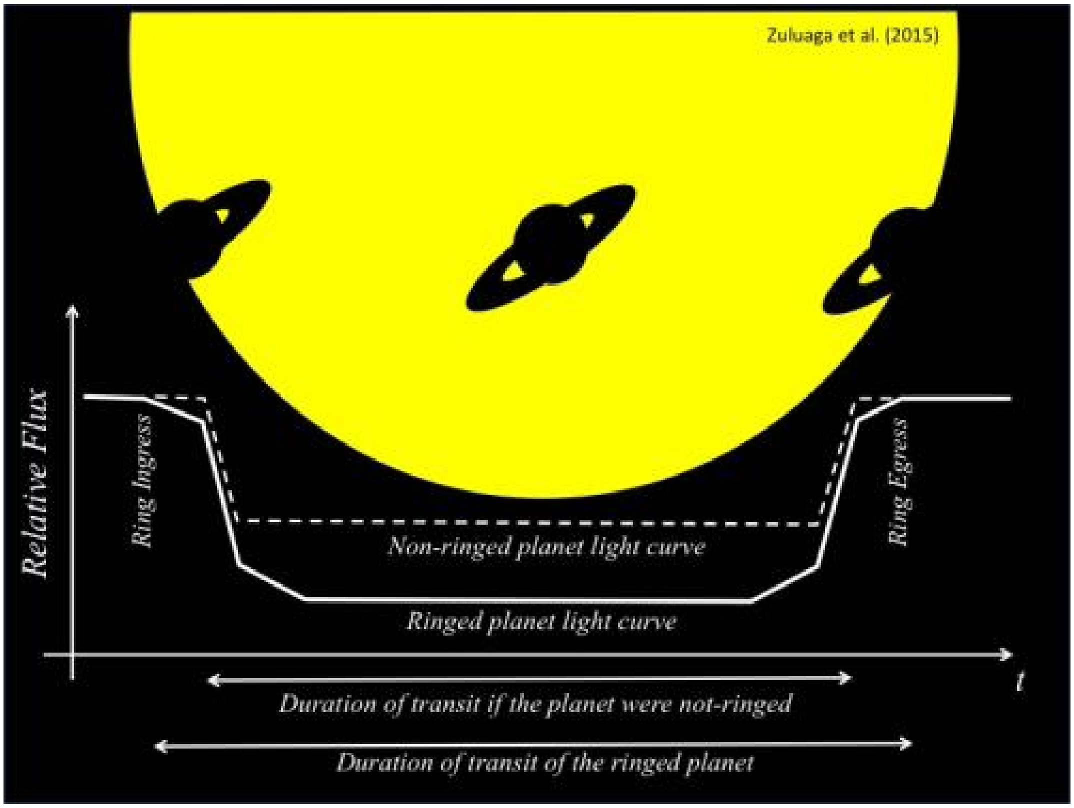
Astronomers from the Harvard-Smithsonian Center for Astrophysics and the University of Antioquia (Medellin-Colombia), have devised a novel method for identifying rings around extrasolar planets (exorings). The method is relatively simple and can be used to rapidly analyze large photometric database and to find a list of exoring candidates deserving further analysis.

Exoplanetary science is one of the most prolific sources of astronomical discoveries since the invention of telescopes. Once you get used to a suprising finding, such as the discovery of an Earth-twin, another exciting discovery beckons, capturing the imagination of scientists and non-scientists. Although we cannot predict the next exoplanetary discovery, several breakthroughs, such as the discovery of the first exomoon or the direct image of an Earth-like planet, have been in the line for years. Exorings are also one of these long-awaited discoveries.

Recently, a group of astronomers lead by Matt Kenworthy of the Leiden Observatory and Erik Mamajek of the Rochester University, announced the discovery of a huge disk orbiting the "Super-Jupiter" J1407b. Beside the initial excitement, the actual nature of the object and its "rings" is still debated. The planet could actually be a brown-dwarf and the rings a version in miniature of a protoplanetary disk.

Rings are common in the Solar System. Jupiter, Saturn, Uranus and Neptune have rings of different sizes. Even smaller objects, such as asteroids and cometary nuclei, could have their own rings. Searching for ringed planets beyond the Solar System is as natural as searching for moons and magnetic fields, two other common phenomena associated with planets.

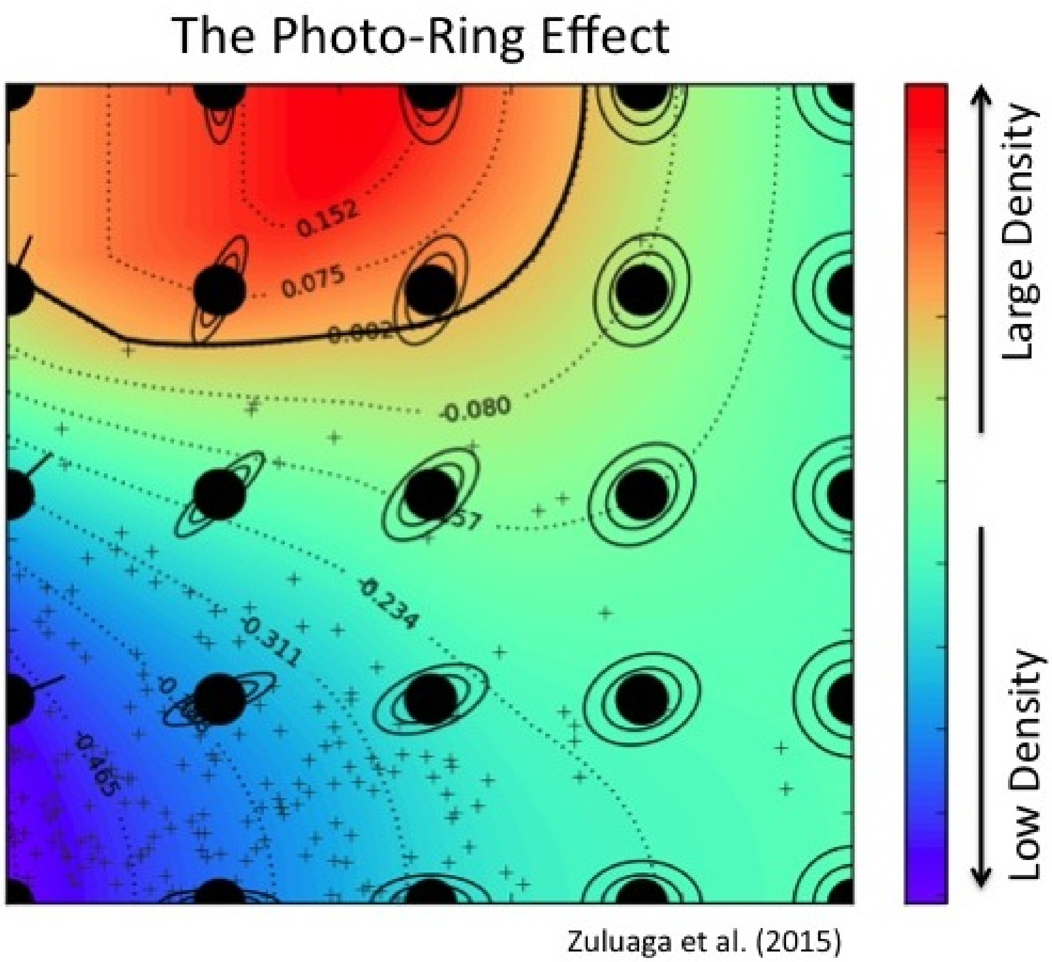
Jorge I. Zuluaga, Associate Professor in the Institute of Physics of the University of Antioquia and Visitor Scholar of the Harvard-Smithsonian Center for Astrophysics (CfA), David Kipping, Menzel Fellow in the CfA and leading expert in exoplanetary research, and two of their dergraduate and undergraduate students, Mario Sucerquia and Jaime Andrés Alvarado, have discovered a fast and novel method for identifying exorings in large photometric databases. The method could pave the way for the discovery of the first exorings in the very near future. Their ideas has been accepted for publication in a forecoming issue of *Astrophysical Journal Letters*.



Schematic representation of the transit of a ringed planet in front of its star. When compared with the light curve of an non-ringed analogue (dashed line) the transit of a ringed planet is deeper (the relative flux diminish by a larger fraction) and longer.

One of the most exciting aspect of the new method is its simplicity: a ringed-planet will produce a "deeper" and longer transit than that produced by a non-ringed twin (see figure).

But, how can a "deeper" and longer transit of a ringed planet be distinguished from the same effect caused by a larger one?. If a Jupiter-sized planet have a ring, Astronomers on Earth, studying the transit of the planet in front of its host star, will think the object is much larger than it actually is. Finding planet much larger than jupiter is not common. Only brown dwarf and small stars are that big. In photometric survey, such as that of the Kepler Space Telescope, objects that appear bigger than expected, are normally tagged as "false positives". According to Zuluaga and Kipping, we should start looking carefully on these false positives. True "ringed jewels" could be hidden among this apparent "trash".



Magnitude of the so-called Photo-ring effect predicted by Zuluaga, Kipping et al., at different projected inclinations and tilts (small "Saturns").

A second idea exploits the so-called "Asterodensity-profiling effect".

Planetary transits have a wealth of information, not only about the planet, but about the star itself. If we combine the transit depth (that depends on the size of the star) and the duration of the transit (that depends on orbital velocity and hence on the stellar mass) we can estimate the density of the star. This transit-based stellar density could be then compared with the density measured independently with another method (asteroseismology for example). If they do not coincide, something is really wrong with our assumptions about the planet or its orbit. Zuluaga, Kipping et al. have demonstrated that the presence of Rings leads to a systematic underestimation of stellar density. This effect is called the "Photo-ring effect".

The identification of rings with this novel method is not enough to claim the discovery and confirmation of an exoring. Once a list of suitable candidates be selected, a battery of powerful and efficient methods must be used to actually confirm the existence of exorings around some of those candidates. Even in that case, the new method has the potential to provide the statistical distribution of exorings properties, well before we discover a significant number of them.

More information: "A novel method for identifying exoplanetary ring", Jorge I. Zuluaga (Harvard-Smithsonian CfA/IF/UdeA), David Kipping (Harvard-Smithsonian CfA), Mario Sucerquia (IF/UdeA), Jaime A. Alvarado (IF/UdeA), *arXiv* e-print: 1502.07818. Accepted for Publication in *Astrophysical Journal Letters*. arxiv.org/abs/1502.07818

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