PRESS RELEASE

Released on May 30th, 2006

Interiors of extrasolar planets: A first step

Based on the article "A correlation between the heavy element content of transiting extrasolar planets and the metallicity of their parent stars", by Guillot et al.

To be published in *Astronomy & Astrophysics*.

This press release is issued as a collaboration with the CNRS and *Astronomy & Astrophysics*.

A team of European astronomers, led by T. Guillot (CNRS, Observatoire de la Côte d'Azur, France), will publish a new study of the physics of Pegasids (also known as hot Jupiters) in *Astronomy & Astrophysics.* They found that the amount of heavy elements in Pegasids is correlated to the metallicity of their parent stars. This is a first step in understanding the physical nature of the extrasolar planets.

Up to now, astronomers have discovered 188 extrasolar planets, among which 10 are known as "transiting planets". These planets pass between their star and us at each orbit (Figure 1). Given the current technical limitations, the only transiting planets that can be detected are giant planets orbiting close to their parent star known as "hot Jupiters" or Pegasids. The ten transiting planets known thus far have masses between 110 and 430 Earth masses (for comparison, Jupiter, with 318 Earth masses, is the most massive planet in our Solar System).

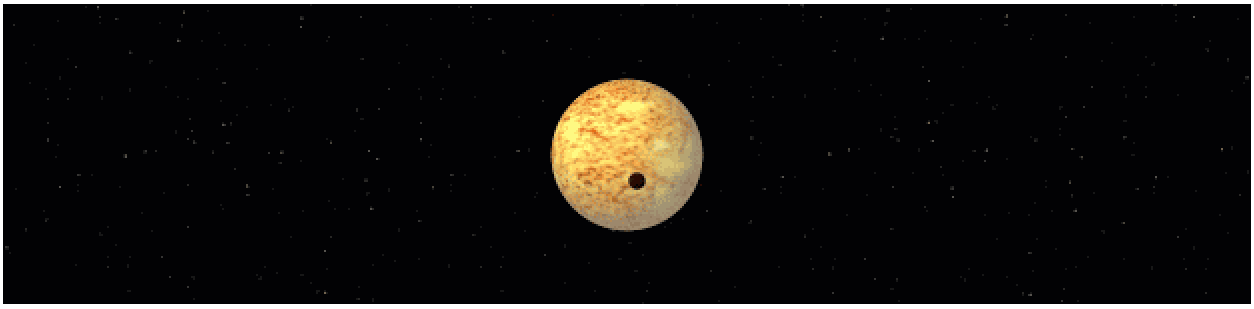

Fig. 1. Animation of a typical Pegasid system, with both the star and planet drawn to scale. Here, the planet orbits the star in just 3.5 days. For comparison, the Earth orbits the Sun every single year, and Mercury, which has the shortest orbital period in the solar system, orbits the Sun every 88 days. The movie file is available in the electronic edition of the press release.

Although rare, transiting planets are the key to understanding planetary formation because they are the only ones for which both the mass and radius can be determined. In principle, the obtained mean density can constrain their global composition. However, translating a mean density into a global composition needs accurate models of the internal structure and evolution of planets. The situation is made difficult by our relatively poor knowledge of the behaviour of matter at high pressures (the pressure in the interiors of giant planets is more than a million times the atmospheric pressure on Earth). Of the nine transiting planets known up to April 2006, only the least massive one could have its global composition determined satisfactorily. It was shown to possess a massive core[1] of heavy elements, about 70 times the mass of the Earth, with a 40 Earth-mass envelope of hydrogen and helium. Of the remaining eight planets, six were found to be mostly made up of hydrogen and helium, like Jupiter and Saturn, but their core mass could not be determined. The last two were found to be too large to be explained by simple models.

Considering them as an ensemble for the first time, and accounting for the anomalously large planets, Tristan Guillot and his team [1] found that the nine transiting planets have homogeneous properties, with a core mass ranging from 0 (no core, or a small one) up to 100 times the mass of the Earth, and a surrounding envelope of hydrogen and helium. Some of the Pegasids should therefore contain larger amounts of heavy elements than expected. When comparing the mass of heavy elements in the Pegasids to the metallicity of the parent stars, they also found a correlation to exist, with planets born around stars that are as metal-rich as our Sun and that have small cores, while planets orbiting stars that contain two to three times more metals have much larger cores, as shown in Figure 2. Their results will be published in *Astronomy & Astrophysics*.

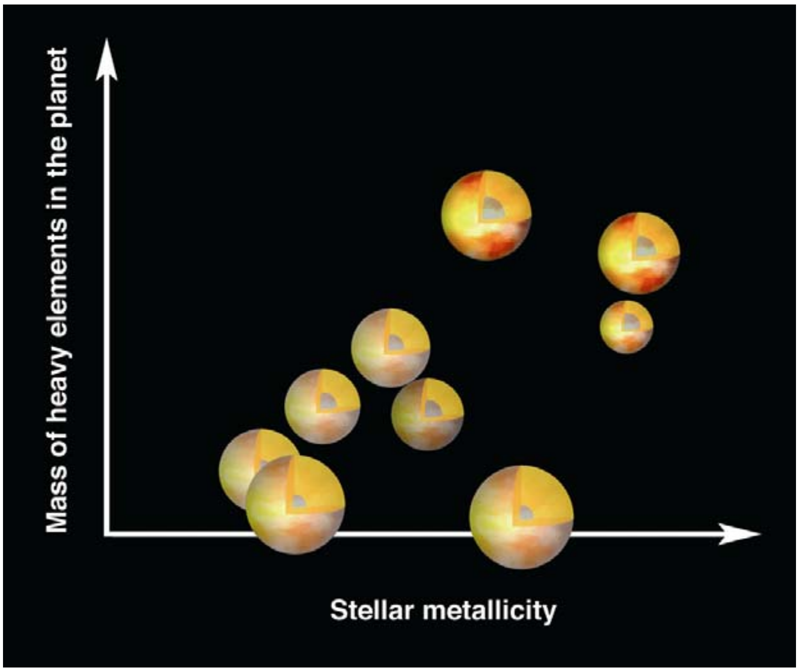

Fig. 2. Correlation between the amount of heavy elements in the transiting planets and the metallicity of their parent stars.

Planet formation models have failed to predict the large amounts of heavy elements found this way in many planets, so these results imply that they need revising. The correlation between stellar and planetary composition has to be confirmed by further discoveries of transiting planets, but this work is a first step in studying the physical nature of extrasolar planets and their formation. It would explain why transiting planets are so hard to find, to start with. Because most Pegasids have relatively large cores, they are smaller than expected and more difficult to detect in transit in front of their stars. In any case, this is very promising for the CNES space mission COROT to be launched in October, which should

[1] Throughout the text, it is admittedly not known whether the core is well-defined or else partially or totally mixed with the envelope.

discover and lead to characterization of tens of transiting planets, including smaller planets and planets orbiting too far from their star to be detected from the ground.

What of the tenth transiting planet? XO-1b was announced very recently (see NASA press release) and is also found to be an anomalously large planet orbiting a star of solar metallicity. Models imply that it has a very small core, so that this new discovery strengthens the proposed stellar-planetary metallicity correlation.

---

[1] The team includes T. Guillot (France), N.C. Santos (Portugal), F. Pont (Switzerland), N. Iro (USA), C. Melo (Germany), I. Ribas (Spain).

A correlation between the heavy element content of transiting extrasolar planets and the metallicity of their parent stars by T. Guillot, N.C. Santos, F. Pont, N. Iro, C. Melo, I. Ribas.

To be published in Astronomy & Astrophysics (DOI number: 10.1051/0004-6361:20065476)
Full article available in PDF format.
Electronic edition of the press release available at http://www.edpsciences.org/aa.

Contact persons:

- Science:

Dr. Tristan Guillot
Observatoire de la Côte d'Azur
Email: tristan.guillot (at) obs-nice.fr
Phone: +33 4 92 00 30 47; +33 4 92 00 31 31

- Press office:

Dr. Jennifer Martin
Astronomy & Astrophysics
61, avenue de l'Observatoire
75014 Paris, France
Email: aanda.paris (at) obspm.fr
Phone: +33 1 43 29 05 41

To subscribe to the *Astronomy & Astrophysics* press release mailing list, please contact Jennifer Martin at aanda.paris (at) obspm.fr.