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Tidal dissipation and characterization of some CoRoT's transiting hot Jupiters

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1. Abstract

It is well-known that transit data added to radial velocity measurements allow for the determination of several physical parameters as radius and mass (without the inclination indetermination), which allow us to obtain the bulk density of the planets and thus to have a hint on their constitution: H/He, ices, silicates/iron … [1] and to be able to know if we are dealing with a rocky or a mostly gaseous planet. In addition to this, the joint consideration of these measurements also allow for a more accurate determination of the eccentricity.
If the eccentricity is definitely not zero and the planet is close enough to the star to tidally interact with it, since the eccentricity has not yet been damped to zero, the traces of its past evolution have not yet been completely erased and can be retrieved. The analysis of the results thus obtained may give us some information on the rate of tidal dissipation inside the planet, which must show compatibility with the age of the system, small dissipation meaning a full fluid/gaseous body and large dissipation indicating the possible existence of a nucleus where the dissipation is larger.

When only radial velocities are used, the determination of the eccentricity depends on the difficult determination of an asymmetry in the radial velocity curve, and often initial determination lead to values larger than the actual ones. This can be seen by comparing some old eccentricity determinations to new ones or comparing results obtained from synthetic samples with those used in the construction of the sample [2, 3]. When precise transits have been observed, one extra condition is added in the determination: the true longitude must be 90 degrees at the minimum light of the transit. Together with the radial velocity measurements, this datum allows for an accurate determination of both the eccentricity and the longitude of the pericenter.

Because of the proximity of the transiting planets to the central star, they often have very small eccentricities and a value different from zero cannot be determined. But for some hot Jupiters, the eccentricity is definitely not zero and the planet is close enough to the star to tidally interact with it. In such cases, since the eccentricity has not yet been damped to zero, the traces of its past evolution have not yet been completely erased and can be retrieved. The analysis of the results thus obtained may give us some information on the rate of tidal dissipation inside the planet, which must show compatibility with the age of the system, small dissipation meaning a full fluid/gaseous body and large dissipation indicating the possible existence of a nucleus where the dissipation.

As an example, we show in figure 1 the tidal evolution of CoRoT-16b [4], obtained using an exact linear tidal model [5] and adopting for the planet's modified quality factor Q' a value derived from that actually determined for Jupiter [6]. The most critical results are obtained when the past evolution is studied. About 1 Gyr before now, the eccentricity would have been very close to 1. The semi-major axis also appears evolving from a very-high value. This behavior is not consistent with the age of the star (larger than 4 Gyr). All possible mechanisms responsible for exoplanets high-eccentricities concern events expected to occur in the early stages of the formation of the system. For compatibility, the actual value of Q' should be larger than the adopted value what is surprising since CoRoT-16b is just half of Jupiter and, in our Solar System, smaller planets have larger dissipation (Saturn's Q' is 20 times smaller than Jupiter's Q').

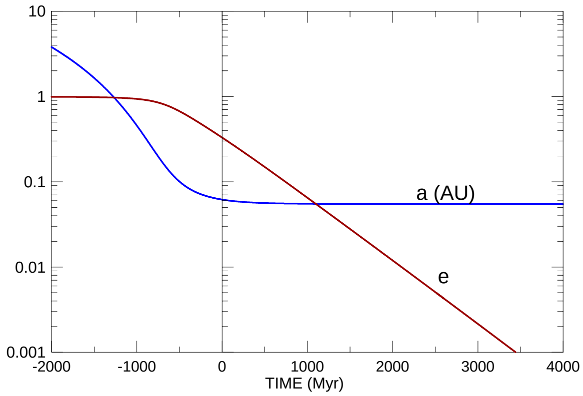

Figure 1: Tidal evolution of the semi-major maxis and eccentricvity oif CoRoT-16b.

This communication will be centered on the results on some CoRoT exoplanets in elliptic orbits, but will also consider some other transiting exoplanets for which transit and radial velocity measurements are publicly available.

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