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The outcome of the CoRoT Exoplanet Program

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Abstract

We present a summary of the results of the last 6 years of research of the CoRoT satellite in the domain of extrasolar planets. We give an overview of the most relevant cases, the impact of their discovery in the research field, and we put the legacy of CoRoT in the context of future transit surveys.

1. Introduction

The CoRoT mission is a space telescope devoted to the search and characterization of extrasolar planets and the study of stellar interiors via asteroseismology.

CoRoT is an afocal telescope with a pupil aperture of 27 cm orbiting in a polar low Earth orbit at 900 km altitude. Since its launch in December 2006, CoRoT has observed around 170 000 stars in 26 fields and produced many relevant results both in the stellar and in the exoplanet domains (see, for example, the reviews by [7], [1], [11], and [12]).

2. Exoplanet science

CoRoT has discovered 35 extrasolar planets, including 3 multiple systems, and 2 brown dwarfs. Figure 1 shows the distribution of the known transiting planets in the mass/semi-major axis diagram. CoRoT planets, highlighted, cover the full range of the current discovery space. Worth of mention are the cases of CoRoT-3b and CoRoT-15b, in the scarcely populated region between planets and brown dwarfs. The CoRoT Exoplanet Science Team has done a large effort to fully characterize these planets, measuring their masses with radial velocity (RV). This effort is justified because the full characterization of exoplanets is mandatory to analyze in detail their internal structure and study their evolution.

2.1. Telluric planets

Today we know 19 transiting planets with masses below 10 Earth masses, defined as super Earth planets,

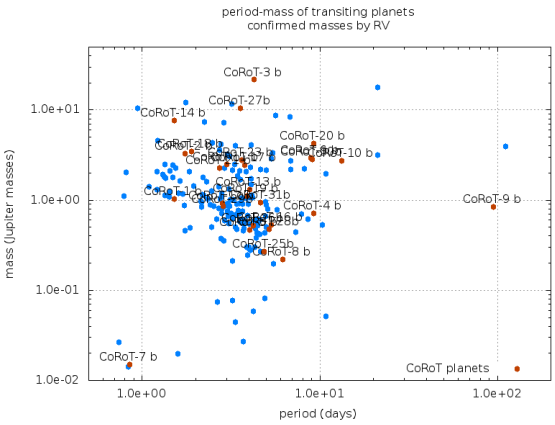

Figure 1: Mass/semi-major axis distribution of known extrasolar planets.

but only 5 of them (CoRoT-7b, GJ-1214b, 55 Cnc e, Kepler-10b, and Kepler-20b) have masses measured from RV. CoRoT-7b is the first rocky planet with measured mass and radius. Together with Kepler-10b, they belong to a class of planets made of dense materials (silicates, iron...). GJ-1214b is far less dense and considered to contain large amount of volatiles. 55 Cnc e and Kepler-20b exist between this two extreme scenarios.

The discovery of CoRoT-7b triggered a number of studies addressing its internal composition ([15],[9],[16]), its origin, and its capacity to retain an atmosphere ([6],[10],[3]). These last aspects are subject of debate and are important to understand the formation and survival of these planets in such extreme environments.

2.2. Internal structure

The simultaneous knowledge of the mass and the radius of transiting extrasolar planets reveals their composition and constrains their formation history. CoRoT giant planets have posed several challenges to our current knowledge of planet interior structure.

Young planets, like CoRoT-2b, 18b, or 20b, pose particular problems. CoRoT-2b, for example, requires an additional source of energy accounting to around 25% of the stellar irradiation to explain its current radius. Other planets, like CoRoT-13b, are relatively dense, considering their masses, and are emerging recently as a class of planets (see also WASP-64b or KOI-680b) having a large fraction of rocky material in their cores. However, we don't have a fully satisfactory theory that explain how could this material accumulate in the early episodes of the life of these planets. CoRoT-23b and specially CoRoT-21b are subjects of study for the tidal interaction between stars and hot-Jupiters. For example, the rotation of the star CoRoT-21 will be spun-up by tidal forces that strongly compensate for the loss of angular momentum and slow-down by magnetic braking till the planet will get lost in the stellar Roche zone [13]. Finally, CoRoT has discovered a number of dense objects with masses larger than 10 Jupiter masses like CoRoT-3b or 27b which also require a particularly high amount of dense material available at early stages of their formation process.

2.3. Planets and their host stars

CoRoT has exploited the synergies of the simultaneous study of extrasolar planets and their host stars. The already mentioned case of CoRoT-2b has triggered numerous studies because of its young age and the activity level of the star ([8],[4],[5],[14],[2]). Recently, we have announced the discovery of CoRoT-32b, a planet which is suspected to orbit a very young star and which could put strong constraints to the scenario of formation of this objects and in the properties of their orbits.

3. The CoRoT legacy

CoRoT has been a pioneer in the discovery and characterization from extrasolar planets from space. We will discuss how the lessons learned by CoRoT have contributed to the design and to the study of the performance of future surveys like TESS or PLATO.

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