The CoRoT Legacy Book

DOI: 10.1051/978-2-7598-1876-1.c040

Part IV

Decisive breakthroughs for stellar physics

Stellar variability is a longstanding issue in stellar physics and covers a large number of underlying physical processes such as stellar oscillations, stellar rotation, binarity, and star-disk interaction. Photometric observations are therefore potentially able to kill several birds with one stone by giving us access to all those mechanisms through the investigation of one single observable: the stellar light-curve. However, this is only possible if the accuracy of the observations is high enough, the duration of the observations is long enough, and the duty cycle is good enough. In 2006 all those requirements were fulfilled by the CoRoT mission that provided highly-accurate quasi-uninterrupted and long-duration photometric observations for a large number of stars. In that respect, CoRoT allowed decisive breakthroughs for stellar physics.

In these chapters, we intend to provide an overview of the scientific results obtained by the exploitation of the CoRoT light-curves in stellar physics. The first chapter, *Insights on the internal structure of stars as provided by seismology*, focuses on the numerous constraints on the internal structure of stars inferred thanks to stellar seismology. It is twofold because it adresses both; the classical and solar-like pulsations. The former type of pulsations, which originates mainly from thermal instabilities, are encountered in a wide variety of stars while the latter type of pulsations concerns low-mass stars which develop an outer convective envelope as it drives and damps these oscillations. Prior to CoRoT, only a handful of seismic constraints were available for a few stars. However, since the launch of CoRoT, followed by *Kepler*, it is possible to infer the internal structure of thousands of stars from the main-sequence to the central helium-burning phase.

The second chapter, *Pulsating red giant stars: ensemble asteroseismology and galactic archeology*, addresses new fields which emerged thanks to CoRoT. Based on the numerous seismic contraints on red giants, it has been possible to develop a statistical approach using global seismic indicators (also named seismic indices) to infer physical constraints on stellar structure and evolution of evolved stars. An additional benefit of ensemble asteroseimology is the determination of stellar global parameters such as the stars masses, radii, or ages. This has been used to investigate the Galactic stellar populations since it shed new light on stellar populations in the Milky Way. Moreover, the synergies between asteroseismology and large spectroscopic surveys is leading to the emergence of a chemodynamical investigation of the Galaxy.

The last chapter, *The wealth of stellar variability: stellar activity, binary, and star-disk interaction*, is dedicated to stellar variability as induced by stellar activity, binarity and star-disk interactions. The first part addresses surface rotation, convection and magnetic activity as well as their interplay. CoRoT allowed us to have surface constraints on those essential ingredients of stellar dynamos. The second part of the chapter is dedicated to binarity, which is another source of stellar variability. Indeed, CoRoT's contributed to the detection of numerous multiple systems and to the characterisation of the evolution of several binary systems, allowing to unravel physical processes occuring on different time-scales. Several binary systems were also used as proof-of-concept to show the potential of the synergy between asteroseismology and binarity. The last part of this chapter concerns the rich harvest of observational constraints obtained for young stars and the interaction with their disk. Particular emphasis is also laid on the coordinated synoptic investigation of NGC 2264 that is a multiwavelenght observational campaign including ground-based and space-borne facilities among which CoRoT.

The aforementioned works demonstrate the leap forward that has been performed thanks to the ultra-precise and long duration photometry provided by CoRoT. Its datasets cover the whole Hertzsprung–Russell diagram in different part of the sky and thus offered (and still offers) a rich harvest of observational constraints on many physical processes up to now hardly understood. The pioneering detection of solar-like oscillations in hundreds of stars has paved the way for making decisive progress in the modelling of stellar structure and evolution. The seismic analysis of CoRoT targets has brought significant constraints on specific physical processes inside stars, but also yielded a wealth of methods and procedures to exploit seismic data on solar-like pulsators to their full potential. The harvest of CoRoT was luxuriant and permitted us to incredibly boost our current understanding of stars and particularly of red giants. This led to the emergence of ensemble asteroseismology as a strong driver for stellar and galactic science. Beyond asteroseismology, the results described in this review emphasize the large possibilities opened thanks to CoRoT. The investigation of the major ingredients of stellar dynamos was made possible. Star interactions with its environment was another issue addressed because CoRoT also allowed a detailed study of the binarity, accretion process, star-disk interaction, inner disk structure and rotation of a coeval sample of stellar objects. Therefore, all those results open the way to a complete description of the thousands of stellar systems observed around ours, including the relation between the star and the planets of these systems.

Obviously, the interpretation of CoRoT's data is a long term ongoing process and will not be completed before a long time. This review is thus a snapshot and the situation will certainly evolve in the forthcoming years along with the exploitation of the observations. Indeed, CoRoT's observations provided a large number of observational constraints that will certainly be breeding ground for future theoretical progress. We also emphasize that it is not intended to provide a comprehensive view but rather to show and highlight how CoRoT allowed us to make significant progress in a number of fields or in some cases permitted the emergence of new fields. In that respect, the *Kepler* mission and its wealth of scientific achievements will not be addressed in detail in this review, even if it will be mentioned when useful.

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