Monitoring stellar evolution with mixed modes

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Abstract

Determining stellar ages is a central issue in astrophysics because it directly or indirectly impacts all fields, from deciphering exoplanetary structure and evolution, through reconstructing the dynamical and chemical evolution of galactic structures, to setting a lower limit to the age of the Universe. Unfortunately, measuring stellar ages is challenging. Even determining stellar evolutionary stages and characterizing the transitions between them is difficult and often impossible for field stars. Up to recently there were no observables that would enable us to infer the evolutionary status. The situation has dramatically changed with the space-borne missions CoRoT and Kepler. Here, we report seismic observations that directly probe the core of low-mass stars all along their evolution. With the detection of global gravity modes for hundreds of stars observed by the Kepler mission, we are able to trace stellar evolution and to precisely identify all key transitions between the different stages. We show unambiguous criteria indicating the end of the subgiant and red-clump stages. The determination of the fine structure of the red clump stars opens new insights for their most precise use as distance indicators.

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