Detection and measurement of strong magnetic fields in the core of red giant stars

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Abstract

Magnetic fields are at the heart of most burning questions in stellar physics. In particular, they are expected to play a central role in the transport of angular momentum and chemical elements in stellar interiors. While surface magnetic fields have been detected and characterized in stars across the HR diagram, internal magnetic fields have long remained inaccessible to direct observations. Over the last decade, the seismology of red giants has proved to be a very powerful tool to test stellar physics, mainly thanks to the detection of mixed modes, which probe both the envelope and the deep core. Here, we present the first direct detections of magnetic fields in the cores of red giants. Magnetic fields induce perturbations in the oscillation modes. In particular, they break the symmetry of rotational multiplets. Besides, strong fields can also modify the usual regularity of g-mode periods. We detected both of these effects in the dipole mixed modes of over 20 red giants observed with the Kepler satellite and we have shown that their characteristics closely match those expected in the presence of strong core magnetic fields (Li et al. 2022, Deheuvels et al. 2023). We thus measured field intensities ranging from a few tens to a few hundreds of kilogauss in the core of these stars, and we placed constraints on the topology of these fields. These results constitute a key step toward a consistent modeling of the effects of magnetic fields in stellar evolution models.

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