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The Sun's core makes a complete rotation in one week

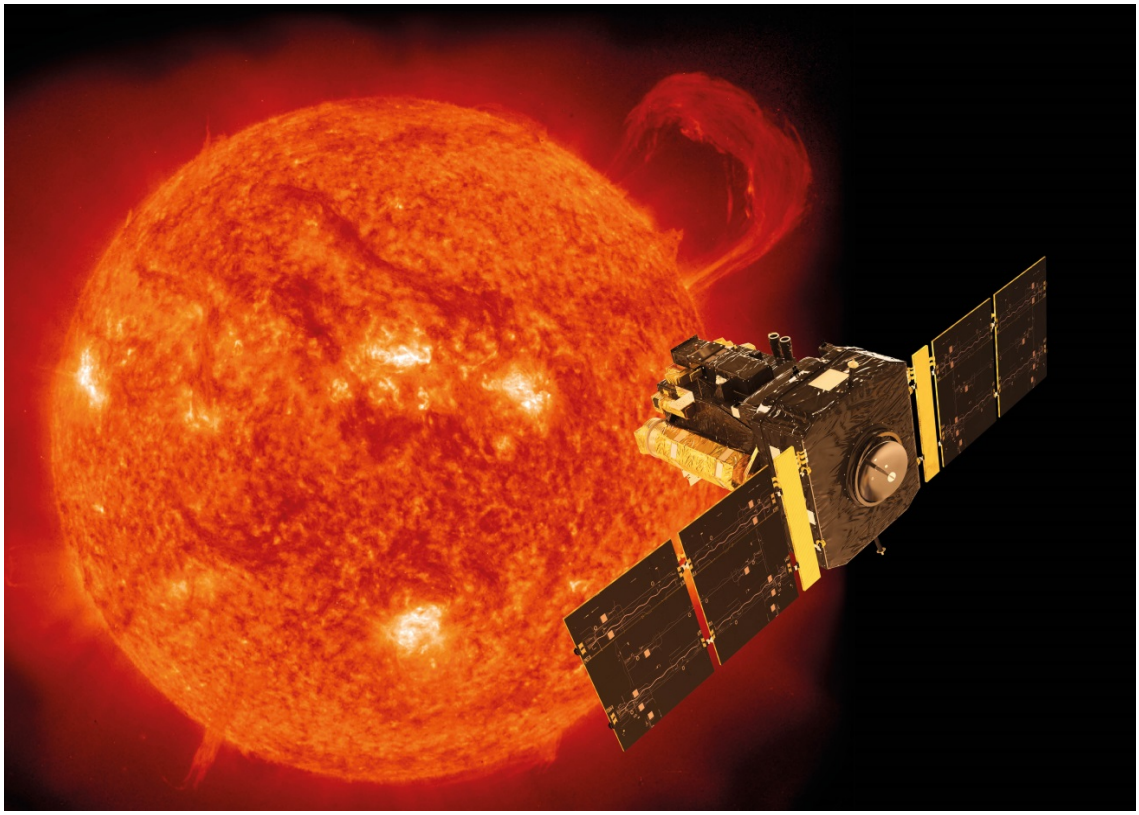
The rotation rate of the Sun's core has been accurately measured for the first time. The Sun, which has been remarkably stable for the past 4.6 billion years, is held together by the almost perfect equilibrium between the force of gravity, which tends to cause it to collapse, and the pressure of the thermonuclear reactions in its core. Now, researchers working together with a team at the Laboratoire Lagrange (CNRS/Observatoire de la Côte d'Azur/Université Nice Sophia Antipolis) have determined that the Sun's core makes a complete rotation once per week. Using the GOLF[1] instrument, orbiting around the Sun on board the SOHO[2] space observatory, to measure solar oscillations, they developed a novel approach that enabled them to unambiguously detect gravity oscillation modes within our star. This work, which will certainly stimulate a new era of research into the physics of the solar core, is published in the journal *Astronomy & Astrophysics*.

The Sun, which has been remarkably stable for the past 4.6 billion years, is held together by the almost perfect equilibrium between the force of gravity, which tends to cause it to collapse, and the pressure of the thermonuclear reactions in its core. The GOLF[1] instrument, orbiting around the Sun on board the SOHO[2] space observatory, measures solar oscillations, which carry information about the physical properties of its different layers. Every ten seconds, GOLF, which has been orbiting our star for over twenty years, records an integrated signal of oscillations of the solar surface. Various teams analyze this flow of data with the aim of identifying the many oscillation modes exhibited by the Sun. Now, researchers from the Laboratoire Lagrange (CNRS/Observatoire de la Côte d'Azur/Université Nice Sophia Antipolis), the Institut d'Astrophysique Spatiale (CNRS/Université Paris-Sud), the Laboratoire Astrophysique, Interprétation, Modélisation (CNRS/Université Paris Diderot/CEA), the Laboratoire d'Astrophysique de Bordeaux (CNRS/Université de Bordeaux), the Instituto de Astrofísica de Canarias, and UCLA (University of California, Los Angeles) have successfully detected the Sun's gravity modes. These are similar to waves in which gravity is the restoring force, such as waves on the surface of the sea, although in the Sun they can only exist in its very deepest layers. Since these oscillations are particularly difficult to observe, the researchers used the GOLF data in a novel way, by making use of a differential parameter of the acoustic oscillation modes, which are observable at the surface. This parameter measures the round trip time of acoustic waves traveling through the center of the Sun. The researchers detected the impact of gravity modes on them, thus demonstrating their existence.

[1] Global Oscillations at Low Frequencies.

[2] Solar and Heliospheric Observatory (ESA/NASA)

The first result of this detection is that the researchers were able to accurately measure the mean rotation rate of the Sun's thermonuclear core, about which little was previously known. The core makes a complete rotation in one week, which is 3.8 times faster than the outer and intermediate layers. This work should stimulate much research in solar physics, making it possible to further refine models of the Sun's birth, evolution, structure and chemical composition. In particular, the gravity modes indicate that there is a region at the boundary of the thermonuclear core where the speed varies enormously, which is not predicted by the standard model of the Sun. It will also stimulate discussion about the nature of a possible magnetic field in the Sun's center.



Artist's impression of ESA and NASA's SOHO space observatory in orbit around the Sun (photograph taken by SOHO's EIT instrument (Extreme-ultraviolet Imaging Telescope) on 14 September 1999).

Bibliography

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