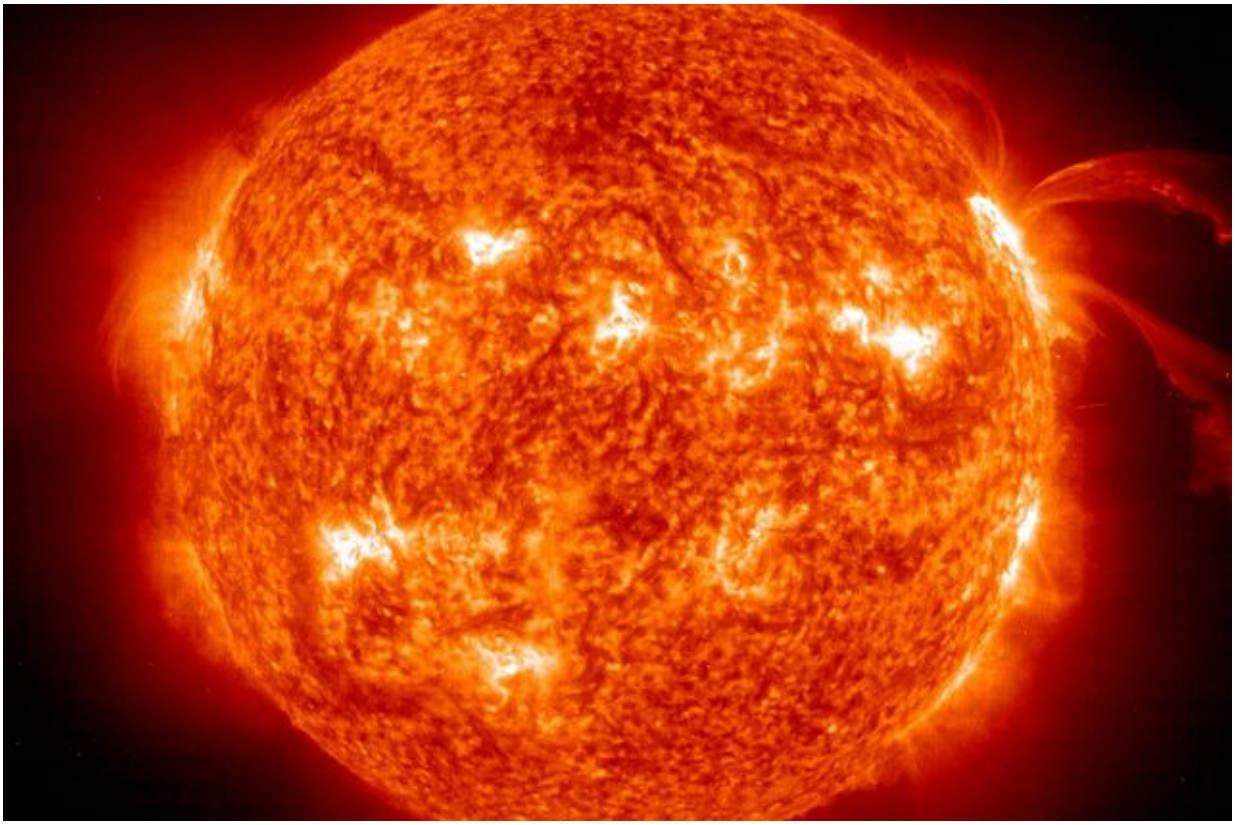
Sun's core rotates four times faster than its surface

August 1 2017, by Stuart Wolpert



The sun is emitting plumes of hydrogen plasma. The white areas are where the sun's magnetic field is especially strong. Credit: SoHO, a joint project of the European Space Agency and NASA

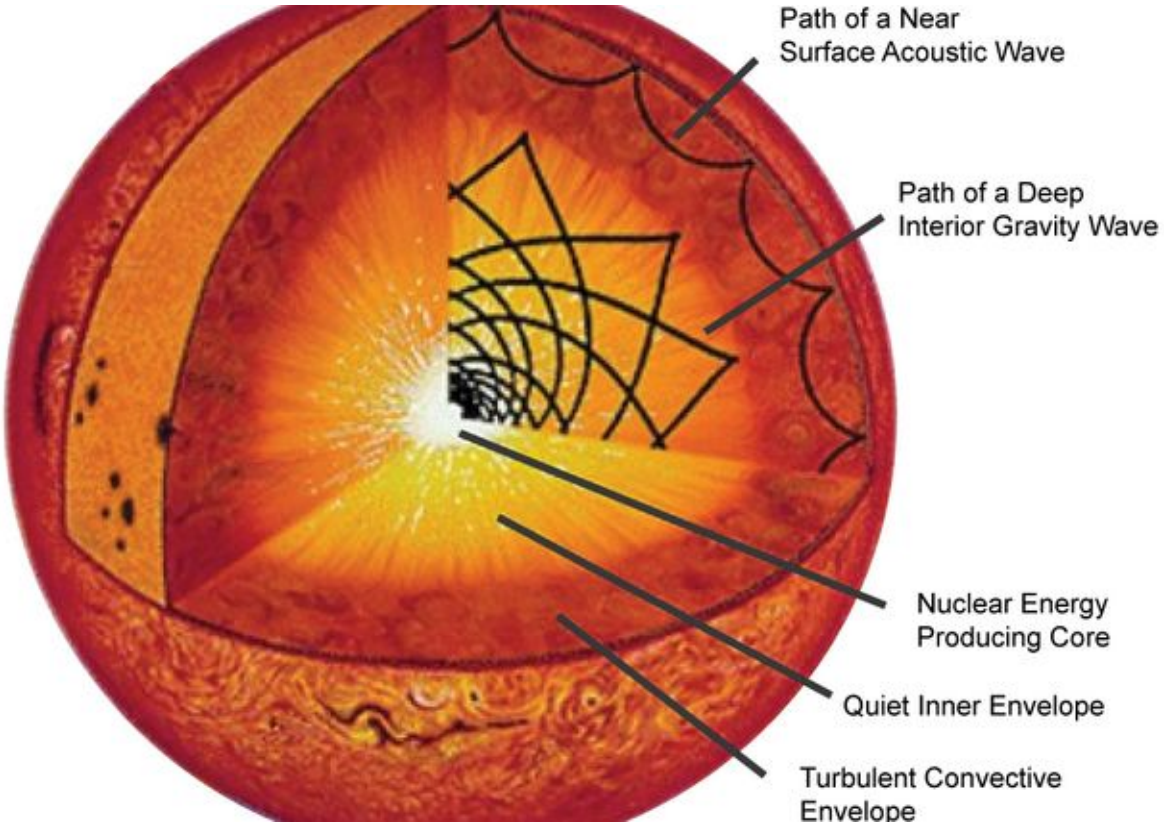
The sun's core rotates nearly four times faster than the sun's surface, according to new findings by an international team of astronomers.

Scientists had assumed the core was rotating like a merry-go-round at about the same speed as the surfa

"The most likely explanation is that this core rotation is left over from the period when the sun formed, some 4.6 billion years ago," said Roger Ulrich, a UCLA professor emeritus of astronomy, who has studied the sun's interior for more than 40 years and co-author of the study that was published today in the journal *Astronomy and Astrophysics*. "It's a surprise, and exciting to think we might have uncovered a relic of what the sun was like when it first formed."

The rotation of the solar core may give a clue to how the sun formed. After the sun formed, the solar wind likely slowed the rotation of the outer part of the sun, he said. The rotation might also impact sunspots, which also rotate, Ulrich said. Sunspots can be enormous; a single sunspot can even be larger than the Earth.

The researchers studied surface acoustic waves in the sun's atmosphere, some of which penetrate to the sun's core, where they interact with gravity waves that have a sloshing motion similar to how water would move in a half-filled tanker truck driving on a curvy mountain road. From those observations, they detected the sloshing motions of the solar core. By carefully measuring the acoustic waves, the researchers precisely determined the time it takes an acoustic wave to travel from the surface to the center of the sun and back again. That travel time turns out to be influenced a slight amount by the sloshing motion of the gravity waves, Ulrich said.



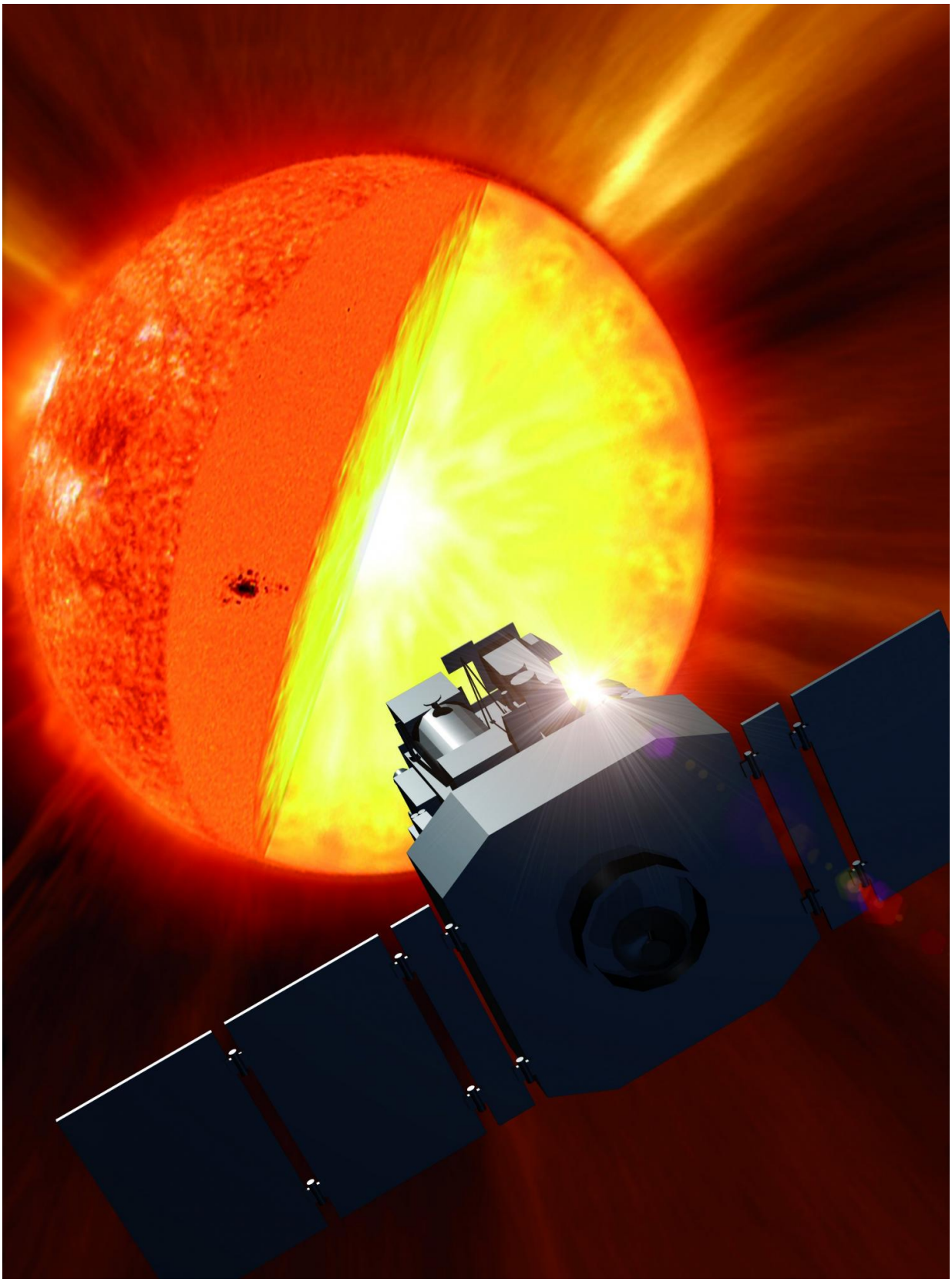
The sun, whose hot, dense core produces nuclear fusion and rotates nearly four times faster than its surface. Credit: University of California, Los Angeles

The researchers identified the sloshing motion and made the calculations using 16 years of observations from an instrument called GOLF (Global Oscillations at Low Frequency) on a spacecraft called SoHO (the Solar and Heliospheric Observatory)—a joint project of the European Space Agency and NASA. The method was developed by the researchers, led by astronomer Eric Fossat of the Observatoire de la Côte d'Azur in Nice, France. Patrick Boumier with France's Institut d'Astrophysique Spatiale is GOLF's principal investigator and a co-author of the study.

The idea that the solar core could be rotating more rapidly than the surface has been considered for more than 20 years, but has never before

been measured.

The core of the sun differs from its surface in another way as well. The core has a temperature of approximately 29 million degrees Fahrenheit, which is 15.7 million Kelvin. The sun's surface is "only" about 10,000 degrees Fahrenheit, or 5,800 Kelvin.



A type of wave detected on the Sun by ESA and NASA's Solar and Heliospheric Observatory, or SOHO, reveals that the solar core is rotating about four times faster than the surface. Credit: ESA/NASA

Ulrich worked with the GOLF science team, analyzing and interpreting the data for 15 years. Ulrich received funding from NASA for his research. The GOLF instrument was funded primarily by the European Space Agency.

SoHO was launched on Dec. 2, 1995 to study the sun from its core to the outer corona and the solar wind; the spacecraft continues to operate.

More information: E. Fossat et al. Asymptotic g modes: Evidence for a rapid rotation of the solar core, *Astronomy & Astrophysics* (2017). DOI: 10.1051/0004-6361/201730460 , www.aanda.org/articles/aa/abs/… 0-17/aa30460-17.html

Provided by University of California, Los Angeles