Sun may be smaller than thought

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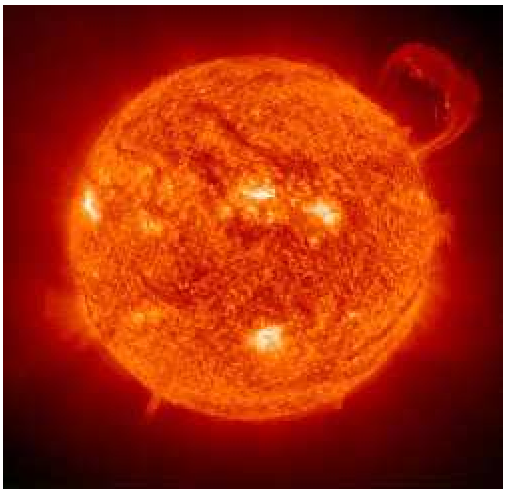
The Sun may be smaller than we thought, a new study argues.

If correct, then other properties of the Sun such as its internal temperature and density may be slightly different than previously calculated. Understanding the Sun's interior is important as it might help scientists make predictions about space weather and answer questions about the solar system.

The Sun has no solid surface. Its atmosphere merely gets thinner and more transparent farther from its centre.

Instead the Sun's "surface" is defined to be the depth in the Sun's atmosphere where it becomes opaque to light. Scientists measure this by observing the Sun with telescopes and measuring the distance between the centre of the Sun's disc and its "edge" – the place where its brightness suddenly drops off. This gives a radius of 695,990 kilometres, or about 109 times the radius of Earth.



Enlarge image
The Sun may be about 300 kilometres smaller than some previous measurements have suggested, if a new study is correct (Image: NASA)

A second, completely different way to measure the Sun's size is by using surface gravity waves called f-modes that ripple across the surface of the Sun like water waves on the ocean.

Multiple choice

Theory implies that these waves should appear only at the Sun's opaque surface, and observations of them can be used to measure the Sun's radius, since their wavelength is tied to their distance from the Sun's centre in a predictable way.

Scientists have been puzzled for years because these methods give two different answers. The wave method gives a radius of around 695,700 kilometres, about 300 kilometres smaller than the result from the light drop-off measurement.

Although the difference amounts to just 0.04%, it is large enough to matter when scientists try to gain insights on the Sun's interior by interpreting observations of sound waves – which ripple the Sun's surface in addition to the f-modes – using a technique called helioseismology.

Understanding the Sun through helioseismology is important as it can help scientists learn about the origins of the magnetic fields that produce sunspots, which in turn can help predict space weather.

Helioseismology has also helped scientists understand some of the mysteries of the solar system – for example, the technique was used to solve part of the solar neutrino problem. The technique ruled out changes in the Sun's interior as a cause of this mysterious disappearance of neutrinos flowing from the Sun to Earth.

Real difference

Now, new calculations of how light propagates in the Sun's atmosphere may have resolved the discrepancy in the Sun's radius in favour of the smaller measurement. The new calculations were carried out by a team led by Margit Haberreiter of the World Radiation Centre in Davos, Switzerland.

The team recalculated the precise spot where the light drop-off should occur, using software that simulates the propagation of light through the Sun's atmosphere developed by Haberreiter and her colleague Werner Schmutz, also at the WRC.

Their results suggest there should actually be a small difference between where the Sun's atmosphere becomes opaque and the point where observers see the light drop-off.

The light drop-off happens 333 kilometres higher up in the Sun's atmosphere than the location of the opaque surface where the f-modes occur, according to their calculations.

Theoretical models of the Sun that are based on the larger radius need to be corrected, the authors say. A more accurate radius could lead to a better understanding of the Sun's interior, says team member Alexander Kosovichev of Stanford University in California, US.

Incomplete knowledge

"It allows us to calculate more accurately the structure of the Sun and compare with the results of helioseismology, learning more about the constitution of the Sun," he told **New Scientist**.

He points out recent observations that suggest the Sun contains only half as much oxygen as previously believed, which appears to conflict with the results of sound wave studies. "Something is still missing in our understanding of the solar interior," he says.

Sarbani Basu of Yale University in New Haven, Connecticut, US, who was not involved in the research, says it is an open question whether the new radius Haberreiter's team propose is the right one. But she agrees that pinpointing the Sun's radius more exactly would help make more reliable calculations of conditions in the Sun's interior.

"For the Sun, all our measurements are so precise, even if it's a few hundred kilometres difference … [it] is a big deal," she told **New Scientist**.

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