

Sun's fickle heart may leave us cold

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There's a dimmer switch inside the sun that causes its brightness to rise and fall on timescales of around 100,000 years - exactly the same period as between ice ages on Earth. So says a physicist who has created a computer model of our star's core.

Robert Ehrlich of George Mason University in Fairfax, Virginia, modelled the effect of temperature fluctuations in the sun's interior. According to the standard view, the temperature of the sun's core is held constant by the opposing pressures of gravity and nuclear fusion. However, Ehrlich believed that slight variations should be possible.

He took as his starting point the work of Attila Grandpierre of the Konkoly Observatory of the Hungarian Academy of Sciences. In 2005, Grandpierre and a collaborator, Gábor Ágoston, calculated that magnetic fields in the sun's core could produce small instabilities in the solar plasma. These instabilities would induce localised oscillations in temperature.

Ehrlich's model shows that whilst most of these oscillations cancel each other out, some reinforce one another and become long-lived temperature variations. The favoured frequencies allow the sun's core temperature to oscillate around its average temperature of 13.6 million kelvin in cycles lasting either 100,000 or 41,000 years. Ehrlich says that random interactions within the sun's magnetic field could flip the fluctuations from one cycle length to the other.

These two timescales are instantly recognisable to anyone familiar with Earth's ice ages: for the past million years, ice ages have occurred roughly every 100,000 years. Before that, they occurred roughly every 41,000 years.

Most scientists believe that the ice ages are the result of subtle changes in Earth's orbit, known as the Milankovitch cycles. One such cycle describes the way Earth's orbit gradually changes shape from a circle to a slight ellipse and back again roughly every 100,000 years. The theory says this alters the amount of solar radiation that Earth receives, triggering the ice ages. However, a persistent problem with this theory has been its inability to explain why the ice ages changed frequency a million years ago.

"In Milankovitch, there is certainly no good idea why the frequency should change from one to another," says Neil Edwards, a climatologist at the Open University in Milton Keynes, UK. Nor is the transition problem the only one the Milankovitch theory faces. Ehrlich and other critics claim that the temperature variations caused by Milankovitch cycles are simply not big enough to drive ice ages.

However, Edwards believes the small changes in solar heating produced by Milankovitch cycles are then amplified by feedback mechanisms on Earth. For example, if sea ice begins to form because of a slight cooling, carbon dioxide that would otherwise have found its way into the atmosphere as part of the carbon cycle is locked into the ice. That weakens the greenhouse effect and Earth grows even colder.

According to Edwards, there is no lack of such mechanisms. "If you add their effects together, there is more than enough feedback to make Milankovitch work," he says. "The problem now is identifying which mechanisms are at work." This is why scientists like Edwards are not yet ready to give up on the current theory. "Milankovitch cycles give us ice ages roughly when we observe them to happen. We can calculate where we are in the cycle and compare it with observation," he says. "I can't see any way of testing [Ehrlich's] idea to see where we are in the temperature oscillation."

Ehrlich concedes this. "If there is a way to test this theory on the sun, I can't think of one that is practical," he says. That's because variation over 41,000 to 100,000 years is too gradual to be observed. However, there

may be a way to test it in other stars: red dwarfs. Their cores are much smaller than that of the sun, and so Ehrlich believes that the oscillation periods could be short enough to be observed. He has yet to calculate the precise period or the extent of variation in brightness to be expected (www.arxiv.org/astro-ph/0701117).

Nigel Weiss, a solar physicist at the University of Cambridge, is far from convinced. He describes Ehrlich's claims as "utterly implausible". Ehrlich counters that Weiss's opinion is based on the standard solar model, which fails to take into account the magnetic instabilities that cause the temperature fluctuations.

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