Sun Has Likely Entered New Evolutionary Phase, Say Astronomers

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Contributor

The Sun has likely already entered into a new unpredicted long-term phase of its evolution as a hydrogen-burning main sequence star — one characterized by magnetic sputtering indicative of a more quiescent middle-age. Or so say the authors of a new paper submitted to The Astrophysical Journal Letters.

Using observations of other sunlike stars made by NASA's Kepler Space Telescope, the team found that the Sun is currently in a special phase of its magnetic evolution.

Heretofore, the Sun was thought to have been just a more slowly rotating version of a normal yellow dwarf (G-spectral type) star. These results offer the first real confirmation that the Sun is in the process of crossing into its magnetic middle age, where its 11-year Sunspot cycles are likely to slowly disappear entirely. That is, from here on out, the Sun is likely to have fewer sunspots than during the first half of its estimated 10 billion year life as a hydrogen-burning star.

"The Sun's 11-year sunspot cycle is likely to disappear entirely, not just get less pronounced; [since] other stars with similar rotation rates show no sunspot cycles," Travis Metcalfe, the paper's lead author and an astronomer at the Space Science Institute in Boulder, Colo., told me.

Metcalfe says this transition takes a few hundred million years, but once the Sun completely crosses this Rubicon of middle age, it will remain magnetically inactive for the rest of its hydrogen-burning life.

We now understand that every star goes through this phase, says Metcalf, and that the Sun has a peculiar magnetic cycle for its rotation rate because it is in the middle of the transition to a less magnetically-active state. And he notes that this new realization does help explain why the Sun's current surface activity doesn't jibe with patterns seen on many other sunlike stars.

What sort of long-term impact will such a shift in the Sun's magnetic evolution have on Earth's climate?

The brightness of the Sun changes by about a tenth of one percent from minimum solar activity to maximum solar activity, says Metcalfe. And given current levels of heat trapped by manmade pollution, even if the Sun transitions permanently to a minimum state, he says, the cooling effect on Earth's climate would still be negligible.

The team was able to draw such conclusions because for the first time, they observed a range of some twenty older solar type stars using asteroseismology, or the photometric measure of a given star's surface. Thus, they were able to more accurately determine their rotation rates; their masses; and ages.

Conventional means of measuring a star's age used to be linked largely to measuring its rotation rate by tracking its surface starspots as they rotated in and out of view. Previously, it was thought that the faster a star's rotation, the younger its age.

But clearly there are stars a bit older than the Sun that rotate faster; suggesting rotation isn't so good as an age indicator after all, David Soderblom, a staff astronomer at the Space Telescope Science Institute who was not an author on the paper, told me. "This paper is an attempt to account for this behavior," he said.

"For years, it has appeared that solar-type stars spin down and converge to a common spin rate by the time they are roughly half a billion years old," said Soderblom.

The Sun itself, for example, has long had a 25-day rotation period which Metcalfe says will remain roughly constant until the Sun begins expanding into a Red Giant, some six and half billion years from now.

But as stars age, their magnetized winds carry away angular momentum — or the quantity of its rotational momentum, says Metcalfe. And their rotation, he says, slows via a process known as "magnetic braking." "This has been the standard picture of [stellar] magnetic evolution since the 1970?s, and it was thought to continue over the entire life of a star," said Metcalfe.

But our paper's new hypothesis, he says, is that around middle-age, magnetic braking stops and the star's rotation rate stays roughly constant for the rest of its life.

In our paper, we are trying to identify the mechanism that is responsible for turning off magnetic braking in middle-aged stars, says Metcalfe. We find evidence, he explains, that the geometry of the magnetic field changes in exactly the way that would explain the disappearance of the star's global magnetic field. As a result, the star's characteristic surface spots also disappear, not unlike what is currently happening to our Sun.

The future Sun, the authors note, is expected to not only have few if any sunspots, but also less coronal mass ejections of the sort that can wreak havoc on satellites and electronics on Earth.

Metcalfe thinks that there may even be a link to the onset of our Sun's middle age and the evolution of life on Earth. "The Sun started the transition to a less magnetically active state in the past few hundred million years," said Metcalfe. "[This] created a less hostile environment in the solar system right around the time land-based life emerged on Earth."

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