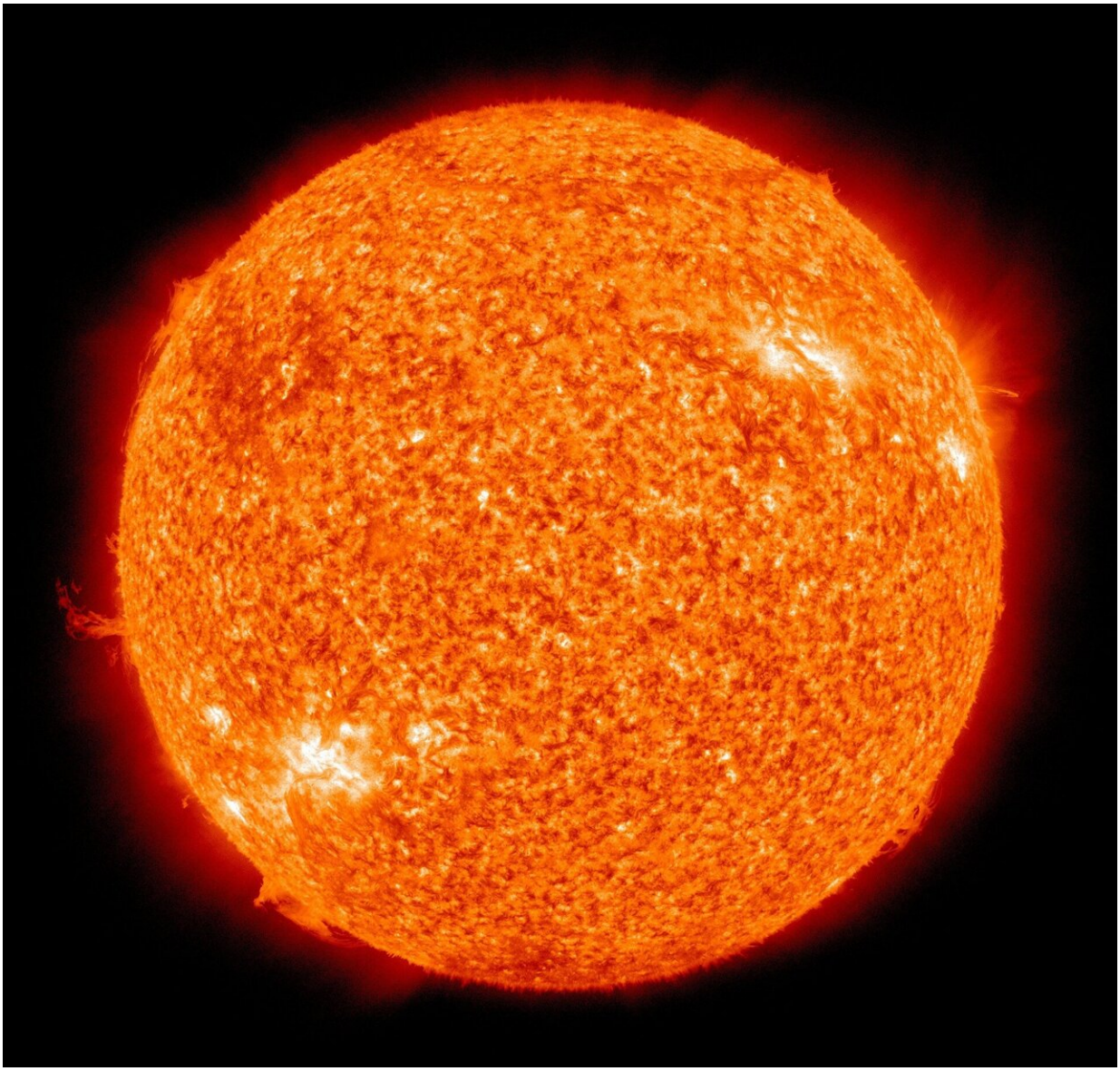
Could there be a black hole inside the sun?

December 18 2023, by Brian Koberlein



Credit: Pixabay/CC0 Public Domain

It's a classic tale of apocalyptic fiction. The sun, our precious source of heat and light, collapses into a black hole. Or perhaps a stray black hole comes along and swallows it up. The End is Nigh! If a stellar-mass black hole swallowed our sun, then we'd only have about eight minutes before, as the kids say, it gets real. But suppose the sun swallowed a small primordial black hole? Then things get interesting, and that's definitely worth a paper on the *arXiv* preprint server.

Primordial black holes are hypothetical black holes that formed during the earliest moments of the universe. Unlike stellar-mass black holes or supermassive black holes, primordial black holes would typically be tiny, with a mass roughly that of an asteroid and a size smaller than a baseball. They show up in certain theoretical models and have been used to try to explain everything from dark matter to a distant Planet X. Many of these models argue that primordial black holes are common, so it's inevitable that a star would eventually capture one. Such stars with a black hole center are known as Hawking stars.

As this new work points out, a captured primordial black hole would initially have almost no effect on a sun-like star. Compared to the mass of the sun, an asteroid's worth of mass might as well be a speck of dust. Even if it were a black hole it couldn't consume much of the sun quickly. But it would affect things over time. A black hole in a star would consume matter in the stellar core and grow over time. If it could grow quickly on a cosmological scale, then it could consume a star completely. If not, it could still affect the evolution and end life of the star.

The study shows that it largely comes down to the initial size of the primordial black hole. For ones at the largest mass range not excluded by observations, around a billionth of a solar mass, it could essentially consume a star in less than half a billion years. If this has happened, then there should be solar mass black holes out there, which are too small to have formed from supernovae like traditional stellar-mass black holes.

If the primordial black hole is much smaller, say less than a trillionth of a solar mass, then things get more complicated. The tiny black hole would consume some matter within the star, but not at a fast pace. It would, however, stir things up in the core, heating it up more than fusion alone. As a result, a star could swell into a "red straggler" which would be cooler and redder than usual red giant stars. All that turbulence in the core could also affect the surface activity of the star. The effects would be subtle, but the authors suggest that the presence of a primordial black hole could be seen through stellar seismology.

Based on the helioseismology studies we've done, there is almost certainly NOT a black hole in our sun. Or if there is, it would need to be exceedingly tiny. So there's no need to pack your bug-out bag for a solar doomsday. But perhaps there are some Hawking stars out there if we only care to look.

More information: Matthew E. Caplan et al, Is there a black hole in the center of the Sun?, *arXiv* (2023). DOI: 10.48550/arxiv.2312.07647

Provided by Universe Today