

Oscillating stars reveal their ages

Astronomers measure the ages of Procyon and Eta Boötis using stellar seismology.

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The bright, nearby star Procyon is 1.7 billion years old, say astronomers in Switzerland. This makes the star about one-third as old as the Sun.

Procyon is the brightest star in Canis Minor and the eighth-brightest star in the night. It's a yellow-white F-type star evolving from the main sequence to the subgiant stage. Someday, it will become a red giant. In the 1990s, astronomers detected tiny oscillations on Procyon. These vibrations let astronomers probe the star's interior, just as earthquakes let seismologists study Earth's core and mantle.

Now, Patrick Eggenberger, Fabien Carrier, and François Bouchy at Geneva Observatory have exploited these oscillations to ascertain Procyon's age. To do so, the team first constructed models of the star's evolution.

A key parameter in these models is the star's mass, which dictates how fast it evolves. Procyon's mass is known because it has a white dwarf companion that orbits it every 40 years. As the two stars tug each other, they reveal their masses. In 2000, Terry Girard of Yale University and his colleagues reported that Procyon has 1.5 solar masses. Girard's team also found Procyon's distance from Earth to be 11.5 light-years, slightly greater than the 11.4 light-years the Hipparcos satellite had measured.

As a star evolves, its temperature, luminosity, and diameter change. At present, Procyon is slightly hotter than the Sun, with a temperature of 6,530 kelvins (versus the Sun's 5,770 K). Its luminosity over all wavelengths is about 7 times the Sun's, so it emits as much light in a day as the Sun does in a week. Interferometric observations, along with the star's distance, indicate its diameter is slightly more than twice the Sun's.

By fitting all of these parameters with their oscillation data, Eggenberger and his colleagues say their best model gives Procyon an age of 1.7 ± 0.3 billion years. For comparison, the Sun is 4.6 billion years old, nearly 3 times older. Eggenberger's team will publish their work in the journal *New Astronomy*.

In related work, to be published in *Astronomy and Astrophysics*, the astronomers analyzed another nearby star's oscillations: Eta (η) Boötis, a yellow G-type subgiant located a few degrees west of Arcturus and 37 light-years from Earth. The astronomers say Eta Boötis has 1.6 solar masses and an age of 2.7 billion years.

The Sun is older than both Procyon and Eta Boötis, but it's in a less advanced stage of evolution because it has less mass and, therefore, consumes its fuel more slowly. It is still a main sequence star, converting hydrogen into helium at its core. According to a model of the Sun's evolution published in 1993, the Sun will leave the main sequence in 6.4 billion years and shine as a subgiant for 730 million years afterward. Then it will expand into a red giant. Long before that time, Procyon will have shrunk into a white dwarf, like its dim companion.

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