The ages of sun-like stars

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"A Spin-Down Clock for Cool Stars from Observations of a 2.5-Billion-Year-Old Cluster," Søren Meibom, Sydney A. Barnes, Imants Platais, Ronald L. Gilliland, David W. Latham & Robert D. Mathieu, Nature, 517, 589, 2015. The cluster NGC 6819, whose stars are about 2.5 billion years old. Astronomers have measured the rotation periods of thirty Sun-like stars in this cluster and used them to refine the calibrations used to infer a star's age from its rotation period.

The mass of a star is perhaps its most significant feature. It determines

how brightly it shines (a star ten times more massive than the Sun will, during its normal lifetime, shine about forty million times brighter than a star ten times less massive than the Sun), how long it will live (tens of millions of years versus tens of billions of years, respectively, for these two cases), and how it will eventually die (as a supernova or as slowly cooling clump of ashes). The next most significant property of a star is its age, which fixes its current character, the age of its planetary system, and the evolutionary state of its environment, and moreover which can be used to refine details in the theory of how stars evolve.

Unfortunately the ages of the most common stars—the modest-mass, cool stars like the Sun and smaller—are difficult to obtain. Traditional dating methods use stellar properties that either change very little as the stars ages or else are hard to determine. Rotation provides an important alternative. Stars rotate (the Sun rotates once approximately every 26 days), and astronomers know that the rotation rate of a cool star decreases with time. Rotation can provide a reliable determinant of stellar age if it can be properly calibrated, in particular across a range of stellar masses. Stars in clusters make perfect reference objects because they all apparently have a similar age. Such age calibrations have indeed, been done, but so far only for stars in clusters less than about one billion years old, not older. This is in part because young stars lose their spin very rapidly as they age, primarily via magnetically powered winds that carry away angular momentum, and after about 600 million years there is a well-defined mass-rotation relationship. The Hyades cluster of stars is about this age, and it has been used to fix the rotation parameters for this young age group. At the older end of the calibration sequence the Sun, at 4.6 billion years, has a well known rotation period. What has been missing is accurate rotation information for the ages in between.

CfA astronomers Soren Meibom and Dave Latham, along with four colleagues, have determined the rotation period measurements for 30 cool stars in the 2.5- billion-year-old stellar cluster NGC 6819. They

used the precise data from the Kepler exoplanet mission to monitor cool stars in this cluster, supplemented by ground-based and other datasets. They find a well-defined relationship between rotation period and stellar mass, and make the case that stellar ages can now be determined with a precision of order 10% for large numbers of cool Galactic field stars. This important new age-dating calibration will enable astronomers to study how astrophysical phenomena involving cool stars evolve over time, and will be important to a wide range of research from the Galactic scale down to the scale of individual stars and their companions.

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