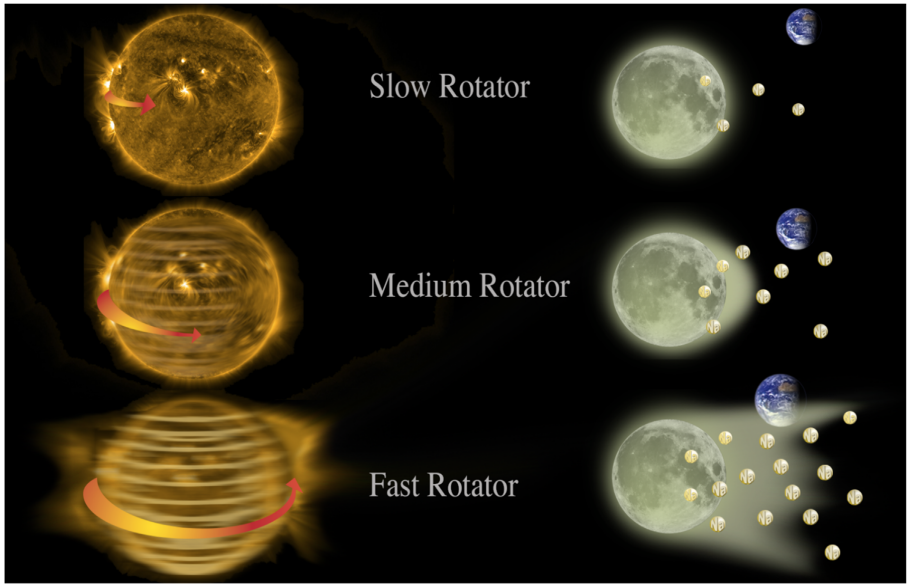
Goddard Space Flight Center
ISFM

Was the Primordial Sun a Slow Rotator?

What is the science question? What was the Sun's primordial rotation state?

What were your findings? By determining the loss of elemental sodium and potassium from the Moon's surface and using stellar rotation vs. stellar activity data from the Kepler space telescope, we have found that that the primordial Sun is highly likely to have been a slow rotator. Using a model that predicts the generation of the Moon's tenuous atmosphere, or "exosphere," as well as the escape of material from the Moons' surface, we are able to put bounds on the solar activity and space weather environment over the history of the solar system. This primordial space weather may have driven the loss of a significant portion of moderate volatiles such as sodium and potassium from the surface of the Moon. Since studies suggest that solar flare activity is greater for stars that rotate quickly, the present amount of remaining sodium and potassium in the Moon's regolith indicates a slower primordial rotation rate of the Sun relative to other Sun-like stars.



Cartoon image depicting the change in loss of sodium and other moderate volatile from the surface of the Moon as a function of solar rotation speed. (NASA GSFC/Jay Friedlander).

What was the impact? Our work shows that the history of the Sun's activity and the space weather environment in the inner solar system is recorded in the lunar crust! Here we show that using current observables of the Moon, we are able to constrain the Sun's primordial rotation rate. Given how solar activity has influenced the atmospheres, surfaces and habitability of all planets in the inner solar system, future missions to the Moon should target further solar activity information.

Why does it matter to non-scientists? The rotation state of the Sun is a fundamental unknown property that has now been constrained. We have also learned that the lunar crust is a unique and valuable recorder of important solar activity history.

Saxena, P. et al., (2019). Was the Sun a Slow Rotator? Sodium and Potassium Constraints from the Lunar Regolith. The Astrophysical Journal Letters, 873(1), L7.