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Planets May Affect the Chemistry of Their Stars

A stellar survey shows that planet-hosting stars tend to be highly depleted in lithium

By John Matson | Wednesday, November 11, 2009 | 9 comments

Planets are, by and large, at the mercy of their stars. Not only do stars provide a ready energy source of radiated light and heat, but the mass and gravitational pull of stars flat-out dwarfs the summed masses and pulls of any orbiting companions. In our solar system, which has more planets—regardless of where one stands on the Pluto debate—than any other planetary system we know of so far, the sun still makes up more than 99.8 percent of its system's mass.

But a new survey of stellar chemistry in solar-type stars reveals at least one way that pip-squeak planets can strike back, affecting the evolution of their parent stars. A paper in the November 12 issue of *Nature* shows that lithium is greatly depleted in stars known to host planetary systems compared with otherwise similar stars that appear to be barren of planets. (*Scientific American* is part of the Nature Publishing Group.)

A correlation between stellar lithium abundances and the presence of planetary systems had been suspected for years—our lithium-weak sun, for one, certainly fits the bill. But the catalogue of stars with such extrasolar planets, or exoplanets, was too small to evaluate the relationship with statistical confidence. In the past dozen years, however, numerous exoplanetary discoveries have been announced, including a suite of 30 new planets unveiled in October by the European Southern Observatory's HARPS planet-finding collaboration that boosted the full set of known exoplanets to more than 400.

Study co-author Nuno Santos, an astrophysicist at the Center for Astrophysics at the University of Porto in Portugal, and his colleagues took chemical-abundance data, derived from precision light spectra, on 133 stars of roughly sunlike temperature from the HARPS survey, 30 of which are known to harbor planets. (They also added more than two dozen other stars to the population to boost the sample size.) The vast majority of stars with planets were excessively depleted in lithium, whereas most "single" stars were only partly depleted. And in a subset of the 84 stars closest to the sun's temperature, the correlation was even stronger.

The researchers suspect that the presence of orbiting planets may increase convective mixing in the host star, plunging the lithium into its hotter regions where nuclear reactions consume the light element as fuel. "We know that lithium depletion in a star is dependent on the history of the star, how it rotates through its history," Santos says. "The presence or formation of planets could change this rotational history of the star."

But might lithium-depleted stars simply be more amenable to planet formation? Not likely, Santos says. "I don't think that's the reason, because actually lithium is not supposed to play any role in planet formation," he says. "There are only very small quantities of lithium, so it's not acceptable that lithium is, by itself, influencing planet formation. The idea is that things come the other way around. By some process, the planet-formation process is influencing the depletion of lithium in the atmosphere of the stars."

Whatever the reason, a simple lithium measurement—in concert with characteristics such as stellar mass and other chemical abundances—might aid future exoplanet hunters in pegging the stars that are most likely to bear planetary fruit.