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Geysers and the Search for Habitable Exoplanets

The search for habitable environments outside of our Solar System isn't confined to exoplanets that may have surface water oceans. While Earth is the only world in our Solar System to harbor a surface ocean *presently*, there are several worlds with subsurface oceans, and there is growing interest in exoplanets that may harbor potentially habitable subsurface oceans.[1] This begs the question, how would you go about detecting a subsurface ocean on a world beyond our Solar System?

A NASA science team led by Dr. Lynnae Quick, a scientist at NASA's Goddard Space Flight Center, recently identified 17 exoplanets that could harbor oceans of liquid water beneath icy shells.[2] The team's recent paper describes how geysers might be observed on two of these exoplanets.[3] Excitingly, one of them is Proxima Centauri b, an exoplanet that orbits the star closest to our Sun at a distance of "merely" 4.2 light years!

Geysers have been observed on Europa and Enceladus, icy ocean worlds in our Solar System that are internally heated by tidal interactions with the planets they orbit (Jupiter and Saturn, respectively). The analyses conducted by Dr. Quick and her colleagues predict the aforementioned 17 exoplanets may receive enough internal heating from the decay of radioactive elements and tidal forces from their host stars to maintain subsurface oceans. Surface temperatures of the exoplanets combined with estimates of the total internal heating allowed the team to estimate the thickness of the ice layer for each exoplanet. By comparing these figures to Europa, they estimated the expected level of geyser activity on each of the 17 exoplanets.

Proxima Centauri b and LHS 1140 b, which is 49 light years away, are good candidates for the possible telescopic detection of geysers. The rate of geyser activity on these worlds could exceed geyser activity on Europa by hundreds to thousands of times. Geyser activity might be detected on Proxima Centauri b, which does not transit (pass in front of) its star, through changes in the exoplanet's reflectivity during its orbit. The prospects for LHS 1140 b, which does transit its star, are even more exciting, as it might be possible to evaluate the exoplanet's habitability potential by analyzing the chemical composition of water vapor from its absorption of starlight during transit.

Lest the discussion of exoplanets and habitability become seemingly mundane, it behooves us to remember the remarkable technology that makes these observations and discoveries possible. Although LHS 1140 b is metaphorically in our backyard in terms of interstellar distances, it is roughly 730,000 times more distant than Europa. Something to think about while sipping that holiday aperitif!

Wishing you all joyful holidays and a Happy New Year!

1 https://www.nasa.gov/specials/ocean-worlds/
2 https://www.nasa.gov/science-research/planetary-science/astrobiology/nasa-some-icy-exoplanets-may-have-habitable-oceans-and-geysers/
3 https://iopscience.iop.org/article/10.3847/1538-4357/ace9b6

Until 2024,

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