Multi-Metric Habitability Assessment of Exoplanet Classes

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The age-old question: Are we alone in the universe? has fascinated us for centuries. The concept of a habitable zone (HZ) was introduced over 170 years ago by William Whewell. Since then, researchers have explored habitability utilizing various metrics to identify exoplanets likely to be habitable.

The presence of liquid water on a planet's surface is the fundamental requirement for life to exist, and to assess this, we use the Habitable Zone Distance metric. It determines an exoplanet's position relative to its host star's HZ. We can also measure how similar an exoplanet is to Earth using the Earth Similarity Index (ESI). It is based on radius, density, temperature, and escape velocity of an exoplanet. Additionally, we can assess potential biological complexity using the Biological Complexity Index (BCI). It utilizes substrate, energy source, surface temperature, geological factors, and the planet's age parameters.

We integrate and apply these metrics to over 4,500 exoplanets to identify the class of exoplanets most likely to reside in HZs, having an ESI greater than 0.8 and a BCI greater than 0.5. Despite the speculative nature of these evaluations, this catalogue refines our search for habitable worlds and helps future missions in narrowing down their targets.