Paper ID: 61280
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

Author: Ms. Hikaru Furukawa
Arizona State University, United States, hikaru.furukawa@asu.edu

Dr. Sara Imari Walker
Arizona State University, United States, sara.i.walker@asu.edu

MOLECULAR WEIGHT DISTRIBUTION: UNIVERSALITY ACROSS LIFE AND POTENTIAL FOR STATISTICAL BIOSIGNATURES

Abstract

The recent advancement in astrobiology taught us how biased our search for life in the universe can be. The famous examples include searching for oxygen or water as a biosignature on exoplanets, which is now known to have the risk of resulting in false positives. What we think to be the properties of life can be heavily biased by life on Earth, and other planets might have life with completely different properties. We can easily miss potential discoveries of life elsewhere by holding such biases. In order to be as less biased as possible, it is important to focus on understanding what life is fundamentally doing and how that is different from abiotic phenomena. This should be distinguished from paying attention to superficial properties associated with life that can lead to false positives.

To this aim, we took a statistical approach using big data to understand the shared patterns of all biological organisms. This approach allows us to look at the universal patterns across various organisms on this planet and uncover fundamental principles of life. There are three distinct domains of life: archaea, bacteria, and eukarya. We use one of the biggest databases that catalogues species in all domains of life, and analyze the chemical compounds used by different species in different domains. This allowed us to look at the statistical patterns of what kind of chemical compounds are utilized universally across different life forms and how complex those compounds are.

Understanding chemical complexity used by life can be a very powerful agnostic way to distinguish life versus non-life as we search for life elsewhere. Unlike paying attention to specific molecules, we look at the number of compounds used by organisms and molecular weight of compounds, where molecular weight is considered as a proxy of chemical complexity.

Our work showed that there is a universal pattern of how biology uses complex heavy molecules and how such molecules are distributed within each species and each domain. The results showed that the three domains of life share the same distribution patterns of molecular weight of compounds they use. This result suggests that unknown life forms on other planets we have not encountered can be potentially distinguishable by looking at its usage of complex molecules and its statistical patterns.