Astrobiology News May 2017:
Revisiting TRAPPIST-1: The Harmony of the Worlds

Two months ago, I reported the discovery of seven Earth-sized worlds orbiting the "nearby" star known as TRAPPIST-1. Because of the significance of this discovery to the search for life beyond Earth, I decided to revisit the incredible TRAPPIST-1 system this month. I encourage those who are interested to keep up with the latest information on the website created by the science team.[1]

All seven worlds of TRAPPIST-1 transit (pass in front of) their star during their orbits, presenting an unprecedented opportunity to study the climates of these planets as starlight passes through their atmospheres. Patterns in the way starlight is absorbed can reveal the chemical composition and structure of the planets' atmospheres. The worlds of TRAPPIST-1 are currently our best bet for discovering evidence of biology beyond our Solar System, and theorists are already working out habitability models based on assumptions that will be better constrained after more detailed studies with the *Hubble Space Telescope* and the future *James Webb Space Telescope*.[2]

Another amazing aspect of the TRAPPIST-1 system is the proximity of the orbits of the seven worlds to each other. The planets are locked in an "orbital resonance", which means the lengths of time it takes them to orbit their star (each planet's "year") are related by integer ratios. In the time it takes the outermost planet to complete two orbits, the next planet inward has completed three orbits, then four, six, nine, 15, and 24 for the innermost planet.

Resonant orbits can be a source of chaos. They provide a gravitational "boost" that is similar to the way periodically pushing a child on a swing causes the swing to go higher and higher. The problem is that the pushes add up and initial computer simulations of the TRAPPIST-1 system indicated the planets should crash into each other in less than a million years, although their star is billions of years old. Resonant orbits can, however, also be a source of stability, depending upon other important factors. The results of research published this month by astrophysicist Daniel Tamayo suggest that if these planets formed slowly, the system could have been fine-tuned to orbits that could persist stably for billions of years.[3]

The research on the planets' orbits led to an interesting collaboration between Tamayo and Matt Russo, an astrophysicist with a degree in jazz guitar who moonlights as a guitarist in an indie pop band.[4] Musical harmonies arise from resonances in the frequencies of particular pitches. Russo, noted, "I immediately recognized that [the orbital resonance] would make beautiful music because it's the same pattern of period ratios that makes chords." Supercomputer simulations illustrate that this remarkable harmony keeps this system stable. I encourage you to listen to *The Song of a Solar System: TRAPPIST-1* on YouTube[5], and while you're at it, check out the short stories, graphic novels, and poems that have been already inspired by this astonishing planetary system![6]

Stay tuned (I couldn't resist!) until next month,

Grace

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[1] See www.trappist.one

[2] Wolf, E. T. 2017, *Assessing the Habitability of the TRAPPIST-1 System Using a 3D Climate Model*, ApJL, 839 (6pp)

[3] Tamayo. D. et al. 2017, *Convergent Migration Renders TRAPPIST-1 Long-lived*, ApJL, 840 (6pp)

[4] https://www.washingtonpost.com/news/speaking-of-science/wp/2017/05/11/watch-the-delicate-song-and-dance-that-keep-trappist-1-planets-from-blowing-up/?utm_term=.9cab5e46a036

[5] https://www.youtube.com/watch?v=7i8Urhbd6eI

[6] http://www.trappist.one/#stories