Strange Nonchaotic Stars and Galactic Communication

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New idea for SETI

Learned et. al. proposed that a sufficiently advanced extra-terrestrial civilization may tickle Cepheid and Lyrae variable stars with a neutrino beam at the right time, thus causing them to trigger early and jogging the otherwise very regular phase of their expansion and contraction. This would turn these stars into beacons to transmit information throughout the galaxy and beyond. The idea is to search for signs of phase modulation (in the regime of short pulse duration) and patterns, which could be indicative of intentional signaling.

John G. Learned. R-P. Kudritzki. Sandip Pakvasa. and A. Zee in The Cepheid Galactic Internet arXiv:0809.0339v2

(not to scale)



What we expected from RR Lyrae



Learned et al. hypothesis



What we found



Data search is now possible

- Goal: Uninterrupted period lengths over long timescales (months, years)
- Earth-bound data is sparsely sampled (day/night, weather)
- Data from the *Kepler* spacecraft is of good quality and continuity (~99% duty cycle)
- A first test was done with the only Cepheid in the (original) Kepler field of view, V1154Cyg. It shows only slight period variations
- Following analysis was done with the 43 Lyrae stars in the Kepler field of view (Nemec et. al. 2013)
- RRc Lyrae star KIC5520878 shows large period variations (~20%) with nonrandom pattern



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John G. Learned







William Edmondson



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A state

Ian Stevens

Is it Aliens?



Period lengths over 3yrs



Disentangle the periods

When looking at the frequencies, we see:

- The main pulsation f_1 (0.27 days)
- Its multiples
- Secondary pulsation $f_{\rm X}$
- Multiples of f_1 and f_X as well as $f_1 + f_X$ etc.
- We can fit sines, simultanously, to all (significant) frequencies but f_x itself and subtract them ("pre-whitening") [here be dragons]
- Ideally, the result will give the pure view of *f*_x, which be think causes the funny modulation
- → This is a natural phenomon! But we found a new (sub)type of star.

The particle zoo: Neutrinos, gravitional waves, and others

[Neutrino communication is]

"so difficult that an advanced civilization may purposely choose such a system in order to find and communicate only with ETCs at their own level of development."

Subotowicz, 1979



A lot of astrophysics research followed



I. Maximized data rate for lightweight space-probes

Hippke, M. 2018, International Journal of Astrobiology (ADS, PDF)



IV. Benchmarking information carriers

Hippke, M. 2017, Acta Astronautica (ADS, PDF)



VII. Benchmarking inscribed matter probes

Hippke, M., Leyland, P., Learned J. G. 2017, Acta Astronautica (ADS, PDF)



II. Application to the solar gravitational lens

Hippke, M. 2017, Acta Astronautica (ADS, PDF)



V. Introduction to photon information efficiency (in bits per photon)

Hippke, M. 2017 (ADS, PDF)



VIII. Hard limits on the number of bits per photon

Hippke, M., 2018 (ADS, PDF)



III. Optimal frequency to maximize data rate Hippke, M., Forgan, D. H. 2017 (ADS, PDF)



Hippke, M., Forgan, D. H. 2017 (ADS, PDF)



Hippke, M., Learned, J. G. 2018 (ADS, PDF)



Wavelength (μm)

X. The colors of optical SETI

Astronomy (in press) (ADS, PDF)

Hippke, M. 2018, Journal of Astrophysics and

XI. Short pulse duration limits of optical SETI

Hippke, M., 2018, Journal of Astrophysics and

0.1

Spacing of Spectral Absorption Lines

Hippke, M. 2018 PASP in press (ADS, PDF)

Redshift z

Periodic Spectral Modulations Arise from Non-random

0.2

0.3

Astronomy (in press) (ADS, PDF)

100

Photogravimagnetic assists of light sails

Forgan, D., Heller, R., Hippke, M. 2018, Monthly Notes of the Royal Astronomical Society (ADS, PDF)

nce (Stellar Radii)



Optimized trajectories to the nearest stars using lightweight high-velocity photon sails

Heller, R., Hippke, M., Kervella, P. 2017, Astronomical Journal (ADS, PDF)



Deceleration of high-velocity interstellar photon sails into bound orbits at alpha Centauri

Heller, R., Hippke, M. 2017, Astrophysical Journal Letters (ADS, PDF)







Spaceflight from Super-Earths is difficult

Hippke, M. 2018. International Journal of Astrobiology (ADS, PDF)

Wavelength λ (nm) VI. Searching X-ray spectra for narrowband communication

Thank you to John Learned for this amazing journey into (astro)physics!