Green Bank 100 m Telescope Observations of Boyajian’s Star from 1–27.5 GHz with the Breakthrough Listen Backend

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Below we show an intriguing (but presumably natural) discovery from our MIR survey. Megastructures—planet-sized or larger artificial structures or swarms of structures in space—would be detectable in a noticeable mid-infrared excess (MIR). Modern MIR surveys are sensitive to excesses of only a few percent. Civilizations with energy supplies comparable to their stellar output (Kardashev type II civilizations) will have detectable signatures of artificial objects. Searches for artificial stellar sources of infrared radiation started in 2004 with the Kepler space mission, and by over 15% over the past century. Both of these phenomena are unprecedented and extremely difficult to explain, given the star’s otherwise ordinary status: it does not appear to be young or evolved and shows no evidence of a disk or radial velocity variations indicative of stellar-mass orbital companions. Its lack of near-infrared excess puts tight constraints on the amount of material that could be orbiting it.

Boyajian’s Star is consistent with predictions of transits from orbiting megastructures. In parallel to our efforts to find a natural explanation for this intriguing star, we have begun a SETI campaign at the Green Bank Telescope to make an unprecedentedly deep and broad survey of the star’s radio spectrum to search for potential transmissions from alien civilizations. Searches for laser emission are also underway.


Links and popular descriptions

GBT Observations

- We were granted 25h of Green Bank 100m Telescope time through the NRAO Open Skies call. Our observations were spread over 4 days between 26 October 2016 and 31 January 2017.
- We used the L,S,C,X, and KPFA receivers to cover much of the spectrum between 1–27.5 GHz. We used the Breakthrough Listen backend to achieve an instantaneous bandwidth of up to 3.938 GHz.
- We covered the entire bandwidth afforded by the KPFA receiver with three intermediate frequency tunings of the down-conversion system.
- We nodded the telescope to produce on/off pairs of observations to enable robust RFI rejection.
- We observed flux and polarization standards in each configuration, and made observations of Mars in X band (to observe signals from its orbiters) and maser sources (including DR 21(0H)) as checks on our procedures.
- We all recorded data in “raw voltage” mode, and are transferring these data over the Internet to the PSU Advanced CyberInfrastructure high performance computing cluster. The total data volume is ~450 TB.
- Because the data were stored as raw voltages, we anticipate applying novel analysis methods, and invite suggestions for them.
- As with all Breakthrough Listen data, we intend to make the data public or publicly analyzable.
- These observations demonstrate the capabilities of the Breakthrough Listen backend and we hope will be emblematic of “gold standard,” high bandwidth SETI observations for future observing campaigns of particularly promising SETI targets identified via artificial intelligence searches.