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51st IAA SYMPOSIUM ON THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI) – The Next Steps (A4)
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ON THE INTERPLANETARY MEDIUM INDUCED SPECTRAL BROADENING OF THE PUTATIVE NARROWBAND SIGNALS FROM ETI (EXTRATERRESTRIAL INTELLIGENCE)

Abstract

Narrowband radio signals with extremely limited spectral occupancy (¡¡1 Hz) are prime candidates for potential beacons from Extraterrestrial Intelligent (ETI) civilizations. Solar wind and interplanetary medium (IPM) density fluctuations can impose significant temporal spectral broadening and scintillation (hereafter referred to as TSB) on a transiting narrowband signal. Using deep space probes such as Pioneer 11, Galileo, and Helios 1 /2 as monochromatic and coherent radio test sources, earlier studies have measured the association between small-scale density fluctuations in the IPM and TSB for narrowband signals as a function of solar impact angle (Woo 1977, Woo and Armstrong 1978, Woo 2007). It was found that TSB has a strong relation with observing frequencies with lower radio frequencies being affected significantly more compared to higher frequencies. Here, we extrapolate these findings to estimate expected TSB from an orbiting putative ETI transmitter with an inclination angle close to 90 deg and thus a line-of-sight temporally passing close to its parent star. We show that at lower radio frequencies, the expected spectral broadening can go up to ¿100 Hz depending upon the line-of-sight impact angle with the parent star. This is significantly larger and can readily influence the sensitivities of future narrowband signal searches. The timescale of TSB depends upon the stellar activity cycles, coronal mass ejection (CME) rate, and other flaring activities which strongly correlate with the spectral type of ETI parent star. For example, an ETI transmitter orbiting a Sun-like star (with inclination angle 90 deg) is likely to exhibit periodic TSB with a few random TSB events due to less frequent CMEs. While an ETI transmitter closely orbiting an M-dwarf star is likely to experience several TSB per day due to high CME activities. In this paper, we modelled the timescale of TSB for all known exoplanets and extrapolate it to all spectral type stars with a range of hypothetical planetary orbits and inclination angles. Large scale wide-field searches are underways at existing low-frequency radio observing facilities and are planned with further upcoming even more extensive facilities to scour for these signals. For these searches, potential ETI signals are searched largely towards known stars in the field of view; in many cases using the newly released Gaia catalogue. Our study is the first of its kind which can provide a validation tool to scrutinize detected narrowband signals towards any known star. It can also allow measurement of the necessary phase-coherent spectral broadening correction to improve SNR for a putative orbiting ETI transmitter. We conclude how these studies are beneficial for wide-field low-frequency surveys from current and future large-scale observing facilities such as LOFAR, extended MWA, and SKA-low.