Spectral Kurtosis Identification of Deep-Space Technosignatures

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Introduction: Given the expansion of radio astronomy instrumentation to ever-broader bandwidths, and the simultaneous increase in usage of the radio spectrum for wireless communication, radiofrequency interference (RFI) has become a limiting factor in the design of a new generation of radio telescopes. In an effort to find reliable solutions to RFI mitigation, Nita et al. (2007) proposed the use of a statistical tool, the Spectral Kurtosis (SK) estimator, which was proven to be an efficient tool for automatic real-time detection of certain types of RFI and their statistical discrimination against astronomical signals of interest that may have similar spectral shapes, but different signal statistical properties (Nita & Gary, 2010a,b).

Due to the conceptual simplicity of its first ever hardware implementation (Gary et al., 2010) the SK hardware design has been proposed to become a standard, built-in component of any modern radio spectrograph or FX correlator that is based on field-programmable gate array (FPGA) or Graphics Processing Units (GPU) architecture. Since then, this proposed design has been adopted by several design teams for the purpose of real-time RFI detection and excision, e.g. the Expanded Owens Valley solar Array (EOVSA, Nita et al., 2016b), GBT (Kar et al., 2019) and the Canadian Hydrogen Intensity Mapping Experiment (CHIME, Taylor et al., 2019). Nevertheless, the mathematical formalism of the generalized SK estimator introduced by Nita & Gary (2010b) allows its integration in the data processing pipelines of already existing instruments that output time-integrated or/and low-bit-depth data streams, in either the spectral (Nita et al., 2016a) or temporal (Nita et al., 2018, 2019) domains.

Given its ability to automatically discriminate natural and artificial signals based on their statistical properties, (Nita, 2016) proposed the use of the SK estimator for searching for deep-space technological signatures and, as a proof of concept, Nita et al. (2018, 2019) employed for the first time this approach to unambiguously infer the Gaussian statistics of one of the observed fast radio bursts (FRB, Lorimer et al., 2007) produced by the FRB 121102 repeating source (Spitler et al., 2016; Scholz et al., 2016).

About this presentation: Here we investigate the SK statistical signature of a signal observed with the Robert C. Byrd Green Bank Telescope Breakthrough Listen back-end (MacMahon et al., 2018) that was transmitted by the Voyager 1 spacecraft, which is up to date the only known artificial signal originating from outside our solar system, and we demonstrate the ability of the SK estimator to perform real-time detection and discrimination against natural astronomical transients of deep-space Voyager 1-like technological signatures of alien origin.

We use the same approach to investigate the yet controversial nature of the FRB 180301 signal detected during the Breakthrough Listen observations with the Parkes telescope (Price et al., 2019).

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