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Quantifying the coherence of Jupiter S-bursts

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We present the results of recent observations of Jupiter S-burst decametric emission performed at the Ukrainian radio telescope UTR-2 equipped with a fast waveform receiver working at sampling rate of $\sim$66 MHz. The analysis is focused on coherent properties of subpulses detected at microsecond time scale resolution. It is shown that the observed coherence of S-bursts can be described either in terms of stationary segments of instantaneous phase, or narrow bandwidth of the instantaneous frequency of S-burst patterns drifting across the dynamic spectra. An efficient algorithm based on the concept of analytic signal is proposed for extracting phase information from the recorded time series. It allowed automated identification of subpulses to be performed, followed by a statistical analysis of coherence properties of quasi-harmonic segments as well as tests for the presence of long-time correlations. The model of narrow band random process is then shown to provide an adequate statistical description of both the amplitude and phase variation in the observed waveforms. It is suggested that distribution of instantaneous amplitude (i.e. oscillations envelope) gives an important clue to underlying physical mechanism of S-burst generation. In particular, it is shown that models of "generator"-type, i.e. a nonlinear system with feedback, are less suitable for reproducing the statistical characteristics of S-bursts at microsecond level of temporal resolution. On the other hand, the concept of a linear system that enhances fluctuations within a narrow band, e.g., a cyclotron-maser-amplifier type model, fits well the observational data.