

Kappa parameter estimations using quasi-thermal noise spectroscopy

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Quasi-thermal noise (QTN) spectroscopy is an accurate technique for in situ measurements of electron density and temperature in space plasmas. The QTN spectrum has a characteristic noise peak just above the plasma frequency produced by electron quasi-thermal fluctuations, which allows a very accurate measurement of the electron density, a thermal plateau at lower frequencies where signal scales with electron core temperature, and a power law decay towards higher frequencies, which has an intensity scaled with total plasma pressure. The size and shape of the peak, as well as properties of the spectral region below the plasma frequency, are determined by suprathermal electrons. Since this nonthermal electron population is well described by a generalized Lorentzian κ velocity distribution, it is possible to determinate the distribution properties in the solar wind from a measured spectrum. In this work, we discuss some basic properties of the QTN spectrum dependence of the κ distribution parameters - total electron density, temperature and the κ index, and give overview on how instrument characteristics and environment conditions affect quality of the measurements. As value of the κ is expected to be approximately 4-5 in the slow solar wind at 1AU, it turns out that the spectral resolution of an instrument is needed to be of the order of 2 – 3% for accurate determination of the κ index. This requirement hasn't been fulfilled in most of the previous missions due to very large number of frequency channels required in order to cover the given spectral range. However, the high spectral resolution is not required on the entire spectral domain, but only on specific areas around and just below the peak, while for other spectral regions the resolution can be significantly (2-5 times) lowered without increasing the measurement uncertainties. This is the reason why usage of adaptive spectrum is proposed for some future missions, like Solar Probe Plus, where the spectral resolution will not be constant on the entire domain, but rather adapted to the changes in estimated local electron density.

[1] M.M. Martinović et al., J. Geophys. Res.: Space Phys. **121**, 129 (2016).

[2] M.M. Martinović, Serbian Astr. J. **192**, 27 [3] I. Zouganelis, J. Geophys. Res.: Space Phys. **113**, A08111