Quasi-thermal noise spectroscopy in space plasmas

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The transport of energy in space plasmas, especially in the solar wind, is far from being understood. Electrons are expected to play a major role for energy transport. Therefore, measuring accurately the temperature of the electrons and their non-thermal properties is essential to understand the transport properties of plasmas in non-local thermodynamic equilibrium. Quasi-thermal noise spectroscopy is a reliable tool for measuring in situ the electron temperature accurately since it is less sensitive to the spacecraft perturbations than particle detectors. This method uses a sensitive radio receiver connected to dipole antennas to measure the electrostatic fluctuations produced by the motion of charged particles in the surrounding plasma. This method has been successfully implemented on a number of spacecraft in various space plasmas. Spacecraft such as ISEE3/ICE, Ulysses, Wind, and STEREO have used or are still using quasi-thermal noise spectroscopy to measure the electron properties in the solar wind, a cometary trail, and the Jovian environment; while IMAGE used this method to study Earth's magnetosphere, and Cassini continuously uses quasi-thermal noise spectroscopy in Saturn's magnetosphere.

After introducing the basics of quasi-thermal noise spectroscopy, we will briefly review results of this method in the solar wind and planetary magnetospheres. Finally, we will present instruments dedicated to this method aboard the future missions Bepi Colombo, Solar Orbiter and Solar Probe Plus, and the new improvements of quasi-thermal noise spectroscopy that will maximize its scientific impact.