INFLUENCE OF RANDOM IRREGULARITIES ON QUASI-THERMAL NOISE SPECTRUM OF PLASMA

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In the past three decades the thermal noise spectroscopy was recognized as a fruitful tool of space plasma diagnostics. Some examples of application of this diagnostic method can be found, for example, in [1]. It is well known that random irregularities of electron density always present in real plasma. Irregularities substantially change properties of the medium with relation to electromagnetic radiation and they may also influence quasi-thermal noise spectrum detected by antenna. What is the physical mechanism of this influence? It is known, that fluctuations in plasma are closely connected with plasma dissipative properties. From the viewpoint of statistical mechanics, random irregularities in plasma may be thought as non-thermal large-scale (in comparison with characteristic time and scale of particle motion) fluctuations. These may considerably change collisional term in kinetic equation and, consequently, velocity distribution function. The change in distribution function will lead to change in the noise spectrum. From the viewpoint of electrodynamics, random irregularities change averaged dielectric properties of the medium. It means that in the media with random irregularities the roots of dispersion equation are shifted with relation to undisturbed values and even new roots may appear (see, for example, [2]). The imaginary part of these roots may also be considerably changed due to additional non-collisional attenuation caused by scattering of waves in random medium.

In the present paper we will assume that noise spectrum in the random medium may be calculated using the tensor of effective dielectric permittivity. Since effective dielectric permittivity tensor determines mean field of the source in random media, it also determines the impedance of antenna which, in its turn, determines the noise spectrum. The method based on effective dielectric permittivity tensor was used to study thermal noise spectrum in dielectrics [3]. We apply this approach to the irregular space plasma and show that irregularities cause noticeable effects. In the ionospheric plasma it is a splitting of the peak in the frequency noise spectrum located just above the plasma frequency, into two peaks (Fig. 1). The magnitude of the width of the gap between those peaks depends upon the value of $\Delta = < (\Delta N / N)^2 >$, what may be useful for the irregularity diagnostics. Analytic estimate for this effect is $\Delta\omega \approx \omega_p \sqrt{\Delta / 2}$, where ω_p is the plasma frequency [4]. In the plasma of solar wind irregularities cause changes of the shape of the main spectrum maximum near the plasma frequency resulting in appearance of a "step" on its left-hand side (Fig. 2). This effect can provide essential information about the solar wind irregularities.

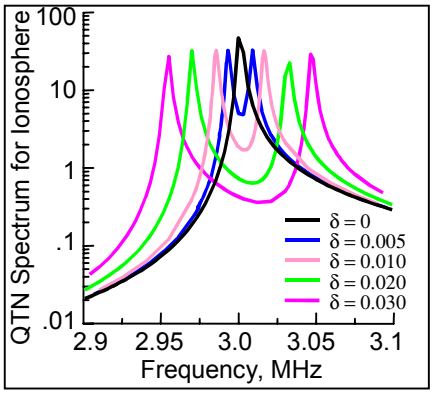

Fig. 1

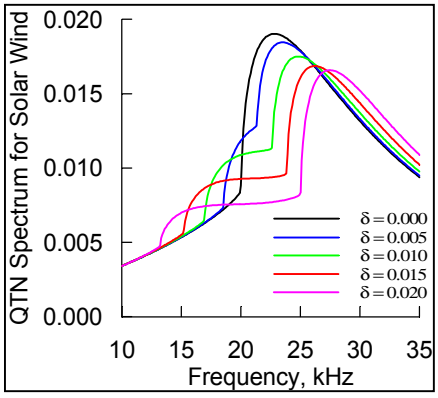

Fig. 2.

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