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Parameters of interplanetary medium

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Abstract. In this article the upper roll-off spatial frequency and the lower roll-off spatial frequency are calculated using diffractive-refractive scattering approach. These results are useful in estimating the parameters of interplanetary medium.

1. Introduction

For various natural situations of scintillation phenomena, Booker and MajidiAhi (1981) distinguishes between diffractive and refractive scattering. The applications of this approach for experiments like ionospheric scintillation, ionospheric drift, spread-F and laser scintillation in the atmosphere are briefly summarized by Vats (1989). This approach is not used for interplanetary scintillation so far. This paper presents a scheme of using diffractive-refractive scattering for interplanetary medium.

2. Result and discussion

The diffractive-refractive scattering approach standardizes the distances in the calculation using Fresnel scale defined as below :

$$F = \sqrt{\frac{\lambda z}{2\pi}} \tag{1}$$

whereas λ = observing wavelength, z = effective distance between irregular medium and observer. For the observation using Rajkot radio telescope (Vats and Deshpande 1994) the wavelength λ is 2.91 m. The value of z for any source in this experiment vary as the Earth orbits around the Sun. The angle between Sun-Earth and the line of sight to the source is the solar elongation angle. For the observations of Rajkot telescope normally z varies from ~.1 to .93 AU. In the present calculations z is taken as 0.34 AU. The plasma irregularities of interplanetary medium are known to have power law distribution in the interplanetary medium and the spectral index could vary from 3 to 4. Here, formulations of Booker and MajidiAhi (1981) for spectral index of 3.5 are used. These formulations are based on numerical experimentation and are given as below :

$$\text{Lens scale L} = F[2<(\Delta\phi)^2>]^{1/4} \quad (2)$$

$$\text{Focal scale l} = Lo/[4<(\Delta\phi)^2>]^{1/2} \quad (3)$$

$$\text{Peak scale P} = F^2[4<(\Delta\phi)^2>]^{1/2}/Lo \quad (4)$$

where $<(\Delta\phi)^2>$ is mean square fluctuation of phase which is related to the integrated mean square fluctuation of ionization density, Lo is the outer scale of the irregularities in the interplanetary medium. Here Lo is assumed to be equal to 10F. The lower roll-off and the upper roll-off spatial frequency may be taken as $[\text{Max}(F,P)]^{-1}$ and $[\text{Min}(F/2,1]^{-1}$ respectively. Using these formulations, the lower roll-off spatial frequency and upper roll-off spatial frequency are calculated for different magnitude of integrated mean square fluctuation of ionization density. This variation is shown in Fig.1.

When diffractive scattering dominates, the lower roll-off occurs at the spatial frequency F^{-1} and the upper roll-off at $(F/2)^{-1}$ Beyond this the lower roll-off and upper roll-off vary in opposite direction as the integrated mean square fluctuation of ionization density increases, as shown in Fig.1. This indicates refractive scattering. This type of theoretical graph along with the actual IPS observations can be used to determine parameters of IPM such as Focal scale, peak scale and lens scale. There is a plan to calculate these parameters for different sources and derive parameters of various locations in interplanetary medium.

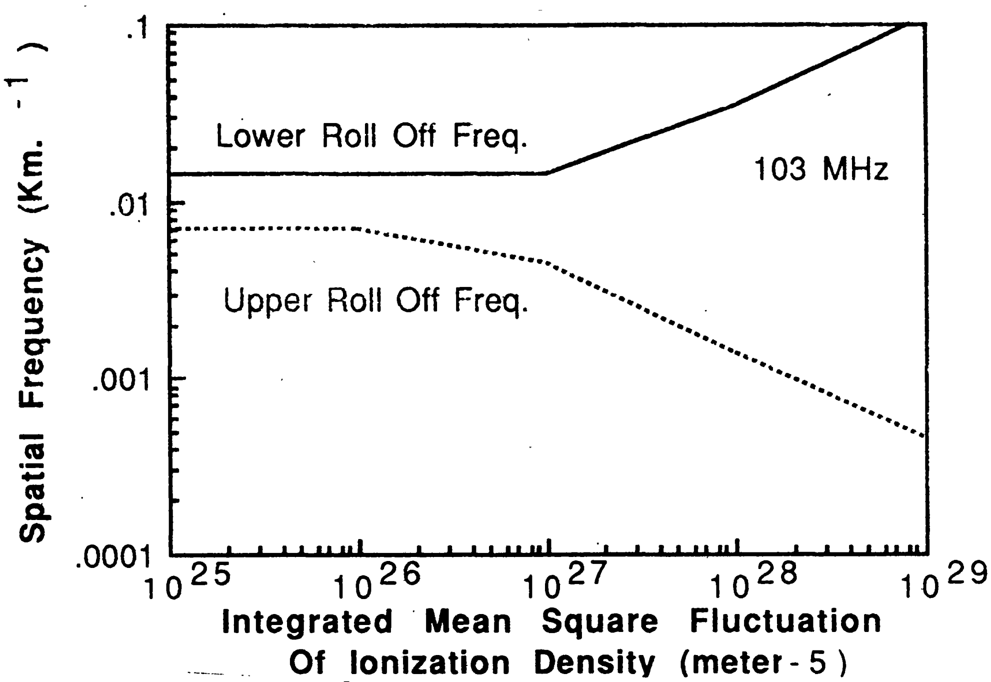

Figure 1. Dependence upon the integrated mean square fluctuation of ionization density of the upper and lower roll-off frequencies in the intensity spectrum at the observers plane. For this z = 0.34 AU, λ = 2.91 m and spectral index = 3.5 are used.

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