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# EFFECTS OF TURBULENT MAGNETOPLASMA ON THE POLARIZED RADIATION FLUCTUATIONS

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As is known, the shape of the wave amplitude or phase fluctuation spectrum in a plasma medium is related to the spectrum of fluctuations in its refractive index and hence that of electron density irregularities. In a number of cases of interest is the question whether fluctuations in the external magnetic field also affect on parameters of the radiation received at the observation points. Is it possible to restore parameters of the spatial spectrum of the fluctuating magnetic field from the correlation function or power spectrum of the observed electromagnetic scintillations? We believe that such measurements coùld be useful for the study of magnetogasdynamic turbulence in the polar ionosphere and magnetosphere and, in particular, near the magnetopause where the random magnetic field component is especially pronounced. There are presented results of studying the fourth-order moments of the polarized radiation passing through a random magnetoplasma. The fluctuations in the electron density and longitudinal magnetic field in the plasma layer are assumed to be statistically uniform. Analytical solutions have been founded for the mean-square deviations and correlation functions of the Stokes parameters, using the solutions to the parabolic equations governing the coherence matrix of the polarized radiation. The Feynman integral technique is used for this purpose.

Let introduce some definitions. The Stokes vector

$\vec{S}(\vec{n}) = \{ I(\vec{n}), Q(\vec{n}), U(\vec{n}), V(\vec{n}) \}$

determines the total flux density (I) and polarization (the rest) of radiation in the direction $\vec{n}$ within the unit acceptance angle and in the unit frequency range. The spatial Fourier component $\vec{S}(\vec{B})$ is denoted as

$\vec{S}(\vec{B}) = \int d^2\vec{n}\, \vec{S}(\vec{n}) \exp ( i \cdot k \cdot \vec{n} \cdot \vec{B} )$,

where $\vec{B}$ is the spatial diversity at the plane perpendicular to the line-of-sight, k is the wave number of the radiation. The interferometer with the baseline $\vec{B}$ measures superposition of such Fourier components. We denote the spatial correlation function of the Stokes parameters $B_\alpha$ using the equation

$B_\alpha(\vec{r}_1, \vec{r}_2, \vec{R}) = \langle S_\alpha(\vec{r}_1, \vec{r}_2) \cdot S^*_\alpha(\vec{r}_1 + \vec{R}, \vec{r}_2 + \vec{R}) \rangle -$
$- \langle S_\alpha(\vec{r}_1, \vec{r}_2) \rangle \langle S^*_\alpha(\vec{r}_1 + \vec{R}, \vec{r}_2 + \vec{R}) \rangle$,

where $\vec{r}_1, \vec{r}_2, \vec{R}$ are the two-dimensional vectors at the observation plane and $S_\alpha$ is either of components of the Stokes vector.

The major result of the study is prediction of a new propagation effect arising from chiral properties of the magnetoplasma, namely:

The lenses formed by the same irregularities of $\delta H$ may be characterized by refractive properties of opposite sense vis-a-vis the rotation of the wave polarization vector. This results in a negative sign of the mutual correlation of amplitude logarithms of the right hand (RCP) and left hand (LCP) circularly polarized waves, bringing forth a weak circularly-polarized fluctuating component from the initially nonpolarized radiation. Evidently, the effect can prove detectable only at sufficiently low observation frequencies close to the plasma frequency level. An order of magnitude estimate for the ratio $G_{VI}=B_V(\vec{R})/B_I(\vec{R})$ is

$$G_{VI} \sim (\omega_H/\omega)^2 (C_H^2 + C_N^2)/C_N^2 ,$$

where $\omega_H$ is gyro frequency, $C_N^2$ and $C_H^2$ are structure constant of the relative fluctuations $\delta N=(N-\langle N\rangle)/\langle N\rangle$ and $\delta H=(H-\langle H\rangle)/\langle H\rangle$, respectively.

In the region of the Earth s magnetopause the contribution of the $\delta H$ - related component may prove predominant during a magnetic storm or substorm. In such cases the value of $G_{VI}$ may be

$$G_{VI} \sim (10^2 \div 10^3)\cdot(\omega_H/\omega)^2 .$$

At frequencies about tens of kilohertses the magnetic field fluctuations show themselves through the domination of circularly polarized fluctuations. Accordingly, the correlation function of the circularly polarized component is determined chiefly by magnetic field fluctuations, while fluctuations of the total flux density are relatively less important than such of the circular component. In fact, the enhanced level of circularly polarized fluctuations allowing to detect the irregular magnetic field can be observed at low frequencies only, say in the radiation passing through the solar chromosphere or Jovian and terrestrial ionosphere ( magnetosphere ).

The behavior of correlation functions of the linear polarized fluctuations $B_Q(\vec{R})$ and $B_U(\vec{R})$ is controlled by the phase difference of the RCP and LCP fluctuating (rotation measure fluctuations). Therefore, an analysis of the invariant $B_Q(\vec{R}) + B_U(\vec{R})$ can give a possibility to determine some parameters of the $\delta H$ or $\delta N$ spectrum over a wide do main exceeding the Fresnel zone in size. In particular, with weak fluctuations of the rotation measure, this is possible as far as the outer scale size. Thus, analysis of linearly polarized fluctuations is in fact more instructive, however it is necessary that the radiation was initially linearly polarized. That is more characteristic of man-made radiation sources.

Since the temporal characteristics of the received signal are measuring more easily than the spatial characteristics of it, then in number of cases of interest is studying of the frequency spectrum of polarized radiation fluctuations. The analysis of the Stokes parameters fluctuations or their frequency spectra may allow detecting the shape of the spatial or temporal spectrum of the irregular magnetic field.