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Processes in complex (dusty) plasmas in the midlatitude ionosphere during high-speed meteor showers

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The emission low-frequency lines in the frequency range of 12 to 60 Hz recorded [1] against the radio-frequency noise background during high-speed (the speed of entry into the atmosphere is about 70 km/s) meteor showers (Perseids, Orionids, Leonids, and Gemenids) are shown to serve as an evidence of the existence of complex (dusty) plasmas in the midlatitude ionosphere. The mechanism for generating the radio-frequency noises in the frequency range of 12 to 60 Hz is shown to be as follows. During Perseid, Orionid, Gemenid, and Leonid meteor showers, the meteors are ablated at altitudes of 70-130 km, depending on their sizes and initial velocities. The result of ablation is the production of supersaturated vapors of such metals as sodium, calcium, magnesium, etc., which then condense into nanometer-to-micrometer-sized secondary (dust) grains of cosmic origin. The grains can acquire an electric charge because of the action of unbalanced electron and ion currents and because of the photoelectric effect resulting from solar light. As an electromagnetic wave propagates in a complex (dusty) plasma in the ionosphere, the modulational interaction [2] excites low-frequency electrostatic waves at characteristic frequencies close to those of the dust acoustic waves, with the result that electromagnetic waves may become modulated. It is the low-frequency component of the wave modulated against the ionospheric noise background that is recorded at the Earth's surface. Our theoretical results are shown to agree well with the data on ionospheric plasma noise observed during meteor showers. We show also that along with the low-frequency component of modulated electromagnetic waves, the lines of infrasonic waves generated in the meteoric precipitation regions should be recorded as well. The infrasonic waves are generated by the dust acoustic waves interacting with neutrals. We determine the conditions for

generation of both linear and nonlinear infrasonic waves by the dust acoustic waves, study their propagation in the atmosphere, determine the intensity of the infrasonic waves generated in the ionosphere by the dust acoustic waves during Perseid, Orionid, Gemenid and Leonid meteor showers, and find frequency ranges where they can compete with the infrasonic waves from other sources.

References

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[2] S.V. Vladimirov, V.N. Tsytovich, S.I. Popel, and F.Kh. Khakimov, Modulational Interactions in Plasmas (Kluwer Academic Publishers, Dordrecht, 1995), 544 pages.