A. A. Galeev and V. V. Krasnosel'skikh. *Plasma mechanisms of the magnetospheric radio bursts of Jupiter.* Dekameter radio-emission bursts from Jupiter, modulated by its satellite Io, have been studied from the Earth for about a quarter of a century.[1,2] This radiation is generated in Jupiter's upper ionosphere by beams of subrelativistic electrons that are accelerated in the plasma shell of Io as a result of its motion in the Jovian magnetic field (see figure). The most likely generation mechanism of the radiation is direct excitation of electromagnetic waves by these beams. The coincidence of the highest frequency of the radiation with the electron cyclotron frequency at the surface of the planet indicates a cyclotron or synchrotron mechanism of interaction of the waves with the electrons. The excitation of extraordinary electromagnetic modes by electron beams[3] is possible only near the surface of the planet, where the density of the ionospheric plasma is quite high ($n_b \sim 10^3$ cm^{-3}). The radiation generated in the northern hemisphere is clockwise-polarized and has a high frequency, of the order of magnitude of twenty megahertz.[4] Estimates of the saturation level of buildup of the oscillations due to bunching of beam electrons with respect to the phases of their rotation in the magnetic field[5,6] give radiation intensities of the order of magnitude of that observed. In the more rarefied upper layers of the ionosphere, preference is given to the synchrotron mechanism of generation of a counterclockwise-polarized ordinary wave by the beam electrons, with buildup saturated by the same phase-bunching effect.[6,7] This last fact agrees with the results of observations according to which the high-frequency dekameter radiation is clockwise-polarized, while the lower-frequency radiation is counterclockwise-polarized. As a result of concentration of the longitudinal electron fluxes into thin current layers, the radiation occurs for the most part along these layers.

Discovery of the kilometer-band radiation of the Earth made it possible to conclude that radio emission is generated in the neighborhoods of all planets that have significant magnetic fields of their own.[8] Here the electron beams are accelerated in the magnetospheres of the planets during substorms—explosive processes releasing energy that has been accumulated as the magnetic-field energy of a solar or planetary wind intensified by plasma motion. In the case of the Jovian magnetosphere, this explains the existence of the dekameter radiation, which does not depend on the position of Io and has a maximum at a frequency of about 8 MHz.[8]

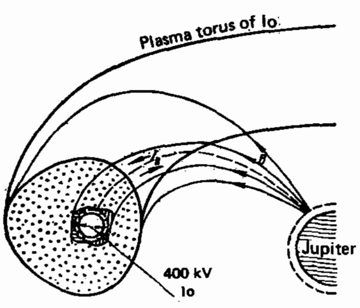

FIG. 1.

Voyager-1 and Voyager-2 spaceprobe measurements of the electromagnetic radiation led to the discovery of a new component of the Jovian radio emission in the kilometer band.[9,10] The frequencies of this radiation (from a few kilohertz to hundreds of kilohertz) are so low that it does not penetrate through the Earth's ionosphere and therefore could not be observed with facilities on the ground. It was natural to assume that this radio emission was also generated by electron beams. Beams are indicated by detection of low-frequency oscillations with a V-shaped spectrogram in which the frequency minimum coincides with the lower-hybrid resonance frequency.[11] It is known from studies of the Earth's magnetosphere that the appearance of such oscillations, which have come to be known as "auroral hiss," is associated with the presence of an auroral electron beam with energies of 10 eV to 1 keV and a total flux of $10^8 - 10^{10}$ cm^{-2}s^{-1}. Since the characteristics of the oscillations in the Jovian magnetosphere resembled those of the terrestrial case, Gurnett *et al.*[11] concluded the presence of an electron beam with the indicated parameters. This conclusion is confirmed by direct flux measurements made by Pioneer 10 and Pioneer 11.[12] The particle source of this beam is the plasma torus of Io, which envelops the orbit of this satellite and was discovered by direct measurements made in the Jovian magnetosphere by Voyager 1 and Voyager 2. The projection of the beam-generating region along the force lines of the magnetosphere onto the atmosphere of Jupiter can also be seen on photographs of the aurora that forms when the atmosphere is bombarded by electrons. Analysis of the interaction of the beam with the ionosphere of Jupiter shows that radio emission with a frequency close to the local plasma frequency in the interaction region is then generated.[13] Observation of the maximum of this radiation at the time at which the north pole is inclined toward the spaceprobe indicates that the generation region is in the polar ionosphere. Earlier hypotheses to the effect that it might be generated in the Io plasma torus itself[10] have now been eliminated by the fact that the plasma frequency in the torus is lower than the upper cutoff threshold of the Jovian kilometer radio emission.[14] The generation mechanism[13] consists of reradiation of plasma oscillations excited by the electron beam when they are scattered by plasma-density fluctuations. Measurements made in the Earth's magnetosphere[15] indicate that such fluctuations may arise as a result of ion-cyclotron instability of the longitudinal currents that connect the electric-field generation region with the ionosphere of Jupiter at the edge of the plasma torus. The low efficiency of this radiation-generating mechanism[13] in the Earth's magnetosphere can be explained by the low values of the electron fluxes in the direction across the magnetic force lines, which ensures that the plasma oscillations escape quickly from the generation region.[16]

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