Scattering of radio waves from the artificially perturbed *F* region of the ionosphere

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In the summer of 1975, experiments were performed in the city of Gor'kii on the backscattering of radio waves from the *F* region of the ionosphere perturbed by an intense flux of radio emission. The perturbing transmitter operated at 4.6 MHz and had an equivalent power of approximately 12 MW in continuous operation, with allowance for the antenna directivity. The backscattering of the radio waves was observed at a frequency ~5.6 MHz with a setup intended to study the ionosphere by the partial-reflection method.[1,2] The experiments showed that when the ionosphere was acted upon by high-power short-wave radio emission at 4.6 MHz, two types of backscattered signals appeared at 5.6 MHz. One of them was registered near and somewhat lower than the level of reflection of the ordinary component of the pump wave, while the other was observed above this reflection level, near the maximum of the *F* layer. Both types of scattered signal had a polarization corresponding to the extraordinary component when the critical frequencies f_0F_2 exceeded 4.6 MHz and when the ordinary component of the high-power radio emission was radiated.

The signals of the first type occupied the height region from 10 to 30–40 km and had an intensity approximately 100 dB lower than the intensity of the specularly-reflected signal. When the sounding-frequency wave frequency was increased from 5.60 to 5.65–5.70 MHz, the scattered signals disappeared, and when the frequency was decreased to 5.55–5.50, the region of heights from which the signals came broadened and split in two. The amplitude of the scattered signal decreased gradually with decreasing pump-wave power. Figure 1 shows a typical motion-picture frame of the height-amplitude scan obtained at 5.6 MHz several seconds after turning on the high-power transmitter. The arrows indicate the backscattered signals that appear below and above the reflection level of the specular channel. The higher-lying signals were due to the backscattering of the radio waves reflected from the *F* layer and registered after a second reflection from this layer (*M* reflection). Figures 2 and 3 show characteristic plots of the relative signal amplitude after turning the high-power transmitter on (Fig. 2) and off (Fig. 3). As seen from Figs. 2 and 3, the signal development and relaxation times amount to several dozen milliseconds. This phenomenon, which apparently was never before observed in the ionosphere, can be qualitatively attributed to the plane-layered, weakly inhomogeneous structure of the plasma which is produced in the standing-wave field of the ordinary component of the high-power radio emission. The periodic structure of the plasma inhomogeneities causes effective backscattering of the radio wave in the case when the period of the structure either coincides with or is an integral multiple of the wavelength. This spatial synchronism appears somewhat below the reflection level of the ordinary component of the high-power radio emission at 4.6 MHz for the extraordinary component in the 5.0–5.65 MHz band.

The second form of the scattered signals was observed when the critical frequencies f_0F_2 were lower than 4.9 MHz and consequently when there were no specularly reflected signals of the extraordinary component at 5.6 MHz. In these cases, backscattered signals from the heights of the maximum of the *F* region either appeared or were strongly amplified when the high-power transmitter was turned on.[3] Their intensity usually exceeded the noise level by several dozen

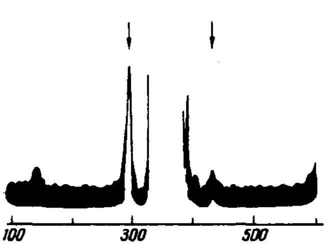

FIG. 1.

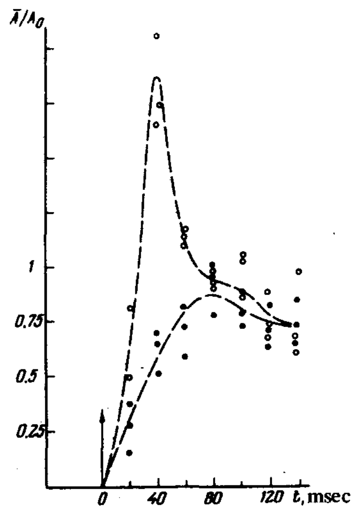

FIG. 2.

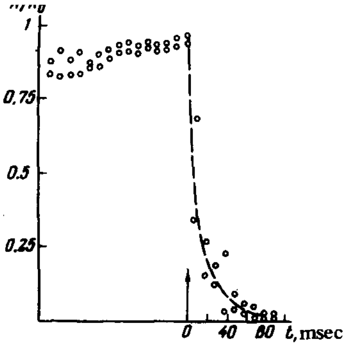

FIG. 3.

decibels, and the development and relaxation times were several minutes. It can be assumed that this diffuse scattering is analogous in many respects to the phenomena observed in the USA.[4,5]

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