Generation of Well-directed Flux of THz Radiation in Magnetized Plasma Column Due to Relaxation of Relativistic Electron Beam

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A relativistic electron beam can generate sub-mm radiation in plasma due to development of the two-stream instability. Such generation was observed in beam-plasma systems located both on Sun surface [1] and in laboratory facilities [2]. At the GOL-PET facility (see [2], the beam with parameters 0.8 MeV/15 kA/6 μs is injected into a magnetized (induction up to 4.7 T) plasma column with diameter 6 cm, length 2.5 m and the density that can be varied in the interval $8x10^{14} \div 2x10^{15}$ cm^{-3} [2]. Experiments showed that for this plasma density interval, the emission from the beam-plasma system is concentrated in a flux directed along the axis of the column. Our studies were focused on the role of strong plasma density gradients in generation of the flux going out from a vacuum chamber along the axis to atmosphere through a Teflon window. We measured the power and the spectral composition of this flux in the frequency band 0.1÷0.8 THz. The flux power was concentrated in the frequency range 0.2÷0.35 THz that is in the vicinity of the upper-hybrid frequency of plasma oscillations. The spectral power density in this range has increased in 30 times when we replaced a plasma column with a homogeneous cross section by a column with a strong gradient on the diameter. In case of the strong density gradient, the total power of the flux achieved 4 MW. We proposed an explanation of the increase in the THz radiation power that is based on resonance between EM mode of the plasma with a periodic density perturbation and the Doppler shifted beam branch. The experimental results are discussed in comparison with analytical and computer modeling.

1. P. Kaufmann et al. Astrophys. J. 603, L121–L124, 2004.
2. A.V. Arzhannikov et al., IEEE Trans. Terahertz Sci. Technol. 6, 245 (2016) DOI: 10.1109/TTHZ.2016.2525783.

* Work is supported by the Russian Scientific Foundation (project number 19-12-00250).