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Spectroscopic studies of the parameters of plasma jets during their propagation in the background plasma on the PF-3 facility

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Nowadays, experiments on the generation and study of the dynamics of plasma jets at the stand PF-3 (National Research Center «Kurchatov Institute») are performed. The measurement of their parameters can be useful to elaborate the physical model for astrophysical jets propagating for a giant distances. Temperature and concentration of plasma as functions versus time are measured by electron-optic spectrochronographic method, including analysis of spectral line profile, in a variety of experimental conditions.
Within the framework of the experiments on the simulating the dynamics of astrophysical jets, a diagnostic complex was developed that A width of 40 Å (each). The complex makes it possible to obtain the time dependences of the intensities and shapes of several spectral lines in a range of scans from a few nanoseconds to milliseconds and to promptly tune the system to the required spectral ranges. Within one discharge of the facility, a digital image of the time-integral spectrum is simultaneously recorded in the entire visible region.

The complex consists of an STE-1 crossed-dispersion spectrograph and a K008 streak camera, which is placed together with a notebook computer and a no-break power unit inside a shielding box for protection against electromagnetic noise. The K008 camera is equipped with an additional image intensifier on the basis of an EP-10 image-converter tube. The spectrum image is recorded with a standard SU-05M video camera and processed with the Klen-5m dedicated program, which automatically corrects the distortion and scan nonuniformities and subtracts regular noise. A relative sensitivity calibration of the spectrometric system SIRSh 6-40 ribbon lamp and the EOP-66 pyrometer.

The time dependencies of the intensities and shapes of the spectral lines of the neutral and hydrogen-like helium ions were used to determine the time behavior of the plasma. The plasma temperature T ≈ 4-6 eV was determined at different moments of time from the intensity of the two observed lines.
The plasma concentration is determined from the Stark broadening of these lines by the Holtsmark and high-frequency electric fields. The range of the measured plasma concentrations was 1015-2 × 1017 cm-3.

Distinct dips and picks are observed in the spectroscopic line profile, if short time intervals (≈0.1 mcs) from the streak record were extracted. They could be explained as an impress of low- and high-frequency microfields, exited in the plasma , , . Such dips and picks on the wings of spectroscopic line profile is a clear property of the Langmuir oscillations, that are characterized by a symmetry position from the centre of the line, like this occurs in our experiments. The number of particles is ND=50, and the electric field tension is E0≈50 kV/cm for the plasma jet with electron temperature of 5 eV and concentration of 1016 cm-3. The comparison of EHF and E0 points to the thermal origin of the Langmuir noise in the investigated plasma. The measurements of the spectroscopic line profile in polarized light, along and transverse to the symmetry axis, reveal the likeness of picks and dips positions and magnitudes. This fact says about the space isotropy of the HF-noise and quasistatic electric fields in plasma jets, being one more argument of the thermal nature of the observed oscillations.

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