INVESTIGATION OF THE EFFECT OF GAS COMPOSITION ON THE PLASMA FLOW STRUCTURE [[1]](#footnote-1)\*)

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The paper presents the results of laboratory simulation of jets from young stars at the PF-3 plasma focus facility at the NRC “Kurchatov Institute.” The objective of research question was to determine factors making the spatial structure of plasma jets in discharges in gases of different chemical compositions, namely, neon, helium, and helium with admixtures of neon, different.

The studies were carried out at a 35 cm from the anode, the place where the discharge was pinched and the supposed generation of the plasma flow. The following diagnostic tools were used: double light collimators for estimating the average and instantaneous velocity of the plasma ejection, as well as synchronizing other diagnostics with the processes in the chamber; frame camera for studying the structure of the plasma flow; a streak-camera K-008, which made it possible to obtain time sweeps at three levels (z = 30.5 cm, 35.0 cm and 39.5 cm relative to the anode); laser probing with obtaining shadow and schlieren photographs.

It was found that the plasma flow in the case of pure neon is the most structured: the head of the ejection consisted of numerous clumps, which makes is very similar to clumps in the jets from young stars, the so-called Herbig–Haro objects. The ejection in the case of pure helium was the least structured. The conducted studies on the effect of neon on the ejection structure have shown that the addition of only 1% neon to helium has practically no effect on the flow velocity, but the shape of the ejection head changes significantly, and a small-scale structure becomes noticeable in it. Several outflows observed in some of the experiments can be associated with multiple generation at the stage of plasma pinching. Using laser schlieren diagnostics, the structure of the shock wave front was determined. In the case of the neon working gas, the shape of the front part of the jet is a cone with a rounded top with a radius of about ~5 mm. On the lateral surface of the cone there are many small-scale inhomogeneities (~1-5 mm), on which the laser beam passing through the plasma jet diffracts. In the case of the working gas helium, the shock wave front is smooth, without small-scale inhomogeneities. Behind the front of the shock wave in helium, an increased density of matter is recorded.

Estimates show that these specific features can be related to the difference in the cooling efficiency of the studied gases both in the plasma ejection itself and in the shock wave generated upon jet propagation through the background gas. It is suggested that the main reason for the appearance of inhomogeneities in the plasma blob are different types of instabilities that develop in the presence of efficient radiative cooling, as is the case of the Herbig- Haro objects. In addition, it was established that, in some cases, plasma ejections can consist of several blobs propagating nearly parallel to each other that appear as early as at the stage of plasma pinching. Collision of shock waves generated by each of the blobs leads to the appearance of clumps, which facilitates formation of the lace-like structure of plasma ejection.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/It/ru/DR-Kharrasov.docx) [↑](#footnote-ref-1)