Radial temperature distributions in a supersonic plasma jet of a pulse capillary discharge

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The construction of the radial temperature profile $T(r_x)$ is based on the following principle: at any radial coordinate r_x in axisymmetric equilibrium plasma, there is an equality between two normalized quantities: (1) the Abel-transformed relative intensity of the selected spectral line $J(r_x)/J_{\max}[T_N(r_N)]$, and (2) The equilibrium population of the line's radiating energy level $n \cdot (T)/n_{\max} \cdot (T_N)$. Both quantities are normalized to unity. We developed a program to process the experimental data and calculate the radial temperature profiles $T(r)$ taking as an example a supersonic plasma jet of a pulse polymer capillary discharge. The program accounts for the influence of the "normal" temperature T_N on the local pressure of the plasma medium (1–10 bar) on the result. Comparing the temperature profile obtained by the T_N method using the C II 426.7 nm line to the profiles obtained with the C III 418.7/C II 426.7 nm and C II 426.7/C II 407.5 nm line intensity ratio methods, we show that the former is characterized by the smallest measurement error $(\delta T/T) \leq 7\%$ and covers a larger discharge region with temperature values from 3.5–3.8 eV on axis to $T \approx 1.8$ eV at the periphery. Simultaneous and independent determination of the $n_{\mathrm{e}}(r)$ profile from the Stark component of the local contours of the C II 426.7 and C III 418.7 nm lines allows us to conclude that Saha-Boltzmann equilibrium is present in the highly ionized axial region of the plasma.
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