measurement of plasma potential in the gas dynamic trap by doppler spectroscopy [[1]](#footnote-1)\*)

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Measurement of electrostatic plasma potential in linear magnetic systems is important for studying the processes of axial transport of particles and energy. The decrease in longitudinal losses is the critical condition for the implementation of the fusion power in an open magnetic trap. The spectroscopic method in the present research has several advantages over alternative ones.

The experiments were carried out in the gas dynamic trap (GDT) [1], which is a linear plasma confinement system with an axially symmetric magnetic field configuration. When plasma is created and heated in the GDT, a positive electrostatic potential, called ambipolar, is formed, decreasing along each field line from the maximum in the center to zero on the wall [2]. This potential is determined by the quasineutrality of the plasma at each point, as well as by the equality of the longitudinal currents of electrons and ions to the end wall. The potential creates a barrier for electrons leaving the trap and accelerates ions escaping in the plasma flow through the magnetic mirror.

In this work the CXRS (Charge eXchange Recombination Spectroscopy) method was used [3], based on the charge exchange of plasma ions on an artificial target which is a beam of injected atoms. A hydrogen gas target was used to convert the accelerated plasma ions into excited atoms with subsequent light emission. The radiation upon recharging on the target was collected by an optical system, entered a spectrometer of the Czerny-Turner scheme with a diffraction grating, and was recorded by a high‑speed CCD camera. Before measurements in the GDT plasma, the spectral dispersion and the instrument response function (IRF) of the spectrometer were calibrated using laboratory H and Ne gas-discharge lamps.

The measurements of potential and ion temperature of different plasma components were performed: main (hydrogen and deuterium) and helium impurity. The shape of the measured spectrum corresponds to the ion velocity distribution function according to the Doppler effect. In the work radiation spectra of H-α (656.28 nm) and He-I (667.8 nm) were presented. The time dependences of the plasma potential and ion temperature were obtained. The spatial profile of the ambipolar potential in a GDT was measured for the first time. The dependence of the plasma potential on the electron temperature was plotted.

References

1. Ivanov A. A., Prikhodko V. V. Gas-dynamic trap: an overview of the concept and experimental results //Plasma Physics and Controlled Fusion. – 2013. – Т. 55. – №. 6. – С. 063001.
2. Mirnov V. V., Tkachenko O. A. Electrostatic potential distribution in the gas-dynamic trap //Preprint 86-28, Institute of Nuclear Physics. – 1986.
3. Sandomirsky A. V., Lizunov A. A. Charge exchange radiation diagnostic with gas jet target for measurement of plasma flow velocity in the linear magnetic trap //Journal of Physics: Conference Series. – IOP Publishing, 2021. – Т. 2036. – №. 1. – С. 012032.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/AQ-Sandomirskii.docx) [↑](#footnote-ref-1)