EXPERIMENTAL OBSERVATION OF DECREASE IN PROBABILITY OF ATOMIC HIGHLY EXCITED STATE REALIZATION IN HELIUM ARC PLASMA AT ATMOSPHERIC PRESSURE

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This work is dedicated to experimental study of distributions of helium atom excited states with energies close to ionization threshold. By utilizing a spectrometer with absolute intensity calibration we were able to obtain concentrations of radiating particles from the intensities of observed HeI spectral lines, and we found that helium arc plasma at atmospheric pressure was substantially deviated from the ionization equilibrium state. The distribution of excited state populations with the principal quantum number $n > 4$ decreases at a rate increasing as their energy reaches ionization threshold. Thus, spectral lines corresponding to transitions from $n \geq 7$ were not observed in the spectra. Thus, in turn, we were able to experimentally confirm the phenomenon theoretically predicted by a large number of works of highly excited state realization probability decrease in helium arc plasma at atmospheric pressure [1] and presence of ionization-type nonequilibrial distributions of excited states [2]. Although the obtained distribution cannot be described by Boltzmann law with electron temperature, we have been able to determine electron temperature and concentration in plasma. Electron concentration was found by analyzing widening of spectral lines contours due to Stark effect, it's value being $n_e = 9 \cdot 10^{16}$ cm^{-3}, which is about 20% lower than its value for equilibrium state. The presence of HeII lines in the observed spectra allowed us to determine electron temperature T_e using our knowledge of electron concentration n_e and the relation between atomic and ion spectral line intensities. It's value was found to be T_e =3 eV, the difference between values found from relations between different line pairs was less than 10%.
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