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SPECTROSCOPIC DIAGNOSTICS OF PULSED PLASMA FLOWS USING SPECTRAL LINE BROADENING

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To apply adequately methods of plasma diagnostics based on atom and ion spectral lines broadening, further improvements in the broadening parameters data bank, as well as experimental checking of particular methods under conditions of real plasma sources, are to be made.

In the laboratory of nonequilibrium processes (presently the laboratory of radiative plasma dynamics) of the IMAF a long-standing experience concerning activities in the above mentioned directions is gained. Development and investigations of various pulsed plasma sources, both electric-discharge and laser ones, have called for conducting spectroscopic diagnostics of plasma under conditions of spatial and temporal nonuniformity inherent in generated pulse plasma flows (Min'ko, 1970; Elashevich *et al.*, 1972; Bakanovich *et al.*, 1978; Bakanovich *et al.*, 1979; Ananin *et al.*, 1990; Astashinsky *et al.*, 1991; Min'ko *et al.*, 1994). On the other hand, created and studied sources of plasma flows provide a means of modeling the rather wide range of conditions characteristic of the laboratory and astrophysical plasmas.

It is well known that available numerous data on Stark broadening of spectral lines (Griem, 1974; SLS 1981, 1985) are often contradictory and remain up to now incomplete, therefore the need for calculations and careful studies of line profiles is still of great importance.

Such studies were conducted in the NBS (e.g., Kelleher, 1981). Broadening parameters of spectral lines for great number of atoms and ions accounting for influence of electrons, ions, and protons, are being effectively calculated in the Yugoslav School (Dimitrijević, 1993; Konjević, 1989; Dimitrijević, 1991; Dimitrijević, 1994). Analysis of calculated profiles of spectral lines broadened by both Stark and Doppler effects, including those with consideration for forbidden components is contained in our papers as well (e.g., Min'ko, 1974). Systematic spectroscopic studies of various electric-discharge and laser plasma formations have shown that sufficiently accurate measurements of electron concentrations in plasma based on the line broadening are possible over the specific and relatively narrow Ne range only, and that checking the appropriate methods for their applicability is the necessary condition of their correct employment. Use of sets of spectral lines with variety of the above mentioned Ne range limits allows coverage of great area of parameters wherein sufficiently accurate measurements of charged particles concentrations based on broadening of lines with differing broadening parameters and excitement potentials are possible.

To further extend the capabilities of spectroscopic diagnostics, we also used the procedure of intentional introduction of the admixtures of atoms and ions of the elements with reliable data on broadening parameters for their spectral lines into plasma (Astashinsky *et al.*, 1991).

Due to nonstationary character and spatial nonuniformity of pulsed plasma flows the spectral diagnostics was conducted, for the most part, by the methods of high-speed cine-spectrography and spectrochronography, enabling spatial-temporal distribution of the plasma parameters to be obtained (Min'ko, 1970; Elashevich *et al.*, 1972; Bakanovich *et al.*, 1978; Bakanovich *et al.*, 1979; Ananin *et al.*, 1990; Astashinsky *et al.*, 1991; Min'ko *et al.*, 1994). The results of electron concentration measurements based on broadening of lines recorded on both frames and streak photographs of spectra, could be compared with those derived from spectral brightness of emission in continuum (Bakanovich *et al.*, 1978; Min'ko *et al.*, 1994), as well as obtained by interferometric and holographic methods (Ananin *et al.*, 1990; Avramenko *et al.*, 1973). For example, investigations of emitting compression plasma flows using high-speed spectroscopic methods and interferometric ones (by means of laser interferometer with photoelectric recording and two-mirror autocollimation interferometer with the field visualization) yielded practically coinciding values of electron concentrations (Ananin *et al.*, 1990).

Spectroscopic studies of the effect of laser radiation on different absorptive materials might give us information only in case we use the methods providing for both space- and rather high time resolution (Bakanovich *et al.*, 1979). This is attainable by high-speed frame-wise spectrum recording which enables the diagnostics of plasma clusters corresponding to separate laser spikes to be performed. Intensive continuum and spectral lines of atoms and ions of target materials elements have been used for measurements of the main plasma parameters. The electron densities have been found both by measured space-time resolved spectral brightness of plasma and by spectral lines broadening due to the quadratic Stark effect. We succeeded in obtaining the electron distribution along the plasma formation due to used technique.

Experimental studies of electric-discharge and laser plasma sources were accompanied by numerical simulations of plasma parameters (Ananin *et al.*, 1990; Eliyashevich *et al.*, 1985). Close correspondence of electron concentrations and temperatures obtained by spectroscopic methods to the results of numerical simulations shows the efficiency in integrated approach to diagnostics of complex plasma formations in modern plasma sources.

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