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SIMULATION OF DIFFRACTION SPECTROGRAPHS FOR RECONSTRUCTION OF PLASMA RADIATION X-RAY SPECTRA ^{*)}

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In the presented work, unique full-scale Monte Carlo models of grazing incidence diffraction spectrographs GIS, GIS-3D, VUV-QFF and a crystal spectrograph JA-1 have been developed, allowing at a fundamentally new level numerical simulation of the operation of spectrographs with a reflective diffraction grating (DG) and a mica crystal. Based on spectrograph models, methods have been developed for reconstructing the true spectra of extreme ultraviolet (EUV) and soft X-ray spectra [1,2] of plasma.

The main problems preventing reliable qualitative and quantitative reconstruction of the EUV and soft X-rays spectra of Z-pinch plasma radiation are the superposition of signals from different diffraction orders and the dependence of intensity distribution in different diffraction orders on the wavelength after its interaction with the DR and mica crystal. In developed spectrographs models, to take into account the processes of interaction of EUV radiation with DR and soft X-ray with the crystal, the differential method and dynamic diffraction theory are used.

Two original methods have been developed for reconstructing true radiation plasma spectra of the mega-ampere Z-pinch at the Angara 5-1 facility:

1) The fast single-pass method for reconstruction of EUV spectra, taking into account the contribution of different diffraction orders to the intensity of experimental signals. [2].

2) The method for reconstructing true soft plasma radiation X-ray spectra using the calculated instrumental function of the spectrograph, taking into account the broadening of spectral lines in a detector plane [1].

Using the developed methods, Z-pinch plasma spectra were reconstructed at the Angara 5-1 facility:

1) The true spectra of EUV plasma radiation obtained in experiments with a load in the form of a tungsten multi-wire cylindrical liner have been reconstructed. It is shown that an emission maximum lies in the range of 5-6 nm, which corresponds to an array of unresolved 4d-4f transitions in W ions [1,2].

2) The transmittance of Al and In were measured in the range of 2-30 nm. The results obtained match with the Henke database [2].

3) A significant influence of the shape of the DG groove profile on the results of reconstruction of the true spectra is shown. Using a priori information, shapes of the DR groove profiles were determined for the GIS-3D and VUV-QFF spectrographs [2].

4) The soft X-ray spectrum of Z-pinch plasma obtained using the JA-1 spectrograph in experiments with a load consisting of Al wires with placed inside W wires has been reconstructed.

References

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^{*)} [abstracts of this report in Russian](#)