Reconstruction of the Electron Energy Distribution Function from Optical Emission Spectroscopic Measurements

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Abstract

The properties of a low temperature plasma (as for example used in energy saving light bulbs) are mainly determined by the energy distribution of the free electrons. This distribution is described by the so-called electron energy distribution function (EEDF). A well established method to obtain the EEDF is to measure the current-voltage characteristics of a plasma using a small wire in contact with the plasma (probe). The approach presented here is motivated by the idea to utilise the light emitted by excited gas atoms, in order to get rid of the perturbing probe brought into the plasma.

The inference of the EEDF from the measured intensities is an example of an ill-posed inversion problem, because of the high sensitivity of the reconstruction on small errors of the line intensities.

The forward calculation consists of a so-called stationary collisional-radiative model which is describing the interaction of atoms and ions with the free electrons and the discharge device.

The systematic uncertainties in the model parameters, namely the different atomic data that enter the calculation, have to be considered with particular care.

First results are shown for the spectrum of a neon discharge lamp. The radially averaged EEDF is reconstructed. The applicability of different functional forms of the EEDF is assessed. In a first step Maxwell and Druyvenstein distributions which are having only a small number of parameters are considered.

Key Words: Plasma Physics, Applied Bayesian Data Analysis