A discharge with a magnetic X-point as a negative hydrogen ion source

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The necessity for an improved cesium-free negative hydrogen ion source motivates the search for new and original concepts. The standard sources of volume produced negative ions rely on vibrational excitation of the hydrogen molecule by electron impact, followed by dissociative attachment [1]. In recent years it has been realized that atom recombination on different surfaces (e.g. quartz [2]) could also result in the formation of vibrationally excited molecules. This study is concentrated on a negative hydrogen ion source, designed to investigate the feasibility of this H^--production channel, i.e. formation of excited molecules at the quartz chamber walls followed by a dissociative attachment. In conformity with the well established necessity of separation of the H^--formation region from the power deposition region, a static magnetic field is also utilized. The field configuration in the form of a cusp (with an X-point on the axis, where the field diminishes, Figure 1) is novel and influences not only the plasma parameter distribution but also the energy deposition and the plasma maintenance.

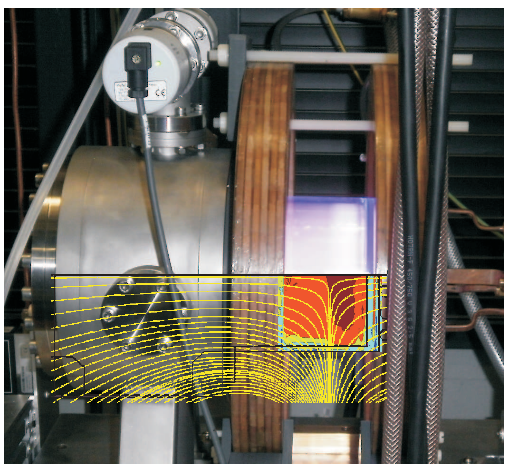

Figure 1: Picture of the experimental setup and the discharge, showing two regions with different optical emission. The lower half of the figure shows also the configuration of the magnetic field lines.

The distribution of the RF field in such magnetic field configuration has already been investigated experimentally in an argon plasma by Shinohara and coworkers [3]. Based on an analytical solution we are able to explain the results obtained by these authors and to get some estimates for the source under investigation. The study also presents experimental results from different diagnostic techniques for the plasma parameters and discusses them in relation with a numerical model based on the fluid equations, coupled with the Maxwell's equations. Various gas discharge parameters (like the gas pressure, RF power and magnetic field strength) have been varied in the experiments.

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