7E4

MULTIPLE SOLUTIONS IN THE THEORY OF NEAR-CATHODE LAYERS AND SELF-ORGANIZATION ON DC GLOW CATHODES

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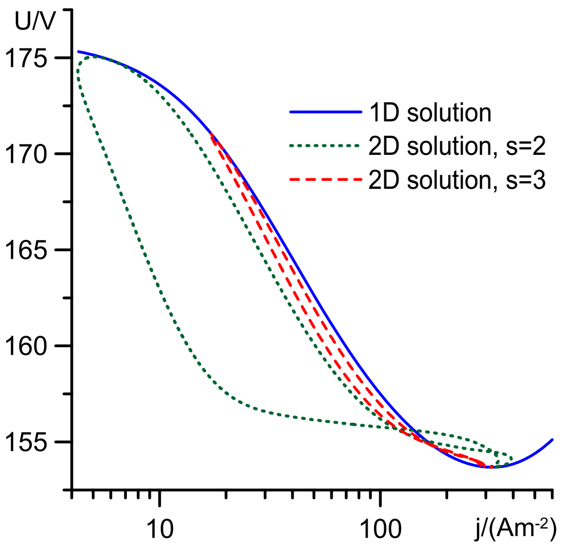
It has been suggested long ago that a self-consistent theoretical model of a near-cathode region in a glow discharge admits multiple steady-state solutions describing different modes. A bifurcation analysis[1] has shown that multiple steady-state solutions must exist even in the framework of the most basic self-consistent model of glow discharge. In the present work, such multiple solutions have been calculated for the first time.
As an example, the figure shows the dependence of the discharge voltage drop U on the average current density j for a xenon 30 Torr discharge of 0.5 mm of radius and height. The 1D solution (which only varies along the axis) is similar to the well-known solution of von Engel and Steenbeck. The axially symmetric (2D) solution with $s=2$ describes the normal glow discharge and a mode with a ring spot at the edge of the cathode. The 2D solution with $s=3$ describes modes with a ring spot; and with a spot at the center and a ring spot at the edge. Calculated structures with ring spots are qualitatively similar to those observed in experiments[2].

1. M. S. Benilov "Bifurcations of current transfer through a collisional sheath with ionization and self-organization on glow cathodes", Phys. Rev. E. 77, 2008, to appear.
2. W. Zhu et. al. "Direct current planar excimer source", J. Phys. D: Appl. Phys. 40, 2007, pp. 3896-3906.



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7E5

ON USING MATLAB IN SOLVING DIFFERENTIAL ALGEBRAIC EQUATIONS IN MHD

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We use Matlab to solve differential algebraic equations (DAEs) in MHD systems. For certain sets of the dissipative parameters involved, the MHD systems may be described by semi-explicit or quasi-linear DAEs with various types of singularities (impasse points, pseudo-equilibrium points, singularity induced bifurcation points). Such singularities result in many challenging problems for standard ODE solvers. The problems involve, for example, identification of multiple trajectories passing through pseudo-saddles and pseudo-nodes located on a singularity (sonic) manifold. Finding such trajectories, that is heteroclinic orbits connecting various equilibrium points located on the supersonic and subsonic Riemann sheets and crossing the sonic manifold (see Fig.1), is not a simple task for standard ODE solvers.

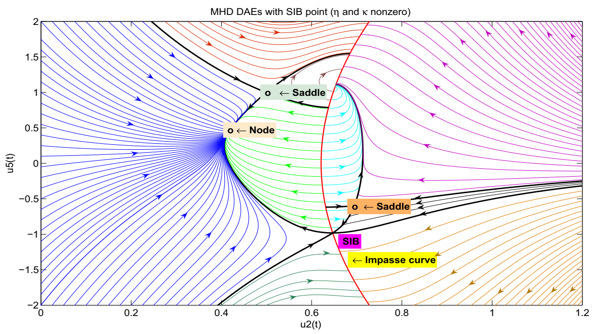

Figure 1: A phase portrait of MHD DAE

In the paper we use the recent developments in the qualitative analysis of DAEs and Matlab's graphing capabilities, to analyze traveling wave solutions in MHD, integrate through singular pseudo equilibrium points and compute solutions of the *singularity induced bifurcation*, or SIB, phenomenon. Various combinations of dissipative parameters (resistivity, viscosity, thermal conductivity) are considered through a series of numerical examples.

1. W. Marszalek and Z. W. Trzaska, "New Solutions of Resistive MHD Systems with Singularity Induced Bifurcations", IEEE Trans. on Plasma Sci., Vol. 35, No. 2, 2007, pp. 509–515.
2. H. Freistuhler and P. Szmolyan, "Existence and Bifurcation of Viscous Profiles for all Intermediate Magnetohydrodynamic Shock Waves", SIAM J. Math. Anal., Vol. 26, No. 1, 1995, pp. 112–128.

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