Abstract Submitted
for the GEC20 Meeting of
The American Physical Society

About the Poisson-Boltzmann equation for magnetized technological plasmas[1] KEVIN KOEHN, DENNIS KRUEGER, RALF PETER BRINKMANN, Ruhr University Bochum — Numerical simulations of magnetized plasma discharges, e.g. high power impulse magnetron sputtering (HiPIMS), generally have a high computational demand because they need to solve the 3d Poisson-Boltzmann equation and take into account that the phenomena are happening on multiple time scales. A step forward to accelerating simulations can be done if the Poisson-Boltzmann equation can be reduced to a simpler 2d case. To find valid arguments for such a simplification, we formulate a variational principle based on fundamental thermodynamic relations. The electrons are assumed to be in thermodynamic equilibrium on each magnetic field line separately (on the time scale of the electron bouncing motion) against a background of given ion density. The variational principle aims to minimize the negative entropy under the constraints of a conserved electron number on each field line and a conserved total energy. For this, so-called flux coordinates (ψ, θ, s) are introduced to describe the characteristic topology of axisymmetric magnetic fields typical for circular magnetrons. For spatially homogeneous magnetic fields, an alternative approach can be made by employing a Fourier-ansatz to find the potential ϕ, which already reveals a lot of interesting insights.

[1]This work is supported by the German Research Foundation in the frame of the Collaborative Research Center TRR 87.

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Date submitted: 11 Jun 2020

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