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Numerical Modeling of a Magnetic Nozzle
MIKHAIL TUSHENTSOV, BORIS BREIZMAN, ALEXEY AREFIEV, The University of Texas at Austin — We present computational study of a magnetic nozzle, which is a component of the VASIMR (Variable Specific Impulse Magnetoplasma Rocket) plasma-based propulsion system for a space vehicle. The magnetic nozzle transforms ion gyromotion into directed axial motion, adiabatically accelerating the plasma, and enabling plasma detachment from the spaceship via self-consistent magnetic field modification. VASIMR employs ion cyclotron resonance heating to deposit rf-power directly to the plasma ions created by the low energy plasma source. We have developed a numerical code to model the axisymmetric nozzle within the framework of collisionless MHD with an azimuthal ion velocity spread. The code implements a reduced model that consists of truncated steady-state equations for the velocity space moments of the ion distribution function and takes advantage of the plasma flow paraxiality. This makes it possible to study the conversion of the ion gyro-energy at the nozzle entrance into the energy of the directed flow at the exhaust. The magnetic field in the vacuum, which is not assumed to be paraxial, is calculated using a given magnetic coil configuration in the presence of plasma. From the computed steady-state flow configuration, the code evaluates magnetic nozzle efficiency, defined as the ratio of the axial momentum flux in the outgoing flow to the axial momentum flux in the incoming flow.

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