Plasma detachment in a magnetic nozzle

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Abstract

This work has been motivated by the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) project [1]. The VASIMR concept involves a magnetic nozzle that shapes the ongoing plasma flow to provide its detachment from the rocket [2]. The detachment can occur after the energy density of the magnetic field drops below the kinetic energy density of the plasma flow [3]. At this point the magnetic field is no longer strong enough to control the flow. The transition from a region with a strong magnetic field to a region with a weak magnetic field corresponds to a transition from a sub-Alfvénic to a super-Alfvénic flow. Once the flow becomes super-Alfvénic, it stretches the magnetic field lines and keeps moving away from the rocket conserving its axial momentum. The super-Alfvénic transition is smooth if the guiding magnetic field lines are straight. We specify the restriction on the vacuum magnetic field configuration that ensures a smooth detachment. Sheared plasma flow is considered in an attempt to find the stability condition for the outgoing plasma flow.

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[1] F.R.Chang-Dìaz, Sci. Am. **283**, 90 (2000).
[2] A.V.Arefiev and B.N.Breizman, Phys. Plasmas **5** (2004).
[3] E.B.Hooper, J. Propul. Power **9**, 757 (1993).