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Influence of manipulation of electron streamlines on plasma formation and electron cross-field transport in $\mathbf{E} \times \mathbf{B}$ plasma

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Understanding plasma formation in $\mathbf{E} \times \mathbf{B}$ plasmas is essential for us to control plasma in a favorable way upon applications. In space travel application, Hall thrusters (HTs), which is one of the $\mathbf{E} \times \mathbf{B}$ plasmas, exhibits anomalous electron cross-field transport, and that has been a subject of extensive research works due to its strong influence on thruster efficiency.

During the conventional operation with the azimuthally uniform magnetic field, electric field, and propellant supply, a certain level of inhomogeneity in physical parameters occurs. However, such self-induced inhomogeneities often exhibit a very small level of ~1% and also temporally fluctuate, making it difficult to investigate their influences experimentally. Recently, plasma structure under nonuniform propellant supply was resolved, and the influence of neutral inhomogeneity on plasma formation and electron cross-field transport is revealed. [1] Such artificial manipulation of inhomogeneity of neutral particles affected ion generation, and the influence of altered ion generation led to the variation of plasma equilibrium structure. One of the big advantages is that it provided an experimental environment in which generated plasma has a spatially large structure and temporally steady.

In this work, we take a similar approach, but this time we alter mainly electron dynamics by artificially inducing inhomogeneity in the magnetic field, Fig. 1. We report on plasma structure formation, Fig. 2, resulting from the magnetic field inhomogeneity, and its relation to electron cross-field drift.

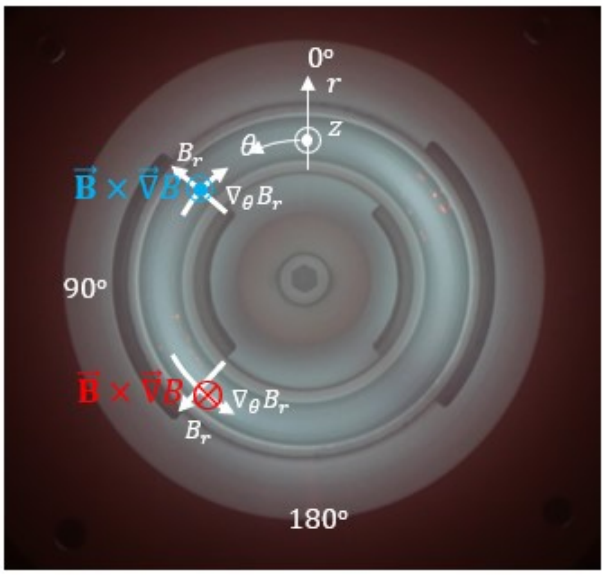

Figure 1. A still-shot of non-uniform magnetic field operation of a Hall thruster. Directions of the gradient B drift of electrons resulting from magnetic field modification are shown.

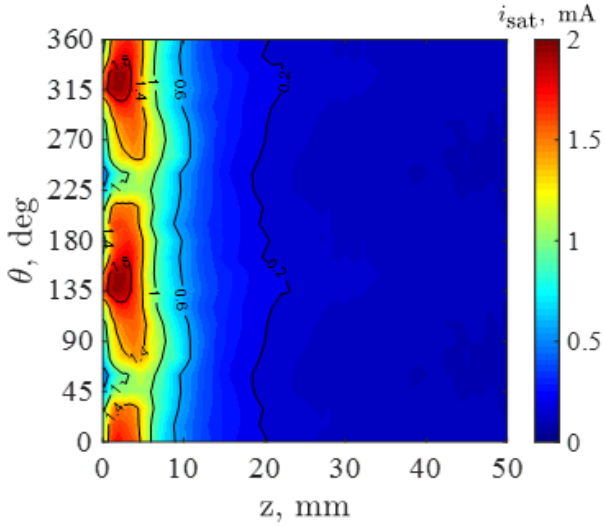

Figure 2. Plasma density structure on $z - \theta$ plane induced by inhomogeneity of radial magnetic field in azimuth.

References
[1] J. Bak, R. Kawashima, K. Komurasaki, and H. Koizumi, Phys. Plasmas **26**, 073505 (2019).

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