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Fluid modeling of plasmas magnetized by electromagnetic waves

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— Strong electromagnetic resonance in cavity resonators and similar devices can lead to many configurations of resonant field enhancement. Some resonant modes lead to strongly enhanced electric fields, but there also exist modes in which the magnetic field enhancement dominates. The typical fluid model of gas breakdown and electromagnetic interaction does not account for magnetic fields, which can lead to significant differences between observed and numerically computed breakdown thresholds, as well as differences in post-breakdown plasma evolution. Starting from an expansion of the Boltzmann equation for charged particles, we develop an analytical model that captures how strong oscillating magnetic fields can affect the plasma evolution even for overdense plasmas. Certain parameter regimes are shown to have unexpected diffusion and drift behavior. We develop a breakdown model that incorporates the effects of both static and oscillating magnetic field energy deposition to electrons. The fluid model parameters are compared to swarm behavior in a particle-in-cell (PIC) computation. The resulting fluid model is used in conjunction with a finite-difference time-domain (FDTD) method to evaluate gas breakdown and plasma behavior in a magnetically resonant cavity.

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