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The rigid-beam model as a test case for simulations of plasma generated by an intense electron beam

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There has recently been a renewed interest at the Naval Research Laboratory (NRL) in better understanding the physics of the breakdown of air by a high-current, fast, pulsed electron beam. In order to simulate the breakdown of air that occurs under these conditions, new computational tools are being developed which will be able to accurately model the breakdown in the relevant parameter regimes. The rapid breakdown of air by an intense electron beam is a complex plasma physics problem. There are three main parts to this problem: the electromagnetic fields governed by Maxwell's equations, the plasma and beam electron dynamics described by the Boltzmann equation, and the plasma-driven chemistry of the air modeled by coupled rate equations for all the chemical and ion species. In order to test various simplified models for the Boltzmann and plasma chemistry parts of the problem, we have developed a standardized approximation to Maxwell's equations and the beam dynamics equations. Here we describe the resulting rigid- beam model, and show an example of how the rigid-beam model can couple to a Boltzmann solver. This rigid-beam model will allow us to more quickly develop and benchmark new models, which can then be validated against new data collected at NRL.
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