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Two-fluid MHD simulation of the sustainment of closed flux by imposed dynamo current drive and the validation of mean dynamo theory
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Validated two-fluid simulations of the HIT-SI experiment using the NIMROD code have served as a launching point for two new parameter settings. The first parameter regime simulates a geometrically larger (Ro = 0.8m, a = 0.65) and higher temperature (108eV) version of the HIT-SI device and demonstrates that the closed flux of a stable equilibrium can survive large fluctuations (δB/B $\approx$ 6%) and shows imposed dynamo current drive is compatible with closed flux plasma confinement. Imposing mostly n = 1 oscillating fluctuations to a stable n = 0 closed-flux equilibrium does not open the flux surfaces and the shaking results in dynamo current drive inside the closed flux sufficient to sustain the current without opening the closed flux. Mean dynamo theory is shown to be accurate by comparing it to helicity balance and both show current drive inside close flux. These results have a large positive impact on the possibility of practical magnetic fusion power generation. The validation of mean dynamo theory and its consistency with helicity conservation are important in understanding the generation of magnetic fields in nature. The second parameter regime is the switch to the three injector configuration used on the HIT-SI3 device, allowing pre-operation predictions and study of operating parameters of interest. These simulations are done using both resistive and Hall MHD at similar temperature and density regime as HIT-SI and preliminary results show a similar current amplification.

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