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On the gradB and ExB drifts of alphas in burning plasmas

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A two-dimensional time depended model based on the two-fluid approach, where the electrons, the reacting ions, and the generated alphas, are treated as separated interacting fluids has been developed. The model computes the conservation equations for the electrons the reacting ions (D-T) and alphas, supplemented with Maxwell's equations in two-dimensional Cartesian geometry, which represents the poloidal plane of a tokamak fusion reactor, with uniform flows in the 3rd direction. The fluid equations for each plasma species are derived by taking moments in velocity space of Boltzmann's equation. We remain in the two-fluid description because in the MHD approximation the plasma is invariant for a broader class of transformations. In addition a zero dimensional multi-fluid plasma burning model has been developed for alpha heating of plasma in a fusion reactor. The model is based on the conservation of the various plasma species particles (electrons, reacting ions and alphas generated by nuclear reactions) and on the energy balance of these plasma species. Using this model we compute the power output of the reactor, the reacting ions and alpha particle density and temperature, and under what initial conditions the reactor will be operating in a steady state.

Here we study: (a) the production of alphas and their drifts, in the very early stages of the burning process by placing high pressure plasma blob in the center of the two-dimensional grid and have an initial magnetic field which has a gradient (f/r) ITER like. And (b) by coupling the zero-dimensional model to the two-dimensional model, we study the drifts of the alphas when the production of alphas is in steady state.