Hybrid code investigation of the physics of plasma blobs in magnetic fields

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Coherent structures that involve local enhancement or depression of plasma temperature, density and magnetic field strength ("blobs") are ubiquitous in both fusion and space plasmas. In many cases, such as those blobs created in the edge region of tokamaks, the size of the blob, and hence characteristic length scales of internal gradients, can be comparable to the ion Larmor radius. In these cases, fully kinetic treatment of ion dynamics can capture physics that is inaccessible to models that embody fluid or guiding-centre approximations.

Here we examine the structure, dynamics and evolution of such ion gyro-scale blobs using a 2D hybrid code, which comprises a multi-species particle-in-cell code for the fully kinetic treatment of the ions, coupled to electron fluid equations.

The blobs are modelled as magnetic flux ropes with enhanced local density and temperature and a local depression in magnetic field strength. They are initialised in pressure equilibrium with a background flow of plasma transverse to the background magnetic field. Variations in the angle of the flux rope to the simulation plane, and in background flow speed, electron-to-ion temperature ratio, and plasma beta are investigated with the aim of identifying and explaining key features of the evolution.