A Core to Edge Model for Radio Frequency Simulations in Tokamaks

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The finite element method (FEM) and the spectral approaches to simulation of ion cyclotron radio frequency (ICRF) waves in toroidal plasmas each have strengths and weaknesses. For example, the spectral approach (eg TORIC) has a natural algebraic representation of the parallel wavenumber and that can be used to calculate the wave dispersion but does not easily represent complex geometries outside the last closed flux surface, whereas the FEM approach (eg LHEAF or COMSOL) naturally represents arbitrary geometries but does not easily incorporate thermal corrections to the plasma dispersion due to the lack of an algebraic parallel wavenumber. The two domains: thermal core with flux surfaces and cold edge plasma with open field lines and complex plasma facing geometries may be combined in such a way that each approach is used where it works best. In this work, we demonstrate the method of mode matching for the domain decomposition. The method is non-invasive to the separate codes and approximately takes twice the computational effort as the original core solution. The net result is a core-to-edge model for RF simulations that is able to resolve wave interactions with plasma facing components and also calculate core interactions and power deposition in both the core and edge. We will present verification cases and initial applications to minority heating and discuss extensions to other frequency regimes and applications to other RF problems such as antenna loading and anomalous edge losses.