An iterative method for including spatial dispersive effects in global wave solvers using FEM decomposition

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Modelling of the wave field for RF-heating is a challenging task because of the spatial dispersive nature of magnetised plasmas and the co-existence of different waves. The issue can be handled by Fourier decomposing the wave equation [1]. Hybrid methods using Fourier decomposition in the toroidal and the poloidal directions and FEM (finite element methods) decomposition across the flux surfaces are commonly used. In the hybrid methods the response across the magnetic surface is represented by higher order differential equations. The Fourier decomposition leads to dense matrixes that become time consuming to invert. FEM methods have the advantages of producing local decomposition which, in general, is faster to invert, but for which it is more difficult to include spatial dispersive effects. Lately methods to include or correct for spatial dispersive effects such as upshift of parallel wave number, finite Larmor radius effects and transit time magnetic pumping have been developed [2-4]. Here a method is proposed using operator splitting to correct for spatial dispersive effects where the correction term appears as a source function in the wave equation representing induced current by the wave field. The wave equation is then solved by means of iteration with the source function calculated from the previous wave field by separating it locally into planar waves and using susceptibility tensors developed for hot uniform plasmas. The method enables modelling of upshift, finite Larmor radius effects to all order enabling modelling of kinetic waves with standard global wave solver without expanding the susceptibility tensors into higher order differential operators or solving integral equations.