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CUT HERMITE FINITE ELEMENT METHODS AND IMMERSED BOUNDARY SBP METHODS FOR THE WAVE EQUATION

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There have been recent advances in creating stable, immersed finite element methods for solving partial differential equations using the Cut Fem approach, [1]. In these methods the elements are not aligned with the boundary, and the methodology allows for high order accuracy, without sacrificing stability, independent of how the boundary cuts the elements. In particular, when applied to the wave equation small cuts do not lead to correspondingly severe time step limitations, [2]. The methodology involves imposing boundary conditions weakly and adding special stabilization at cut elements. The cut FEM community has mainly considered piecewise C^0 polynomials on triangles or quadrilaterals. Here we explore the family of C^1 Hermite elements on rectangles. These elements are hard to work with on irregular grids, but since the aim is an immersed method, using a Cartesian mesh is not a severe restriction. By weakly imposing boundary conditions, which is known as Nitsche's method in the finite element community, the resulting spatial discretization on a Cartesian domain can straightforwardly be interpreted as a Summation-By-Parts finite difference method of Padé type. By using the cut finite element framework for the corresponding problem with an immersed boundary, we obtain a discretization of the wave equation, which can equally well be considered as an immersed SBP Padé finite difference method or a Cut Hermite finite element method.

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