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THE SPECTRAL CELL METHOD FOR WAVE PROPAGATION ANALYSIS OF HETEROGENEOUS MATERIALS

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We present an extension of the Finite Cell Method (FCM) [6, 3] for the simulation of wave propagation in heterogeneous materials. The FCM is a fictitious domain method which simplifies the meshing procedure by combining Cartesian grids with hierarchic shape functions of high order. During the integration of the cell matrices, the geometry of the problem is taken into account. In order to further develop the FCM for an efficient simulation of wave propagation problems utilizing explicit time integration methods, we borrow ideas from the Spectral Element Method (SEM) [4]. The proposed Spectral Cell Method (SCM) [2] applies Lagrange shape functions through Gauss-Lobatto integration points. In this way, the mass matrix of all cells that are completely located within the physical domain are automatically diagonalized. However, those cells which are cut by the boundary of the domain or which include pores or material interfaces need special treatment, see Fig. 1. In order to account for the geometry, we apply an adaptive integra-

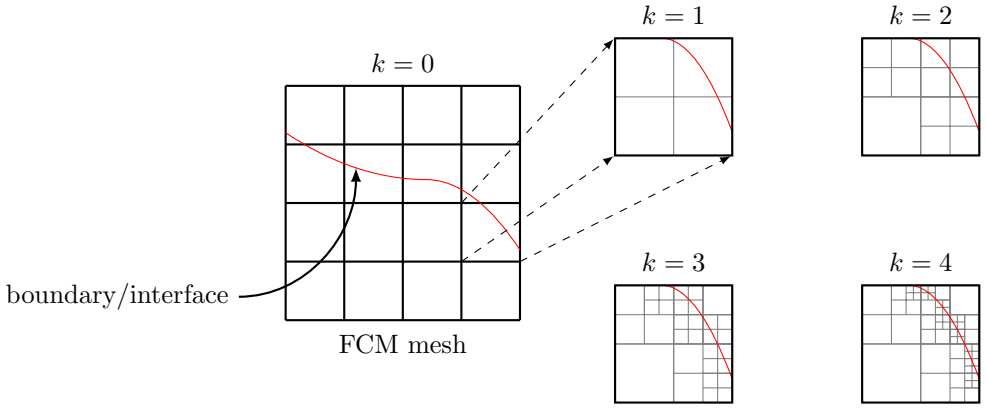

Figure 1: Adaptive integration based on a quadtree refinement. k is the level of refinement.

tion scheme [1, 5], which is based on a quadtree/octree (2D/3D) refinement, capturing the boundary which intersects the corresponding cell. As a result of the adaptive integration, the corresponding mass matrix will be no longer diagonal. In order to still take advantage of explicit time stepping schemes, we further develop the computation procedure to preserve the diagonal structure of the mass matrix. Several examples including heterogeneous materials with complicated microstructure will be presented to demonstrate the basic properties of the proposed Spectral Cell Method. We will study the influence of the mass lumping on the convergence and accuracy of the proposed method and demonstrate the efficiency by drawing a comparison to existing methods.

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