

This article is concerned with accurate and efficient numerical methods for solving viscous and nonviscous wave equations. A three-level second-order implicit algorithm is considered without introducing auxiliary variables. As a perturbation of the algorithm, a locally one-dimensional (LOD) procedure which has a splitting error not larger than the truncation error is suggested to solve problems of diagonal diffusion tensors in cubic domains efficiently. Both the three-level algorithm and its LOD procedure are proved to be unconditionally stable. An error analysis is provided for the numerical solution of viscous waves. Numerical results are presented to show the accuracy and efficiency of the new algorithms for the propagation of acoustic waves and of microscale heat transfer.