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Simulation of multidimensional gaseous detonations with a parallel adaptive method[1]

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A detonation wave is a self-sustained, violent form of shock-induced combustion that is characterized by a subtle energetic interplay between leading hydrodynamic shock wave and following chemical reaction. Multidimensional gaseous detonations never remain planar and instead exhibit transverse shocks that form triple points with transient Mach reflection patterns. Their accurate numerical simulation requires a very high resolution around shock and reaction zone. A parallel adaptive finite volume method for the chemically reactive Euler equations for mixtures of thermally perfect gases has been developed for this purpose. Its key components are a high-resolution shock-capturing scheme of Roe-type, block-structured Cartesian mesh adaptation, and operator splitting to handle stiff, detailed kinetics. Beside simple verification examples to quantify the savings in wall time from mesh adaptation and parallelization, large-scale computations of Chapman-Jouguet detonations in low-pressure hydrogen-oxygen-argon mixtures will be discussed. These computations allowed the detailed analysis of triple point structures under transient conditions and a comparison between two and three space dimensions.

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