Abstract

The following dissertation is devoted to the development and analysis of a novel modern numerical method for the simulation of compressible Euler flow fields at all speeds. Introducing the insight gained by an asymptotic multiple scale analysis [10][20] in order to extend a classical numerical method an accurate and stable numerical scheme in the low Mach number regime is achieved which passes over to the underlying compressible method if the reference parameter M is greater or equal to one. The decomposition of the pressure distribution into a high and a low frequency part represents a basic step inside this scheme. A novel version of a discrete evolution algorithm [14] is used to decompose the pressure and to gain an approximation of the reference parameter based on the length scale information. This curve evolution algorithm posses several advantages compared to the classical Fourier and conjunction approaches. It is parameter-free, independent of the discretization and operates only with local data. In order to ensure high resolution of the changing flow phenomena a time-dependent adaptation of the reference parameter M is necessary to compute unsteady flow fields. A physical motivated adaptation is described based on results obtained using the asymptotic analysis. Numerical experiments are presented to show the performance and applicability of the new numerical scheme.

Key words: asymptotic analysis, image processing, low Mach number, Euler equations