On singular limits arising in astrophysics

Donatella Donatelli

Department of Information Engineering, Computer Science and Mathematics,
University of L'Aquila

Abstract

A broad range of interesting phenomena in science and engineering occur under various scaling regimes, among them it is particularly relevant the low Mach number regime, in which the fluid velocity is much less than the speed of sound. In this talk I will focus on one example arising from astrophysics, where the modeling equations are given by the coupling of the compressible Navier Stokes equations with equations that take into account of the chemical reactions and heat effects.

One feature of these flows is that they take place under a low Mach number and high Reynolds number regime and so they are affected by the presence of high oscillating acoustic waves. In order to understand this type of dynamic one has to derive a model for low speed flows (low Mach number) in a hydrostatically balanced, radially stratified background that removes acoustic waves and allows for the development of finite amplitude temperature and density variation.

Here, we analyze a simplified model arising in astrophysics and we identify the asymptotic limit in the regime of low Mach, low Froude and high Reynolds number. The system is driven by a long range gravitational potential. We show convergence to an anelastic system for ill-prepared initial data. The proof is based on frequency localized Strichartz estimates for the acoustic equation based on the recent work of Metcalfe and Tataru.

References:

- D. Donatelli and E. Feireisl, An anelastic approximation arising in astrophysics, Math. Ann, 369, (2017), 1573–1597.