MATHEON Multiscale Seminar

TU Berlin, MA 313

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Rupert Klein: A three-scale asymptotic problem in atmospheric flows

The Euler and Navier-Stokes equations for incompressible flow can be justified as low Mach number asymptotic limiting models for flows on engineering length and time scales. Atmospheric flows generally feature small Mach numbers as well but, as a consequence of their much larger characteristic scales, they are not "incompressible". In fact, today there remain several competing candidates for an atmospheric analogue of the engineers's incompressible flow equations. In this talk I will explain how this ambiguity is rooted in an asymptotic three time scale limit for atmospheric flows, and I will discuss recent steps towards a rigorous justification of associated "sound-proof" model equations.

Kersten Schmidt: High order asymptotic expansion for viscous acoustic equations close to rigid walls

In this study we are investigating the acoustic equations as a perturbation of the Navier-Stokes equations around a stagnant uniform fluid and without heat flux. For gases the viscosities η and η' are very small and lead to viscosity boundary layers close to walls. We will restrict our attention on those viscosity boundary layers and do not consider non-linear convection.

As a small factor η comes out in front of the curl curl operator in the governing equations, the system is singularly perturbed, i.e., first, its formal limit $\eta \to 0$ does not provide a meaningful solution, and secondly, a boundary layer close to the wall $\partial\Omega$ appears. The choice of asymptotic expansion method seems to be the best adapted to this case.

In this approach we separate the solution in far field and correcting near field, where far field represents the area away the wall and exhibits no boundary layer, at the same time near field decays exponentially outside the zone of size $\mathcal{O}(\sqrt{\eta})$ from the boundary.

To complete the solution, effective (impedance) boundary conditions are derived for the far field.