Texas Tech University. Applied Mathematics Seminar.

Nonreflecting boundary conditions in aeroacoustics

MIKHAIL SURNACHEV

Keldysh Institute of Applied Mathematics RAS

Wednesday, December 4, 2013
Room: MATH 101. Time: 4:00pm.

ABSTRACT. The subject if this talk is nonreflecting (weakly reflecting, artificial, transparent...) boundary conditions. This type of conditions are required when one sets up an artificial boundary to limit the computational domain. The problem is that no "natural" physical condition is available at this boundary, because it has no preimage in the real world. So, ideally, this boundary should be transparent for all outgoing disturbances and produce no reflections back into the domain of interest.

For the wave equation, at least theoretically, this can be achieved with the help of the Kirchhoff formula - the exact integral representation of a solution. For more general linear equations, one can use the technique of pseudo-differential operators. Unfortunately, these conditions are of non-local nature, computationally expensive, and may have problems with stability. This creates a need to have simple and efficient local nonreflecting boundary conditions.

A number of transparent boundary conditions has been proposed over the years. The simplest solution is just to set all variables to zero outside the domain. More "advanced" conditions are based on some form of the radiation condition, on the study of the asymptotics of solutions at infinity or on the analysis of plane waves falling on the boundary. For the scalar case this analysis is more or less straightforward, although not without traps. We work with the 2D Euler *system*, so a new level of difficulties arises. There are three types of disturbances - entropy, acoustic and vortical. A good boundary condition has to handle them all simultaneously. The entropy equation is separate, so the main problem is in the balance between treating acoustics and vortices.

The performance of a group of nonreflecting boundary conditions was evaluated on a series of numerical tests. For the time being, we use the linearization of the Euler system on the uniform mean field. I present and discuss the results of these experiments. The original *nonlinear* system is the subject of future work. The ultimate goal of this study is to obtain a stable and efficient set of boundary conditions to use in real applications in aeroacoustics.