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A comparison between IBM with feedback forcing and a volume penalization method for compressible flows

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Immersed Boundary Methods consist in adding a source term in the equations and keeping a simple Cartesian grid for the mesh. In this work, two methods have been implemented and benchmarks have been addressed on both incompressible and compressible flows, with fixed or moving bodies.

The first method consists in a classical Peskin's approach [1] where the source term is computed with a feedback forcing and the fluid-solid interface is represented with a set of Lagrangian points. The second approach is based on a penalization method, where the source term is governed by a porous media law for compressible flows [2], and is activated only inside the solid with a mask function that is null in the fluid and equal to one in the solid. One can note the fact that for the penalization approach, the solid is fully modeled, while only its boundary is in the first approach.

Both methods have been tested and compared with experimental and numerical data from the literature on incompressible flow with an oscillating cylinder, supersonic flow with a cylinder or a triangle at Mach 2, and a shock-cylinder interaction (*figure 1*). For the penalization method with moving bodies, a smooth mask function has also been tested in order to vanish spurious oscillations of the aerodynamic coefficients. On supersonic cases, the influence of the treatment on the continuity equation has been studied to better simulate waves transmission. The results have shown a better performance of the penalization method for the analysis of compressible flows.

REFERENCES

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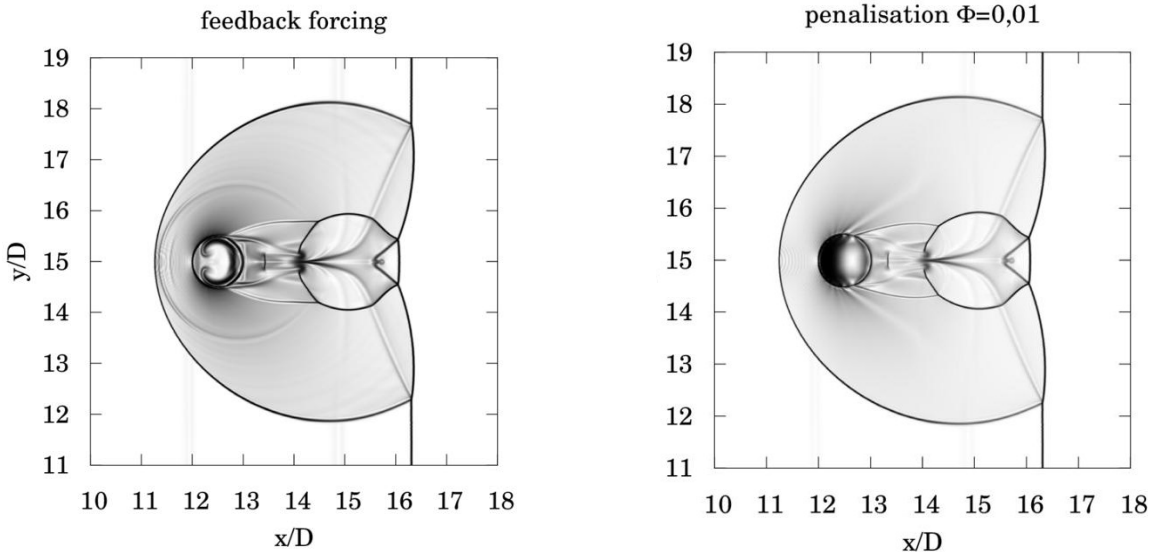

Figure 1: Instantaneous Schlieren like vizualisations for the shock-cylinder interaction case, computed with both methods