95st MSS-Seminar
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Nägelsbachstr. 49b

Smoothed Particle Hydrodynamics: consistence, convergence and transport - velocity formulation

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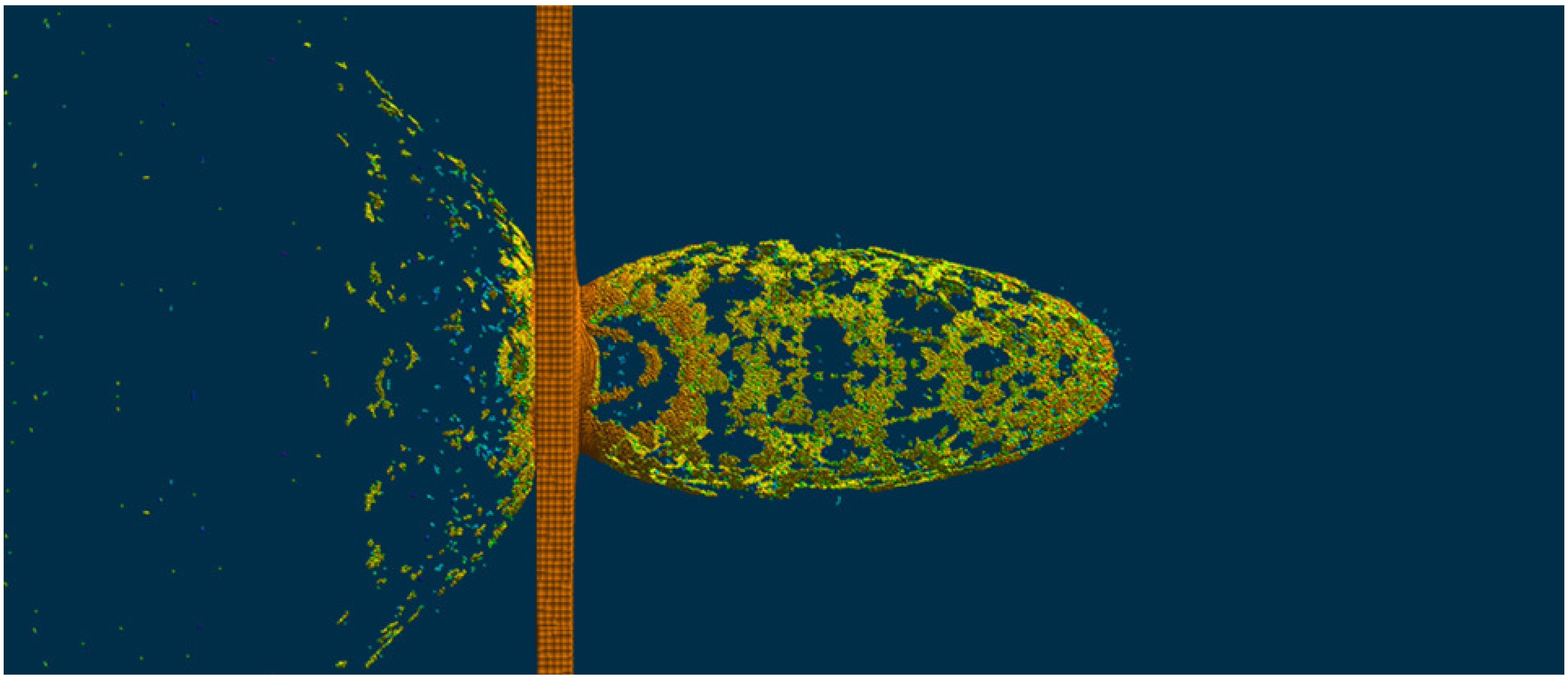

The lack of consistence and convergence is often considered as a major drawback of smoothed particle hydrodynamics (SPH). Here, we analysis two errors introduced by typical conservative SPH approximations of the gradient of a scalar field: one (smoothing error) is due to smoothing of the gradient by an integration associated with a kernel function; the other (integration error) is due to approximating the integration by summation over all particles within the kernel support.

We confirm that partition of unity is the condition under which the conservative SPH approximation achieves both consistence and convergence. We show that this condition can be achieved by relaxing a particle distribution under a constant pressure field and invariant particle volume. The resulting particle distribution is very similar to that is typical for liquid molecules. We further show that with two different typical kernel functions the SPH approximation, upon satisfying the partition of unity property, is able to achieve very high-order of the integration error, which previously could be shown only with particles on a uniform grid.

The background pressure used in a weakly compressible SPH simulation implies a self-relaxation mechanism, which explains that convergence with respect to increasing particle numbers could be obtained in SPH simulations, although not predicted by previous numerical analysis. By relating the integration error to the background pressure, we explain why our previously proposed transport-velocity formulation of SPH is able to achieve unprecedented accuracy and stability. Furthermore, we will present the extension of the transport-velocity formulation to simulate solid dynamics problems with free material surfaces.