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Towards numerical consistency and conservation for SPH approximations NIKOLAUS ADAMS, XIANGYU HU, SERGEJ LITVINOV, Technische Universität München — Typical conservative Smoothed particle hydrodynamics (SPH) approximations introduce two errors: smoothing error is due to smoothing of the gradient by an integration associated with a kernel function; integration error due to approximating of the integration by summation over all particles within the kernel support. The integration error leads to violation of zero-order consistency, i.e., the inability to reproduce a constant field. We show that partition of unity is the condition under which the conservative SPH approximation achieves both consistency and convergence. The condition can be met by relaxing a particle distribution under a constant pressure field and invariant particle volume. The resulting particle distribution is very similar to those observed for liquid molecules. We further show that with two different typical kernel functions the SPH approximation satisfying the partition of unity property is able to achieve very high-order of the integration error for random particle locations. 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. Furthermore, by relating the integration error to the background pressure, we explain why the previously proposed transport-velocity formulation of SPH is able to achieve unprecedented accuracy and stability.

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