Comprehensive tests of artificial viscosities, their switches and derivative operators used in Smoothed Particle Hydrodynamics

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In the field of astrophysical and planetary science, hydrodynamical numerical simulations for rotating disk play important role.
So far, Smoothed Particle Hydrodynamics (SPH) has been widely applied for such simulations.
It, however, has been known that with SPH, a cold and thin Kepler disk breaks up due to the unphysical angular momentum transfer.
There are two possible reasons for the breaking up of the disk; the artificial viscosity (AV) and the numerical error in the evaluation of pressure gradient.
However, which one is dominant has been still unclear.
Thus, we performed a systematic survey of how the lifetime of a cold disk varies depending on known implementations of AV and various switchs.
As a result, we found that the angular momentum transfer due to AV at the inner edge triggers the breaking up of the disk in the case of Monaghan (1997)'s AV.
We also found that with the classical von-Neumann-Richtmyer-Landshoff type AV with a high order derivative estimate the disk survives for more than 100 orbits.

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