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# The Kelvin-Helmholtz Instability in Smoothed-Particle Hydrodynamics

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**Abstract.** Smoothed Particle Hydrodynamics (SPH) simulations are a powerful tool to investigate hydrodynamical processes in astrophysics such as the formation of galactic disks. Dense gas clouds raining on the forming disk are possibly disrupted by Kelvin-Helmholtz-Instabilities (KHI). To understand the evolution of the halo clouds, we have to ascertain the capability of SPH to treat the KHI correctly, since SPH-methods tend to suffer from an innate surface tension and viscosity effects, both of which could dampen the KHI. We analytically derive a growth rate of the KHI including surface tension and viscosity in the linear regime, and compare this growth rate to results of numerical simulations by an SPH method and a grid-based method. We find that SPH in some cases suppresses the KHI (Junk *et al.*, in prep).

**Keywords.** hydrodynamics, instabilities, simulations

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This study focuses on SPH's capability to model shear flows, motivated by the passage of a cold gas cloud through hot halo gas (e.g., Murray *et al.*(1993)). In the absence of thermal instabilities and/or gravity, such clouds would be disrupted by shear flow instabilities within the time they need to travel through their own mass. We start by deriving an analytical expression for the growth of KHI modes, considering surface tension and physical viscosity. For this we extend the approach by Chandrasekhar (1961). The viscosity $\nu$ is a free parameter and is obtained by fitting the growth rate to the simulated modes.

We use two independent numerical approaches - particle based and grid based - to follow the hydrodynamics of the system, the SPH simulations were carried out with VINE (Wetzstein *et al.*, in prep) and the grid simulations with PROTEUS (Prendergast & Xu (1993), Slyz & Prendergast (1999), Slyz & Prendergast (1999), Slyz *et al.* (2006), Slyz *et al.* (2006)). We find that the KH-instability is successively suppressed for an increasing artificial viscosity parameter $\alpha$. SPH is unable to follow the evolution for the KHI for fluid layers of different densities due to problems arising in its intrinsic smoothing properties.

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