Spreading sedimentation fronts

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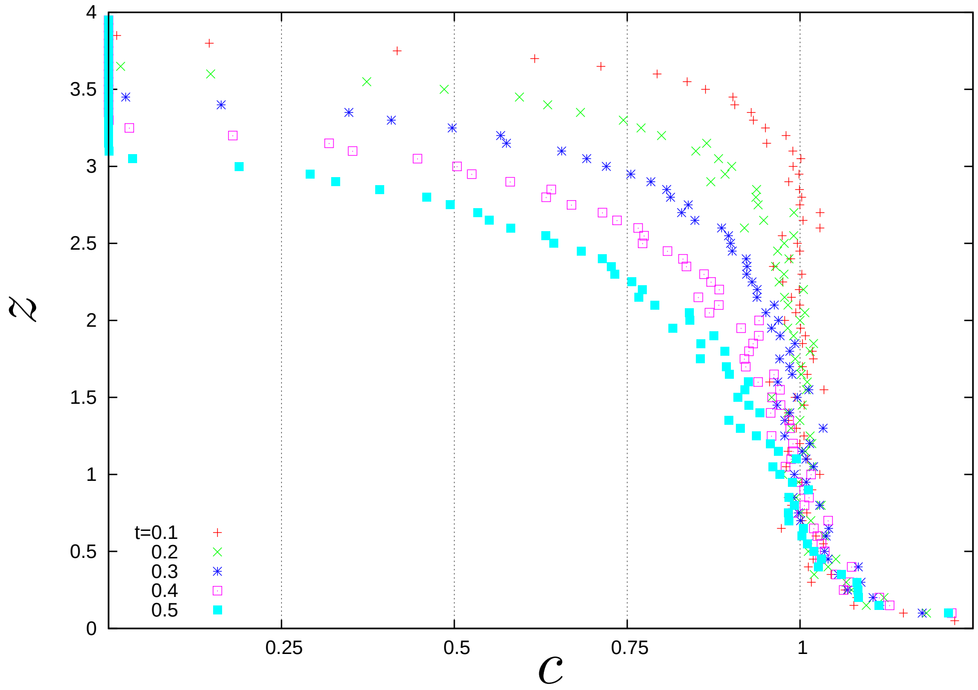
Effects of particle-size polydispersity and hydrodynamic interactions

Spheres. Very dilute – no hindered settling

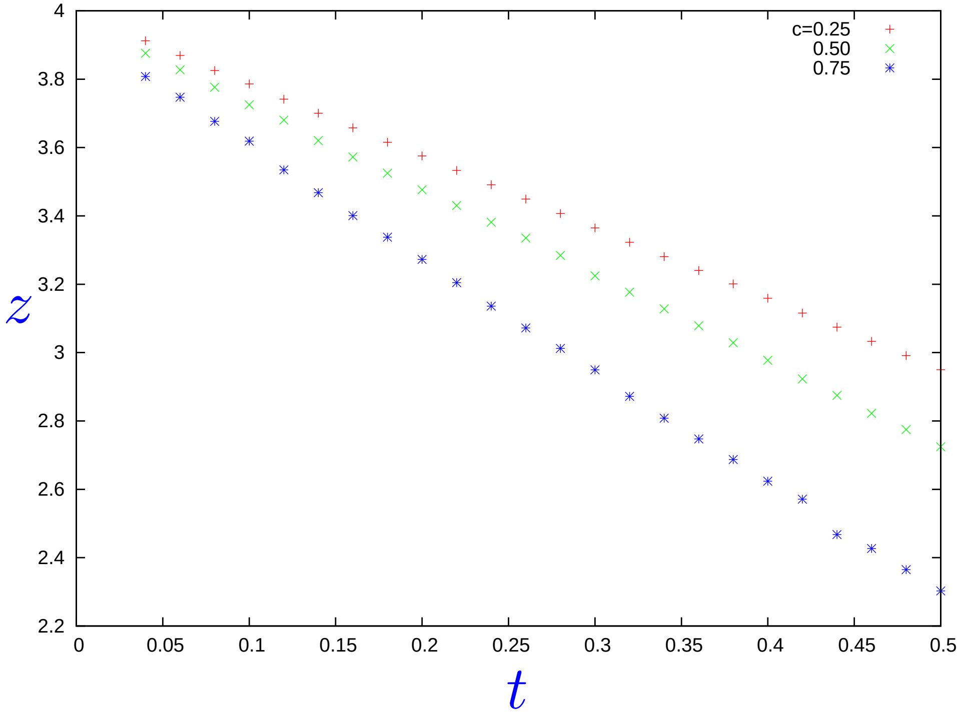
Sedimentation front

Monodisperse numerical simulation

$1 \times 1 \times 4$ box
4000 point particles
$10 \times 10 \times 40$ Fourier modes
80 realisations



Height of concentration quartiles



Thickness of front $\delta(t) = z_{0.25}(t) - z_{0.75}(t)$.

Growth of thickness

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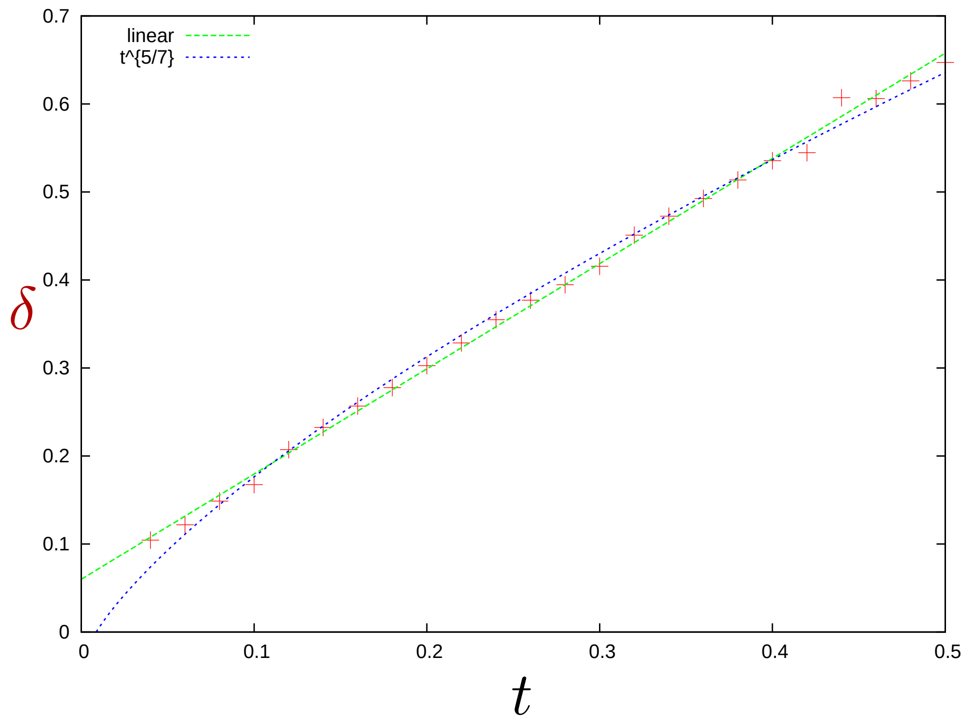
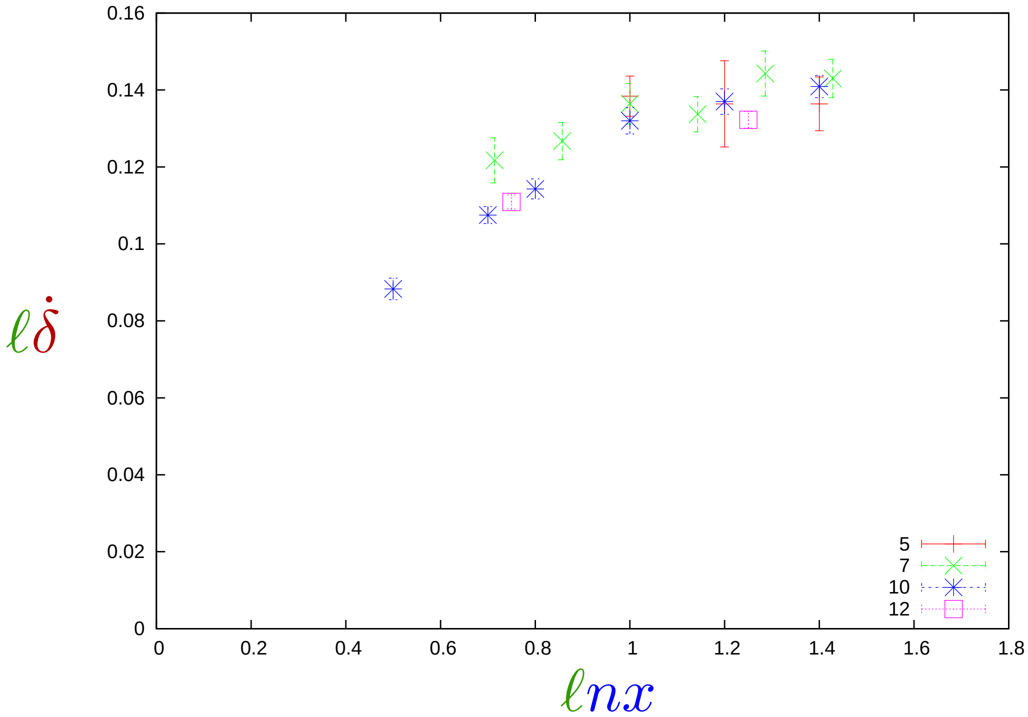


Linear in time or $t^{5/7}$ for nonlinear diffusion equation?

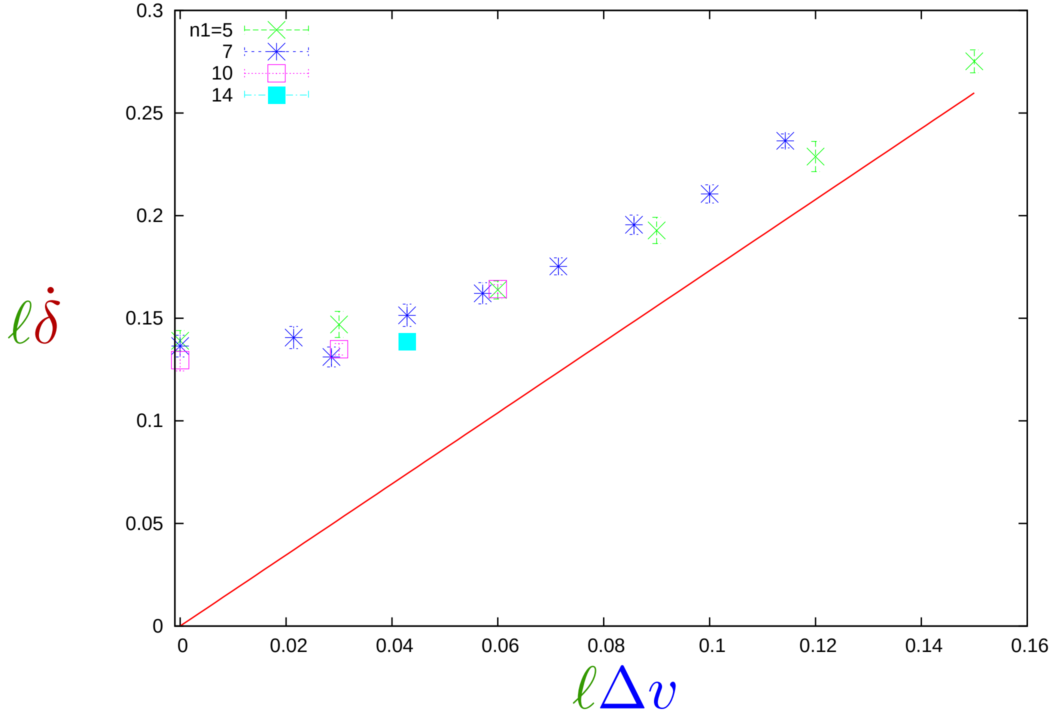
Numerical resolution

Mean interparticle separation ℓ, number of linear Fourier modes nx



Growth rate of front thickness $\dot{\delta}$ independent of numerical resolution once can resolve interparticle separation $\ell nx > 1$

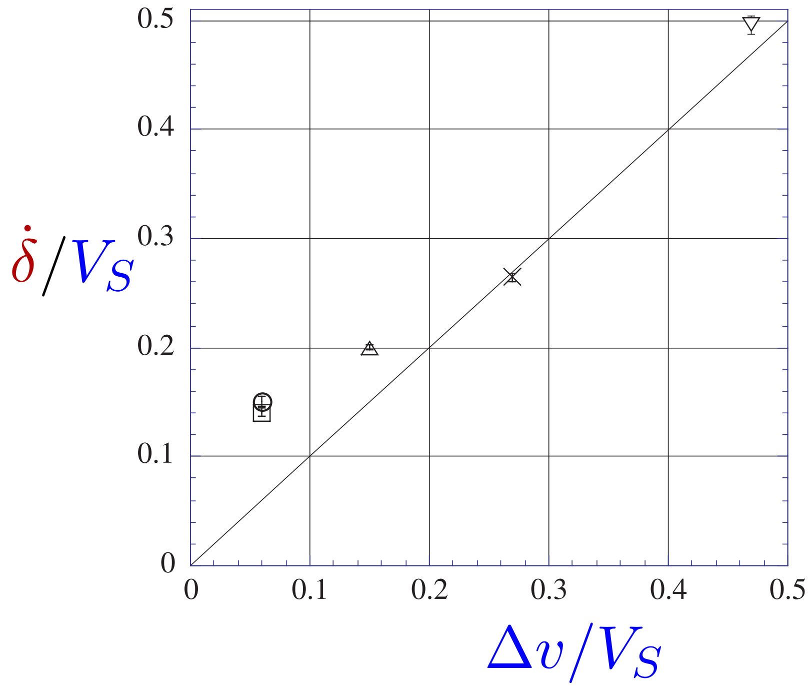
Polydisperse results



Polydispersity or hydrodynamic interactions have little effect if minor contributor

Experiments results

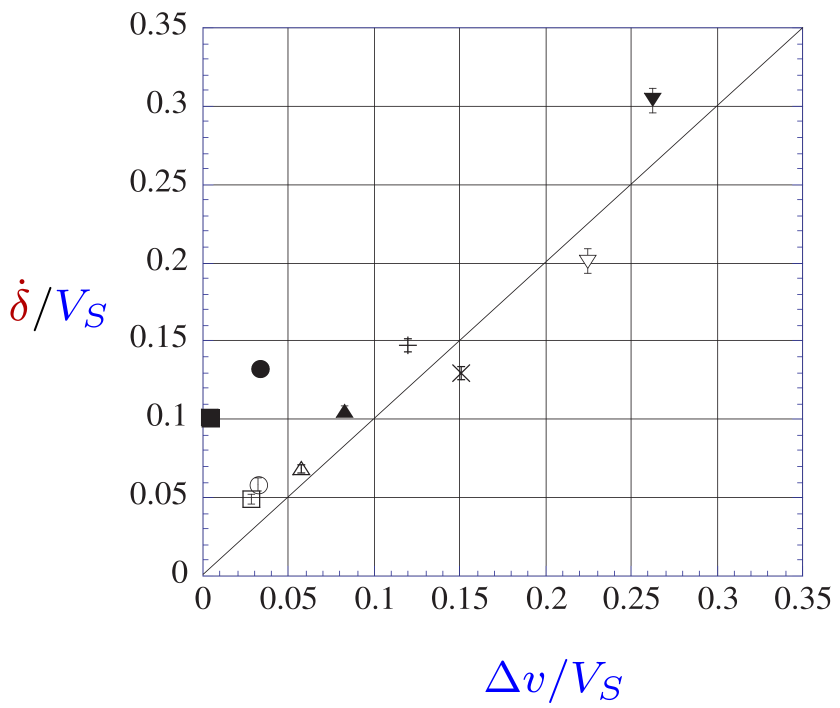
Concentration $\phi = 0.3\%$

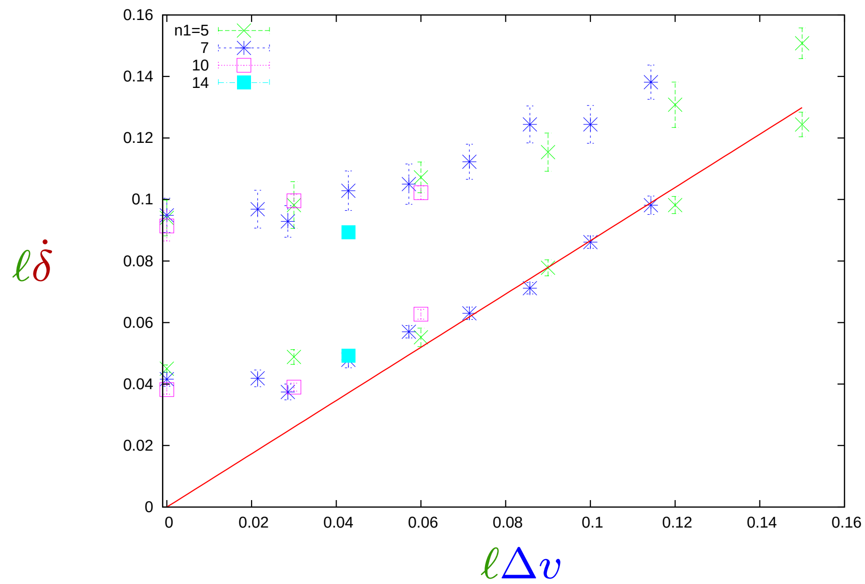


Polydispersity or hydrodynamic interactions have little effect if minor contributor

Quartiles rate of spreading

Upper data is 50%–75% quartile, lower 25%–50%

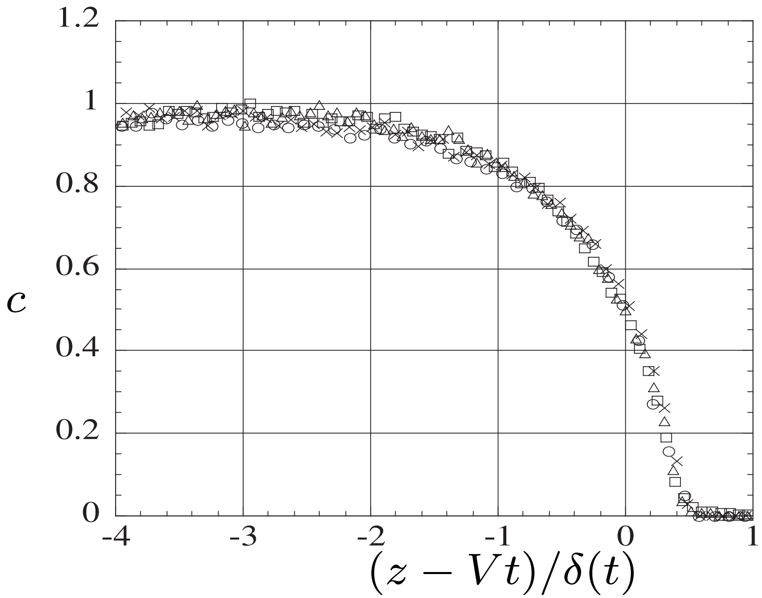


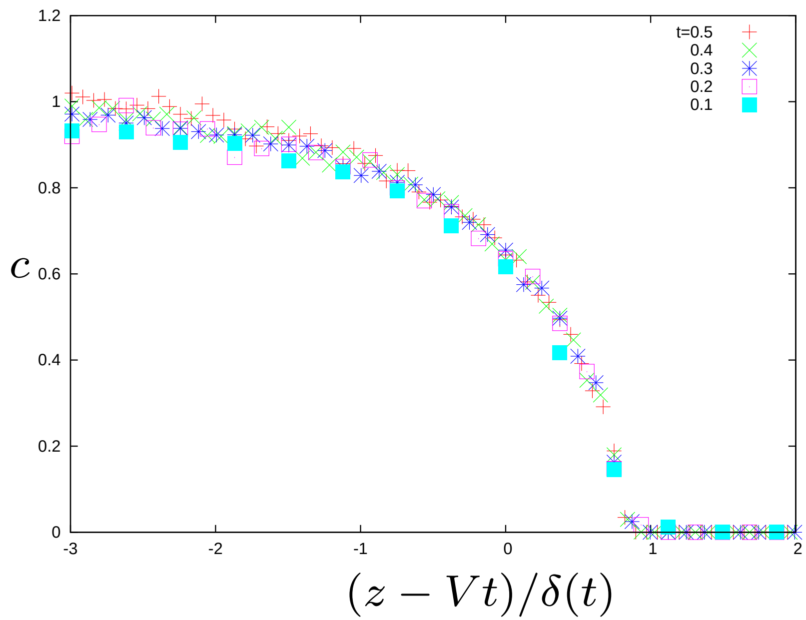


Larger hydrodynamic effect on 50%–75%.

Concentration profiles

Profiles rescaled with width of front.





Universal form