garate@mpia.de

Dynamical effect of the dust back-reaction at the water snowline

M. Gárate, T. Birnstiel, J. Drążkowska, S. M. Stammler
Max Planck Institute for Astronomy, Heidelberg

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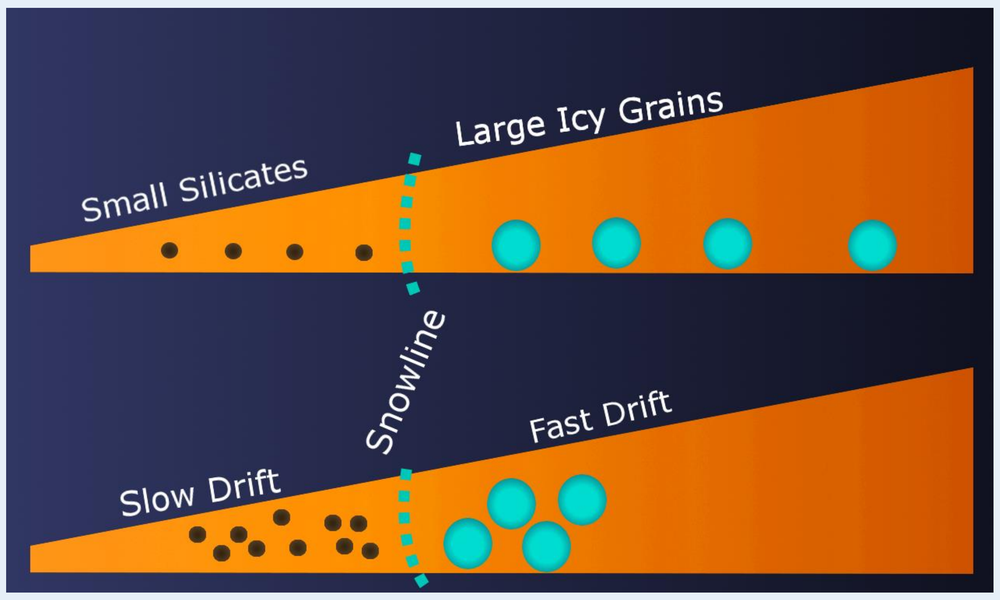
1. The snowline as a traffic jam

At the water snowline, solids accumulate because of the different drift speeds.

Can high dust concentrations affect the gas?



2. Gas motion with dust back-reaction

The dust back-reaction has two effects:

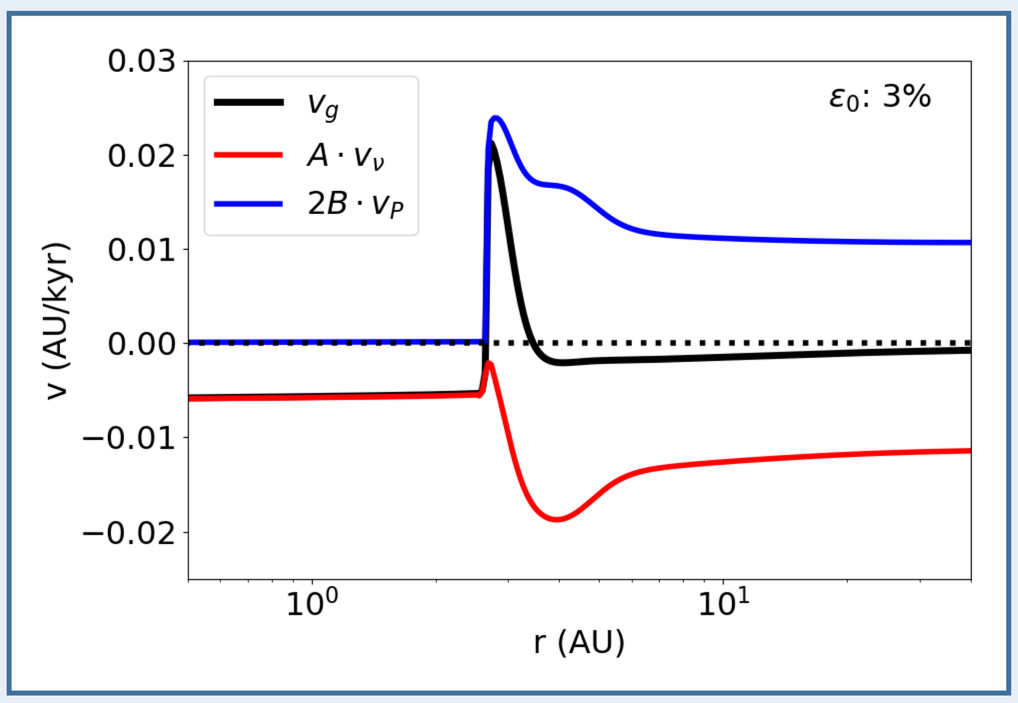
- Damp the gas viscous accretion.
- Push the gas against the pressure gradient.

Viscous Velocity — Pressure Velocity

$$v_{\rm gas} = A \cdot v_\nu \; + \; 2B \cdot v_P$$

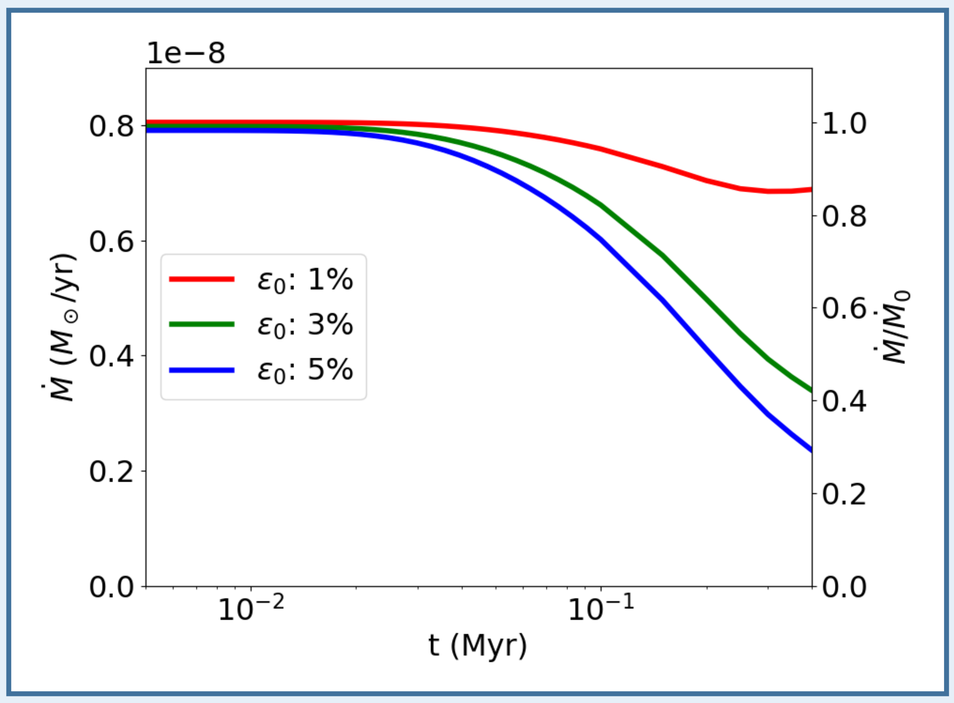
Damping factor: $A \approx (\epsilon + 1)^{-1}$

Pushing factor: $B \approx \epsilon\, St\, (\epsilon + 1)^{-2}$

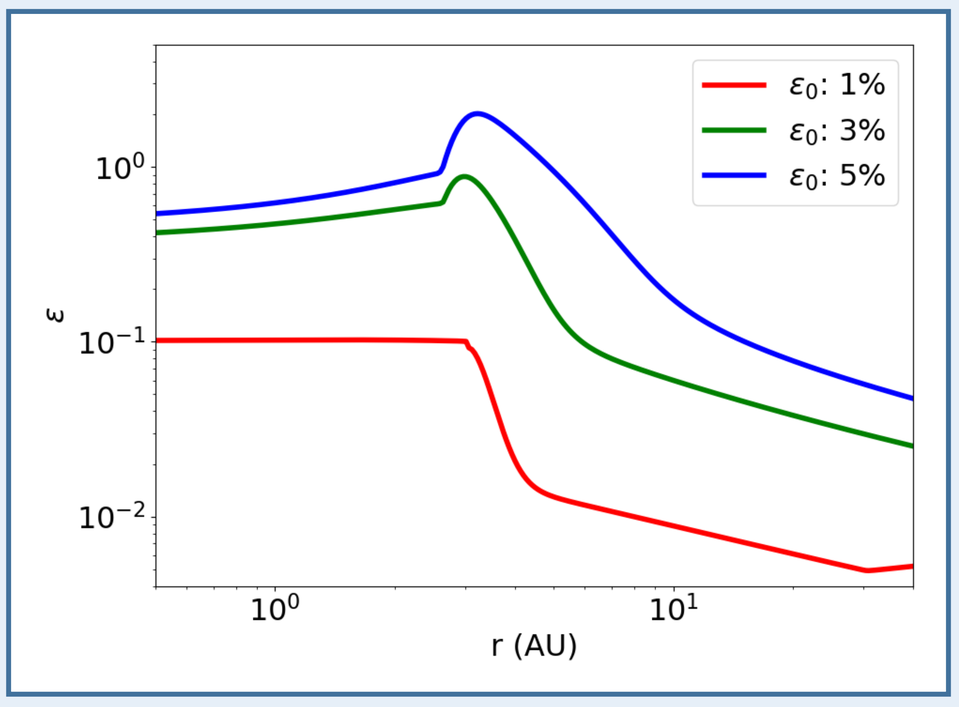


3. Accretion rate and dust concentration

Dust back-reaction damps the gas accretion rate on the star over time.



Dust concentration at the snowline is enhanced.



4. Summary

The back-reaction of dust at the snowline can:

- Stop the gas flow
- Reduce the gas accretion onto the star
- Enhance the pile-up of solids to $\varepsilon \approx 1.0$

Yet, this only happens if:

- The global dust-to-gas ratio is high: $\varepsilon_0 \geq 0.03$
- The turbulence is low: $\alpha \leq 10^{-3}$

Check Gárate et al. (2020) – Arxiv: 1906.07708

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