Pebble Pile Planetesimals Formation

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Planet Formation and Evolution
Kiel
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collaboration:
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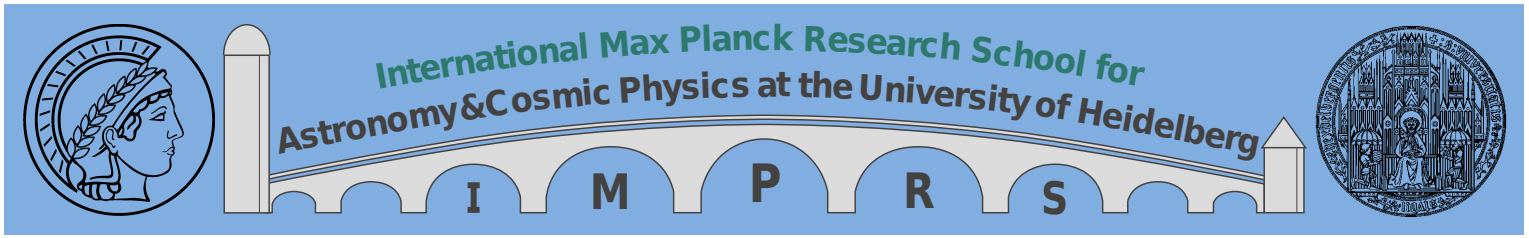
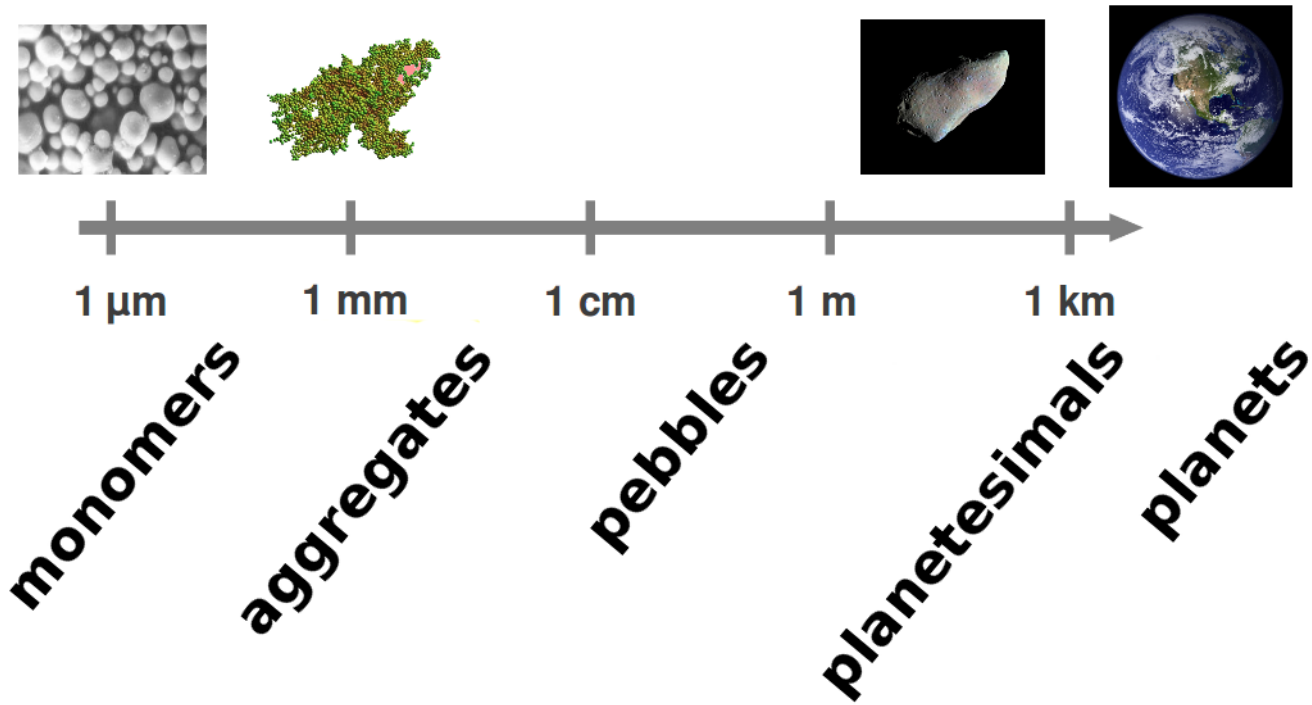
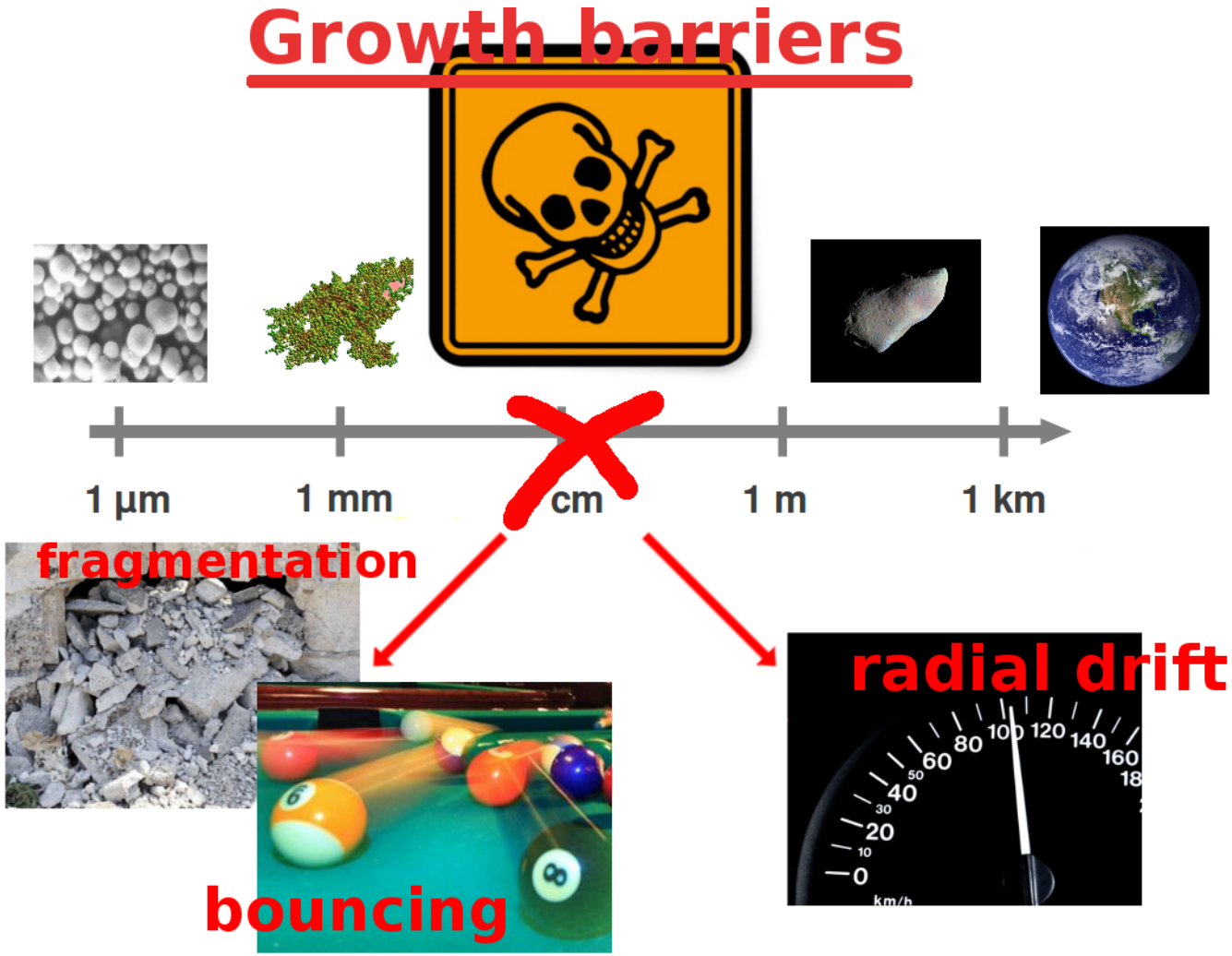


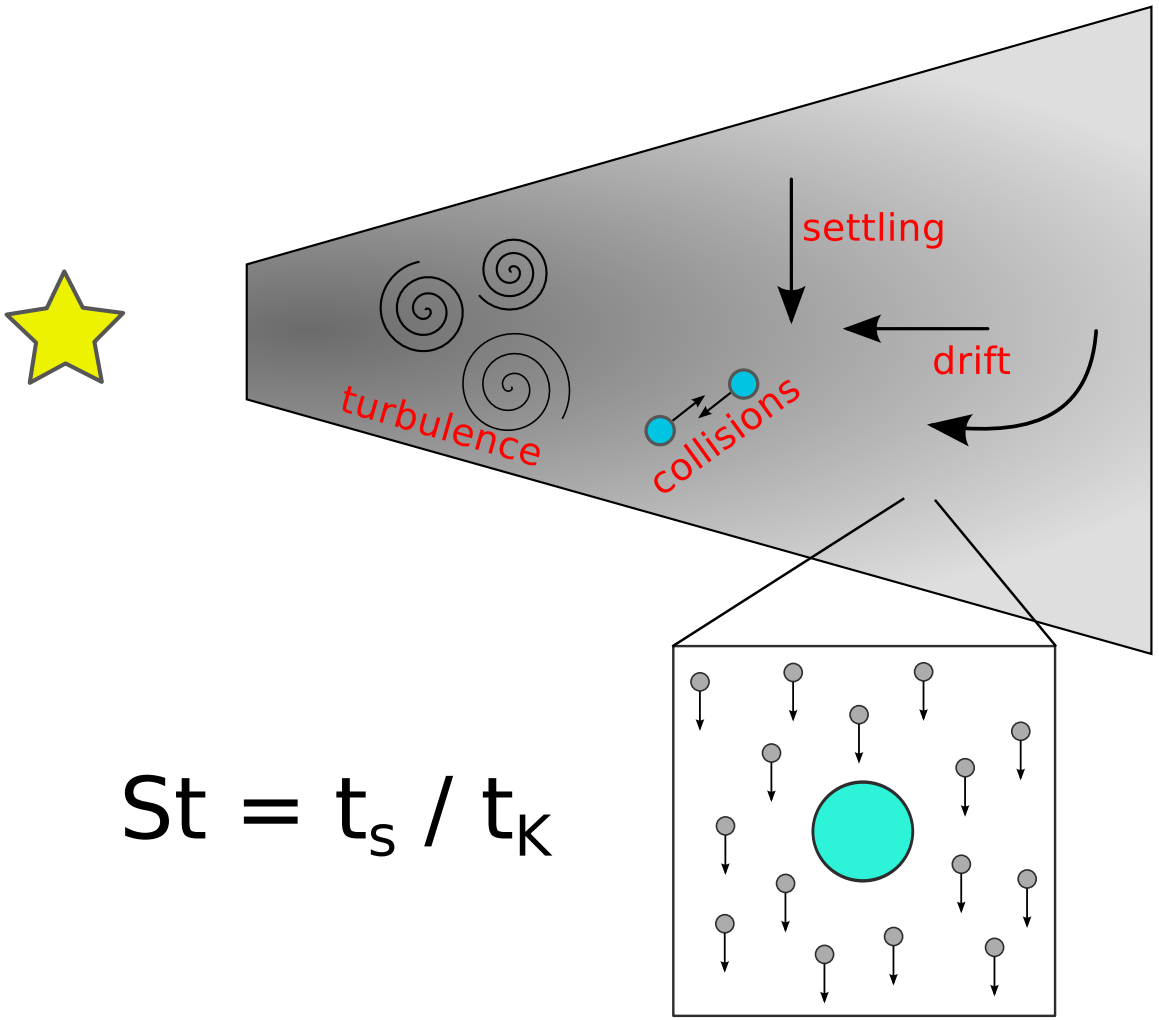
Planet formation via subsequent sticking



Growth barriers

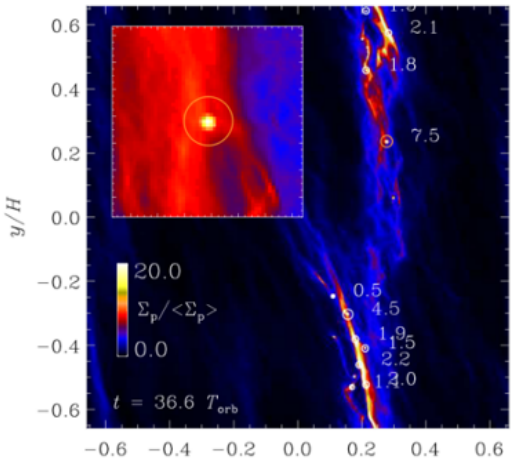


Where do the barriers come from?

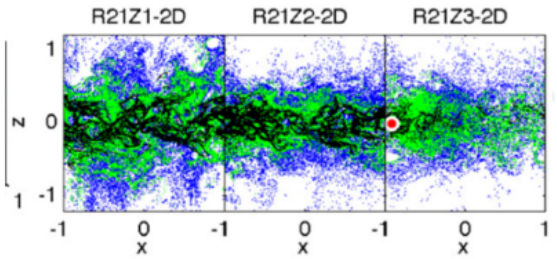


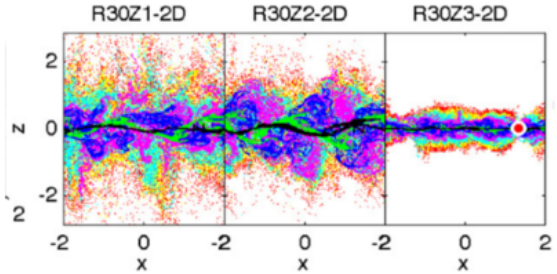
$$St = t_s / t_K$$

Planetesimal formation via the streaming instability

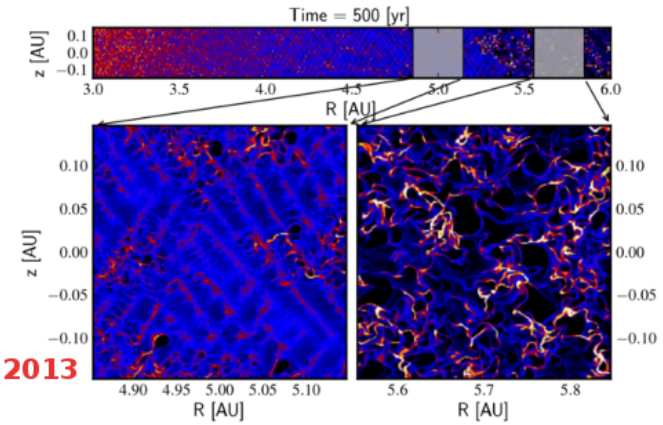


Johansen et al. 2011



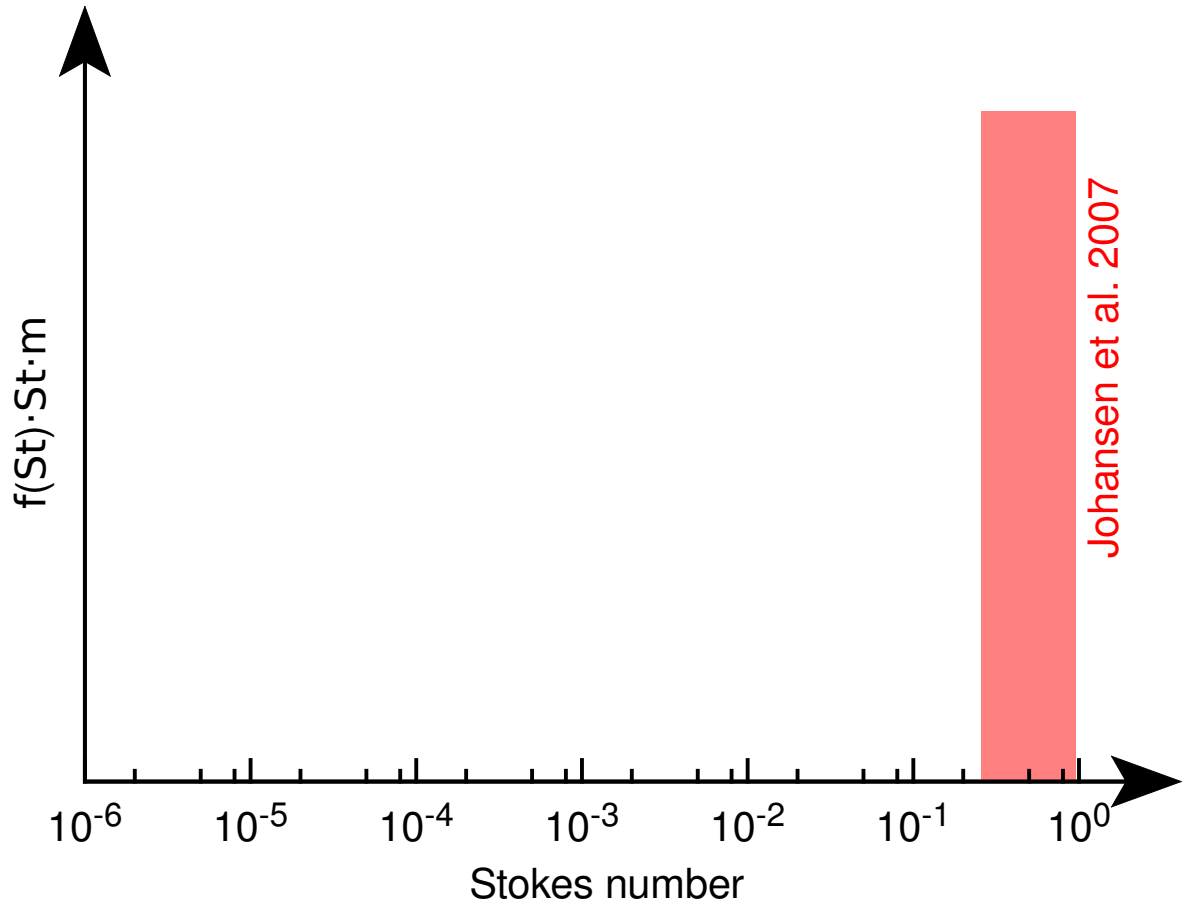


Bai & Stone 2010

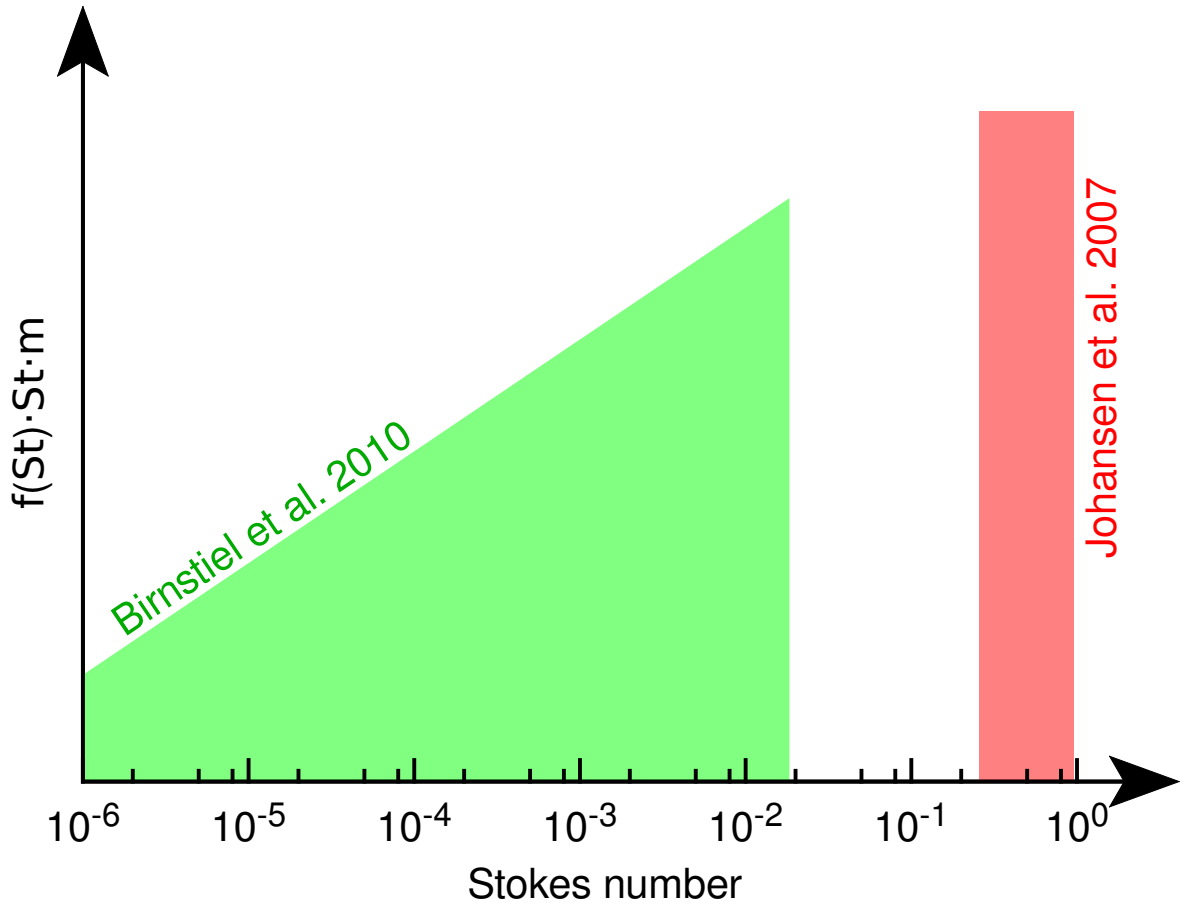


Kowalik et al. 2013

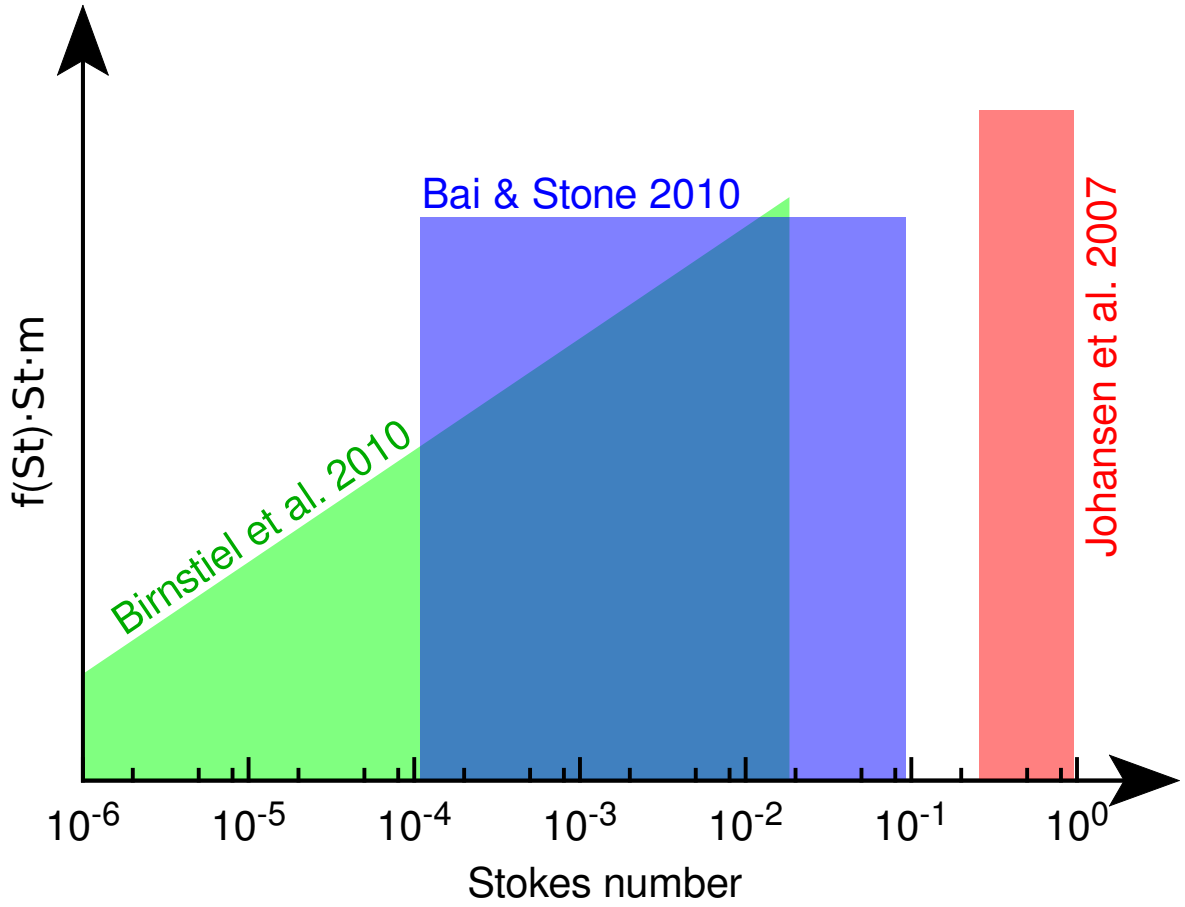
Dust grains size used in the SI models vs 'realistic'



Dust grains size used in the SI models vs 'realistic'



Dust grains size used in the SI models vs 'realistic'



A semi-analytical streaming instability model

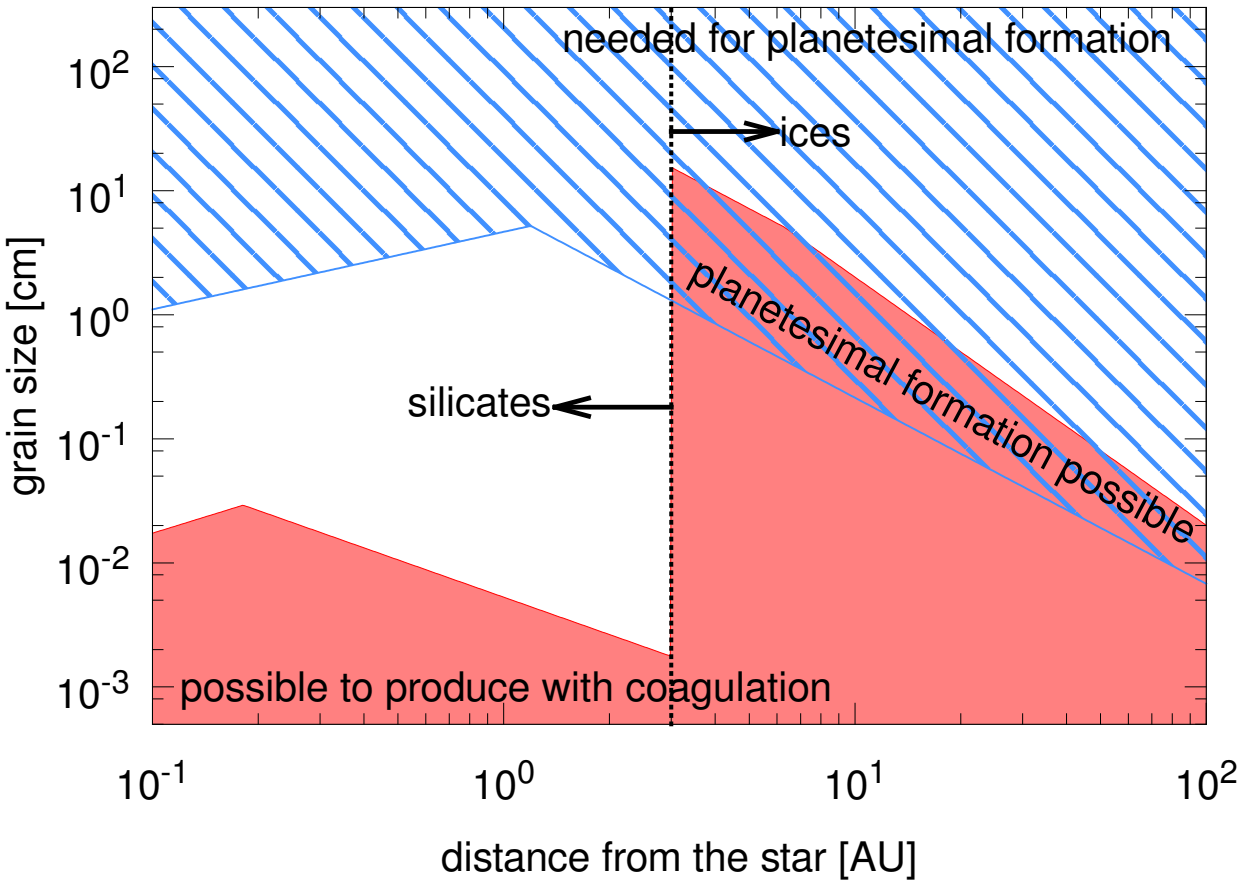
What have we done?

Using the Bai & Stone results, we have built a semi-analytical model of planetesimal formation via the streaming instability and coupled it to our dust coagulation code

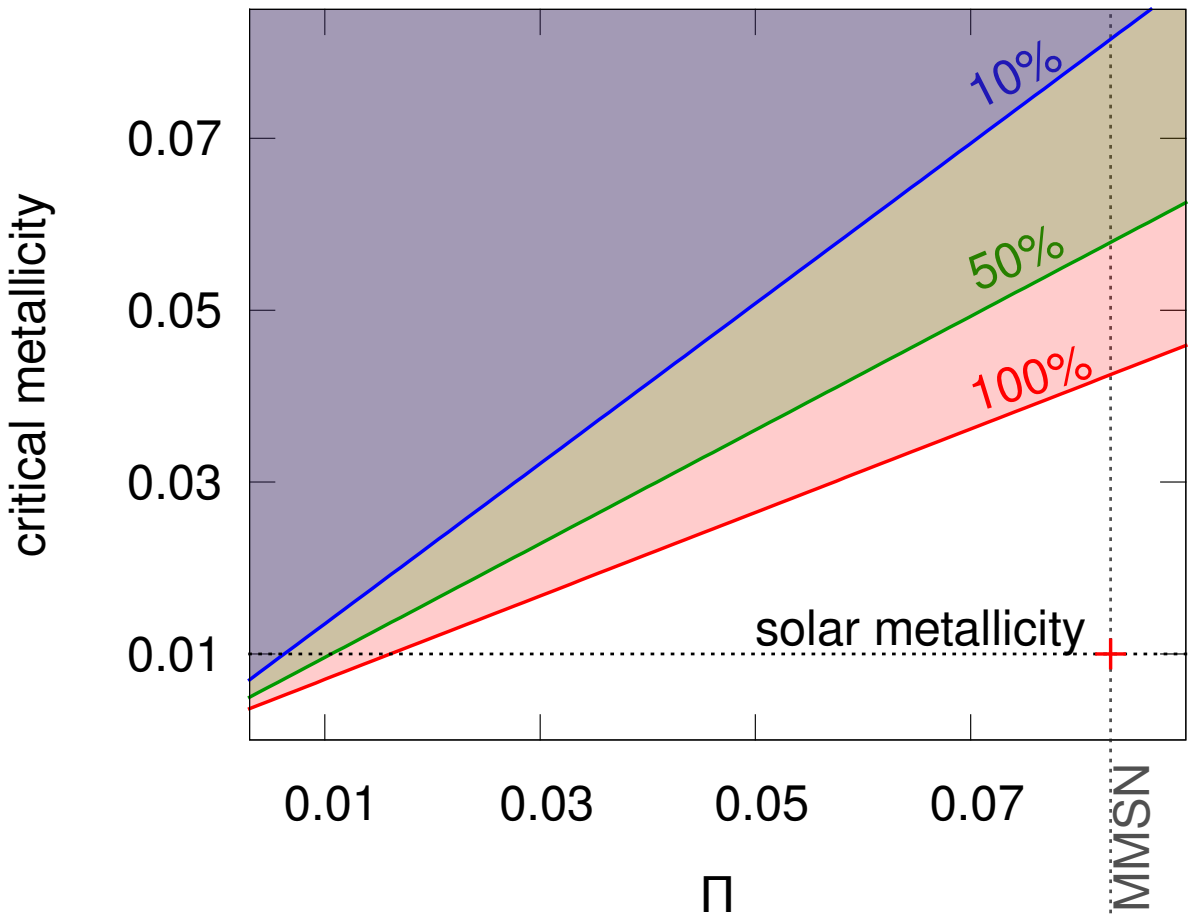
The principles

- minimum Stokes number $\mathrm{St} = 10^{-2}$
- minimum metallicity (counted only for the large grains) $Z(\mathrm{St} > 10^{-2}) > Z_{\mathrm{crit}}(Z_{\mathrm{tot}}, \Pi)$

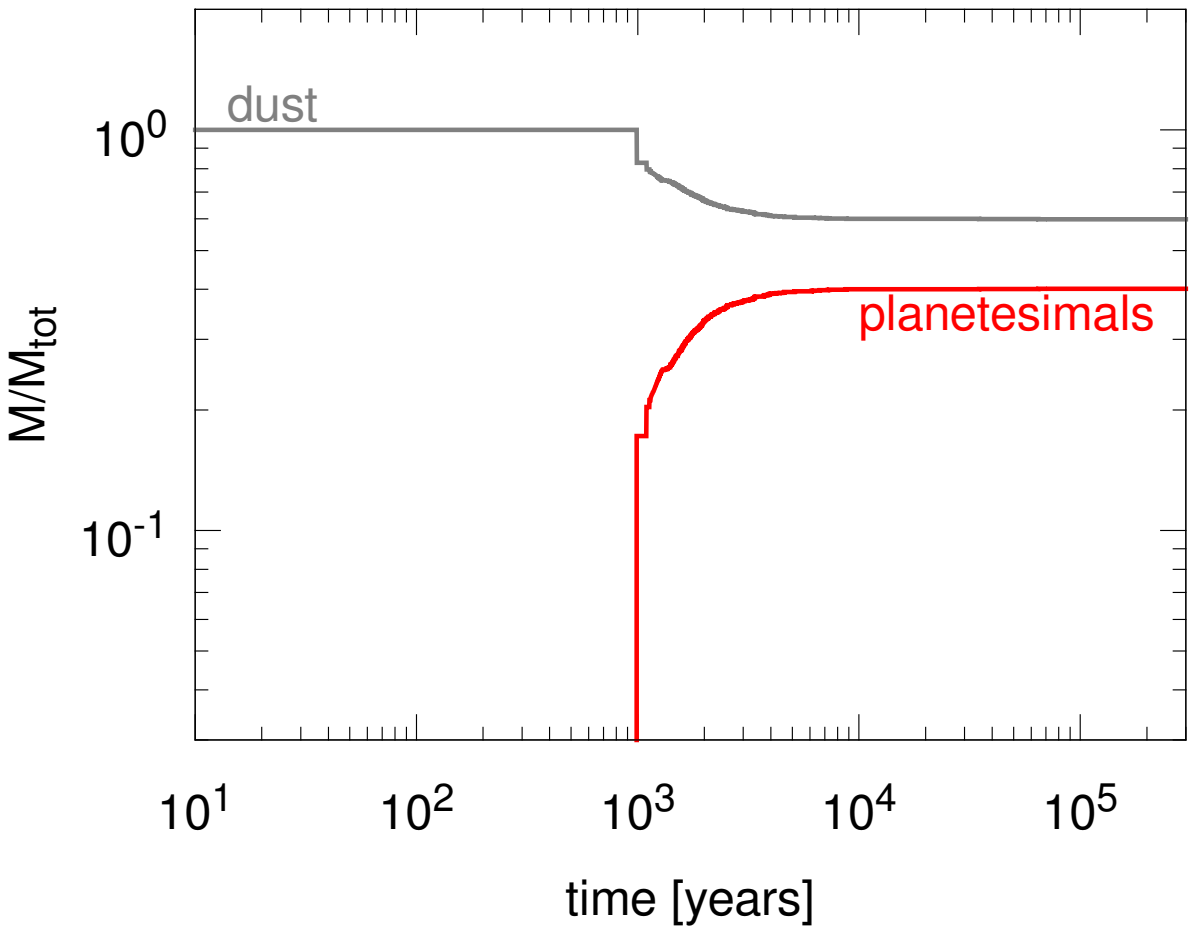
Can we produce the $\mathrm{St} > 10^{-2}$ grains by coagulation?



How much dust do we need?



What happens if planetesimal formation is possible?



Summary

- The minimum size of $\mathrm{St} = 10^{-2}$ **cannot** be reached if the **bouncing barrier** is present
- Planetesimal formation via the streaming instability requires an **enhanced dust abundance** and/or a **reduced pressure support**
- If planetesimal formation via the SI is possible, only a **moderate** amount of pebbles is directly turned to planetesimals