Enhanced Grain Growth at Planet Gap Edges in Protoplanetary Disks

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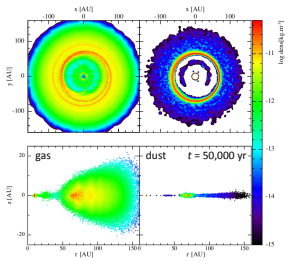
INTRODUCTION

In a previous study of planet gaps in 3D protoplanetary disks (*Fouchet et al. 2010, A&A 518, A16*; *Gonzalez et al. 2012, A&A 547, A58*) we showed that gaps are much sharper in the dust phase than in the gas and that ALMA in its full configuration should easily detect them in nearby star-forming regions. Here we include the processes of grain growth and fragmentation to investigate whether the particle traps at gap edges are favorable sites for dust grains to reach planetesimal sizes.

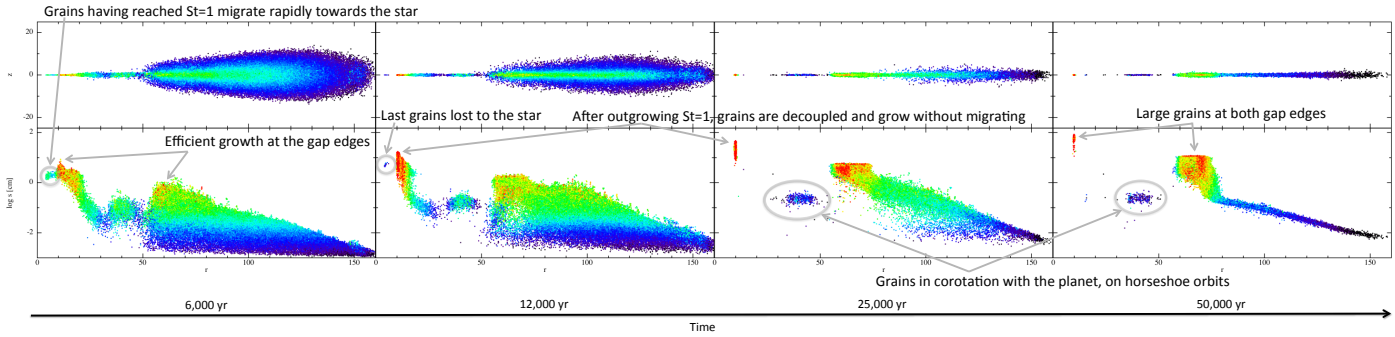


Gas and dust densities in the pure growth simulation

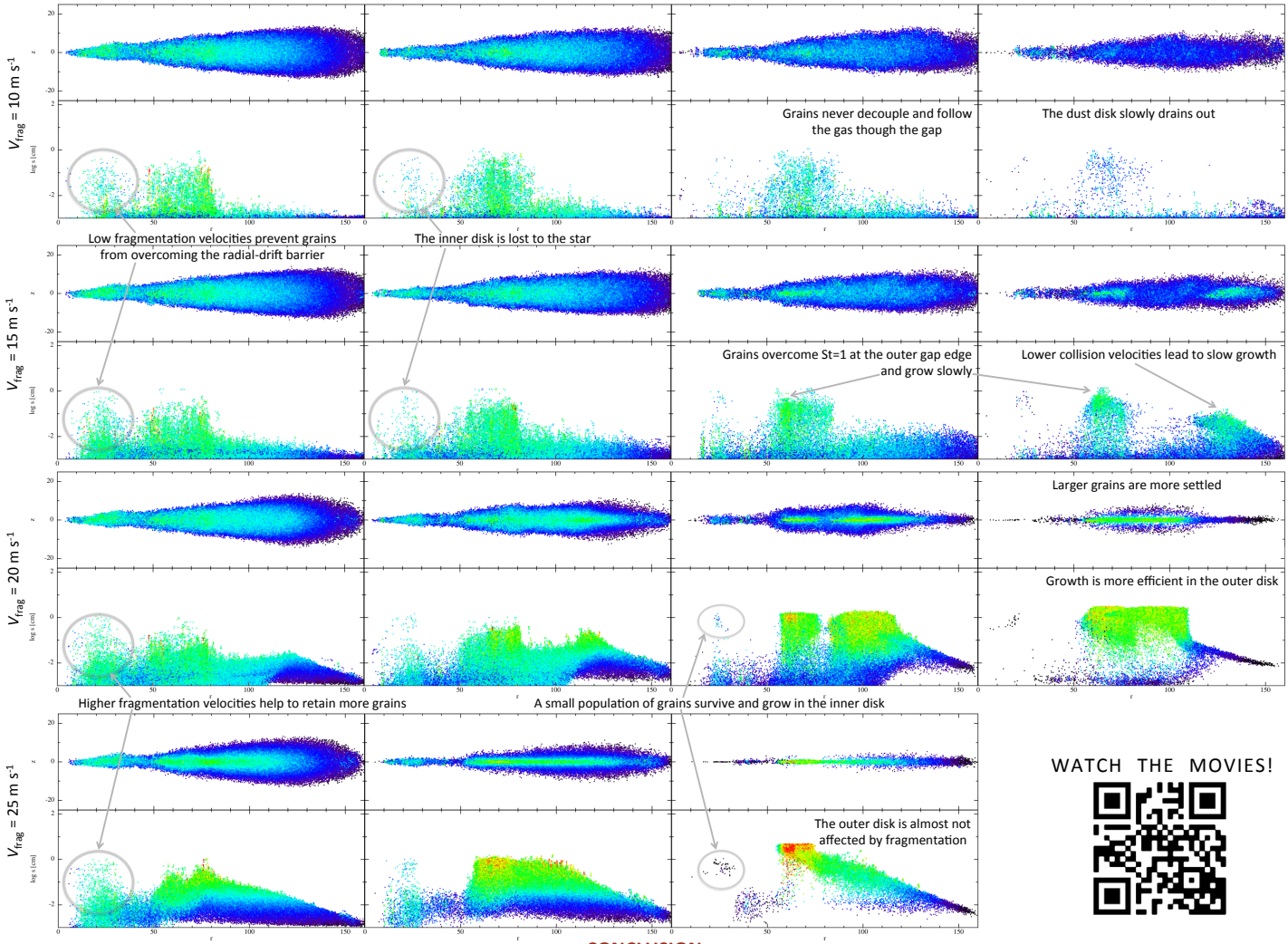
3D HYDRODYNAMIC SIMULATIONS

- Two-phase SPH code (*Barrière-Fouchet et al. 2005, A&A 443, 185*)
- CTTS disk: M_d=0.02 $M_\odot$ around 1 $M_\odot$ star
- 99% gas + 1% dust grains, initial size of 10 µm
- Aerodynamic drag ⇨ self-consistent, grain-size dependent dynamics
- Grain growth (*Laibe et al. 2008, A&A 487, 265*)
- Fragmentation above a relative velocity threshold V_{frag}
- Intrinsic spread in relative velocities
- Planet of 5 M_J orbiting at 40 AU (similar to GJ 504b, *Kuzuhara et al. 2013, ApJ, in press*)

PURE GROWTH



GROWTH & FRAGMENTATION



WATCH THE MOVIES!

CONCLUSION

In our simulations with no fragmentation, grains grow very efficiently in the particle traps at both gap edges. They reach sizes larger than 10 cm and continue to grow at a decreasing rate. Gap edges appear as potential sites for the formation of additional planets. We then included fragmentation above a relative velocity threshold V_{frag} taking values from 10 to 25 m s^{-1}. We observe different growth behaviors depending on the radial location, with growth being generally easier as V_{frag} increases. Low fragmentation velocities, considered in most studies (e.g. Pinilla et al. 2012, A&A 545, A81) do not result in significant growth past the radial-drift barrier. Significant growth is only possible with the larger values of V_{frag}, which are allowed when considering porous material (Meru et al. 2013, submitted). Porosity appears to be one of the key parameters to consider when studying the evolution of dust grains to planetesimals.