Disk & Planet dynamics

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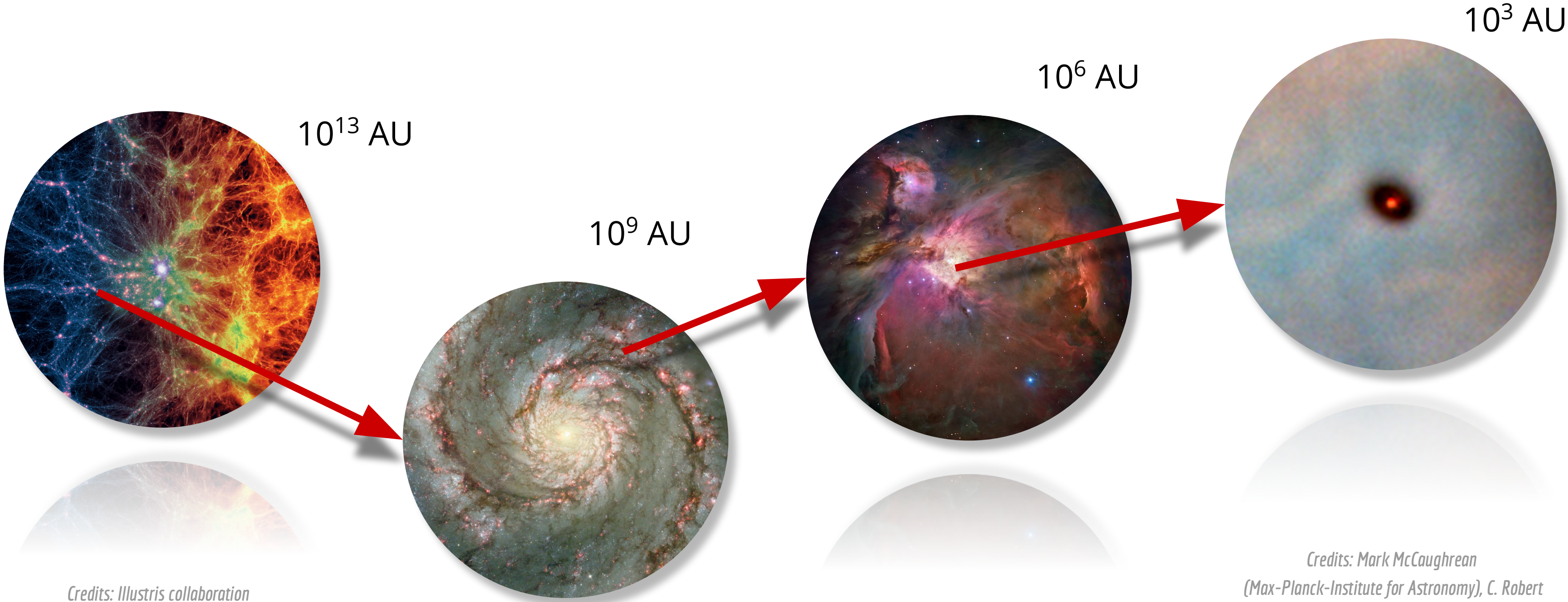
MSc day - 9/10/2020

From galaxy clusters to protoplanetary disks



Credits: Illustris collaboration

Credits: NASA/Hubble

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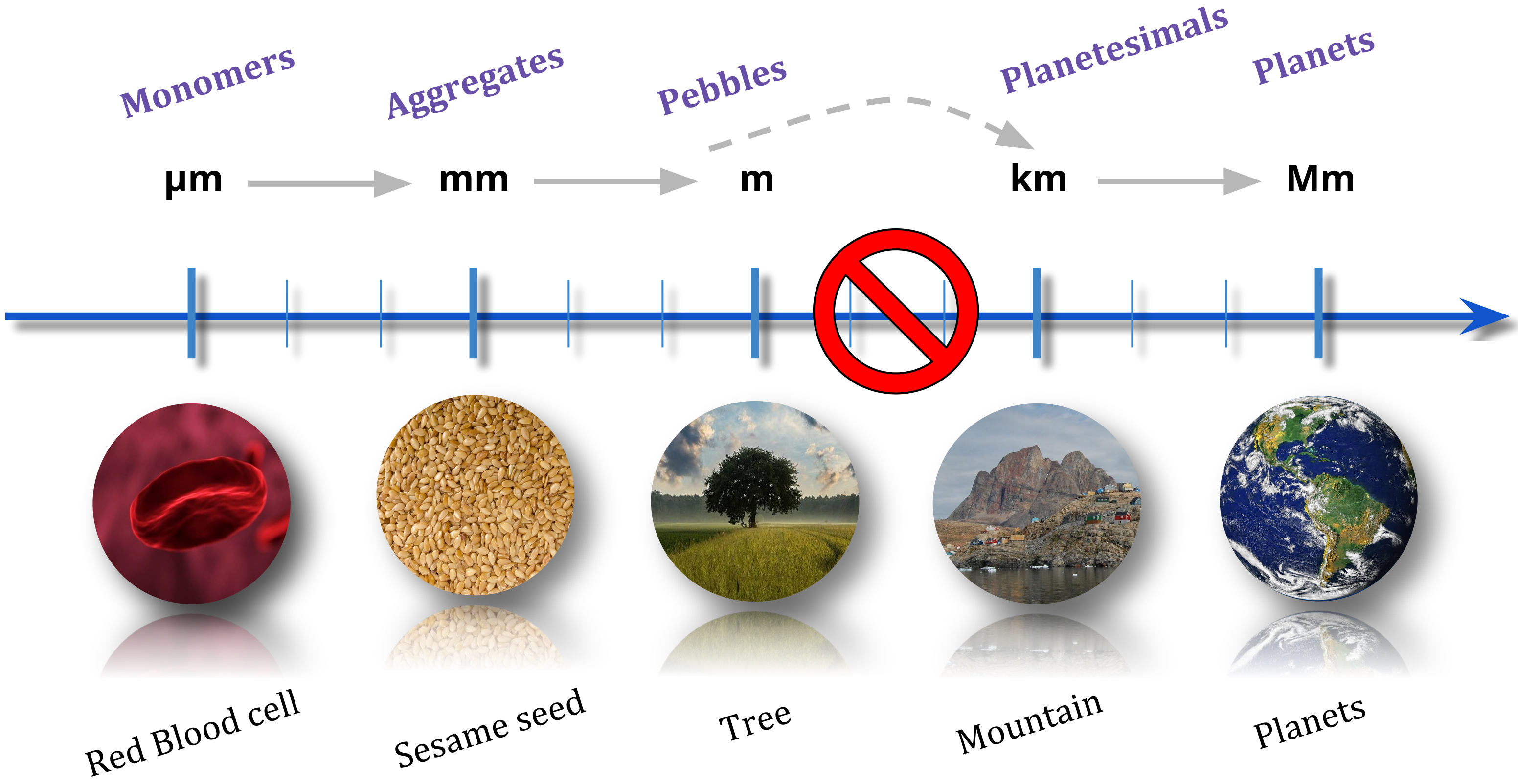
Credits: Mark McCaughrean (Max-Planck-Institute for Astronomy), C. Robert O'Dell (Rice University), and NASA/ESA

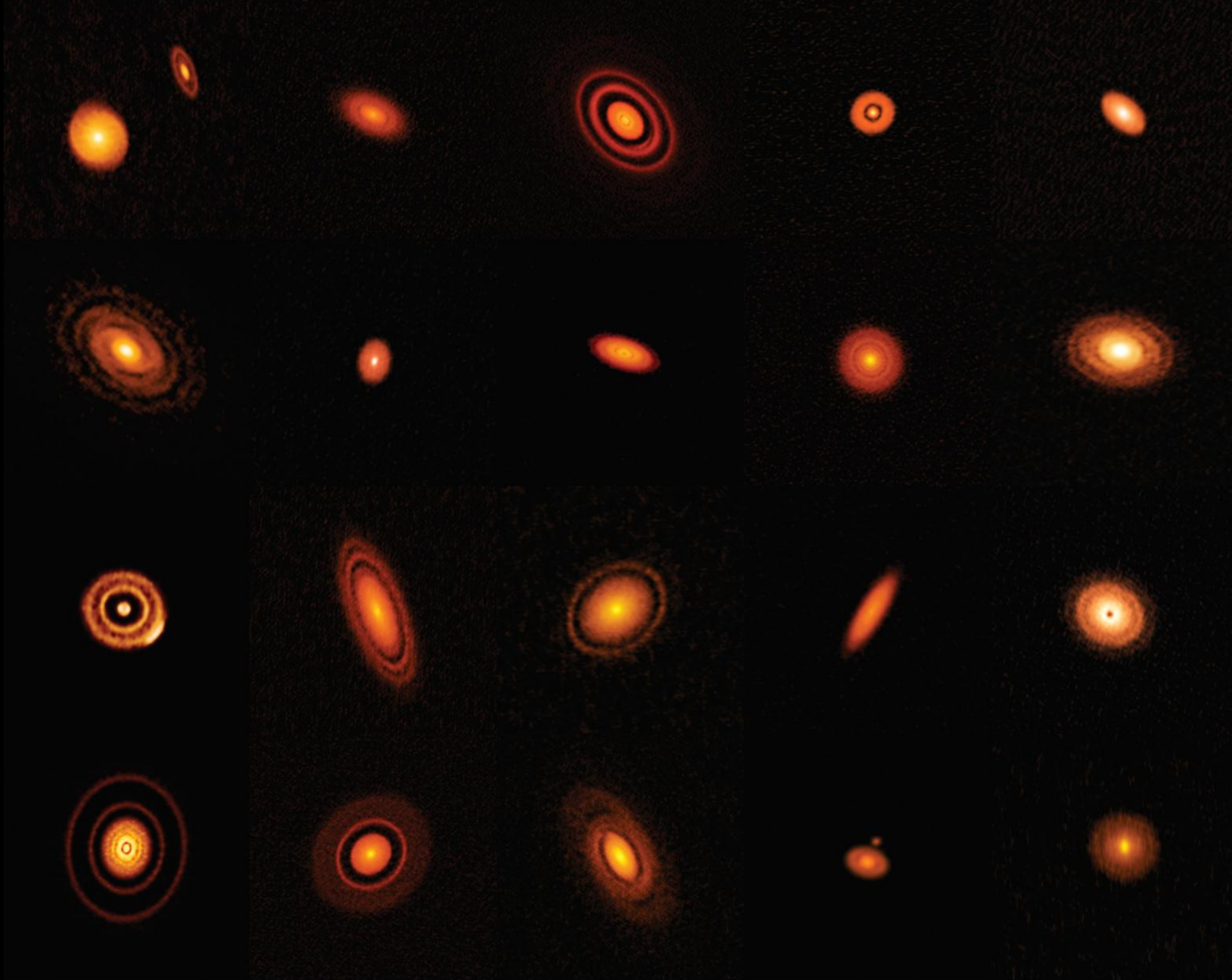
From stardust to planets

13 orders of magnitude in size
39 orders of magnitude in mass

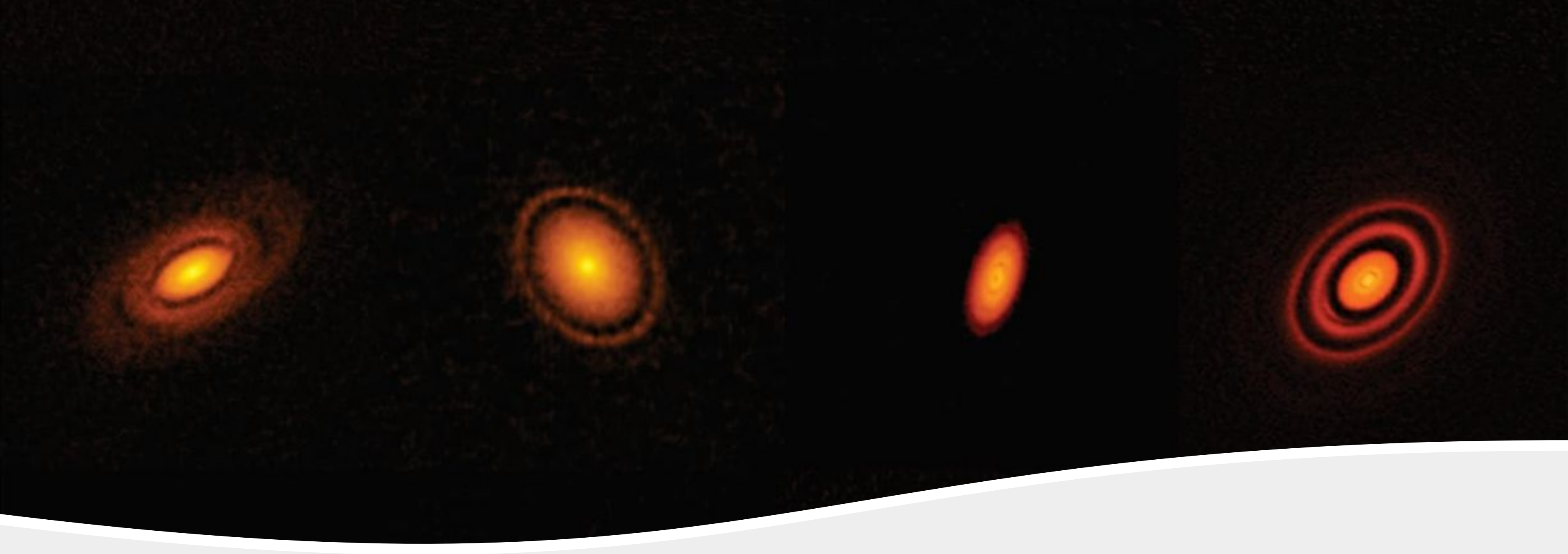


DSHARP

"Disk substructures at high Angular resolution Project"



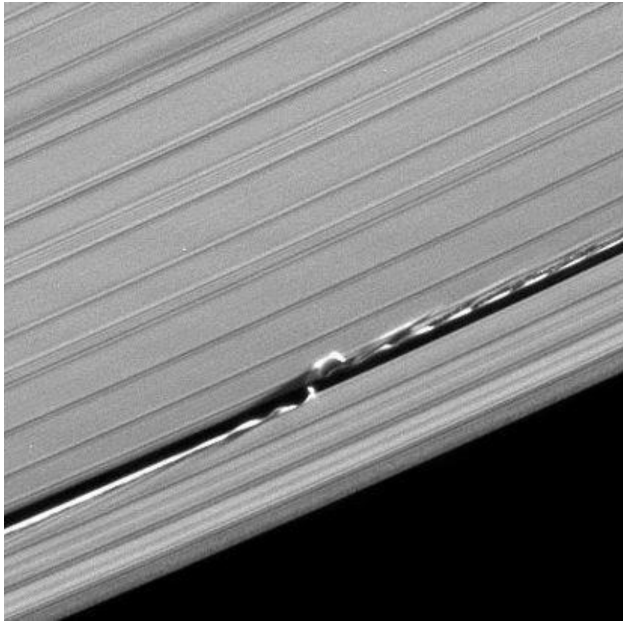
Credits: ALMA (ESO/NAOJ/NRAO), S. Andrews et al.; NRAO/AUI/NSF, S. Dagnello

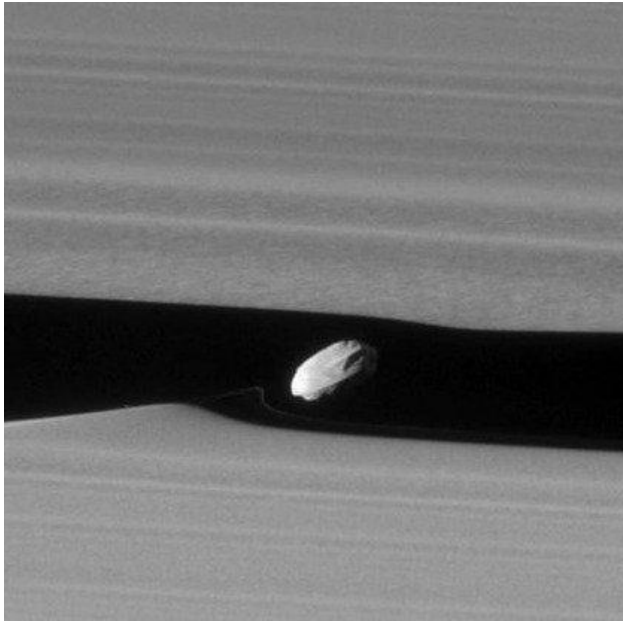


Some fundamental questions...

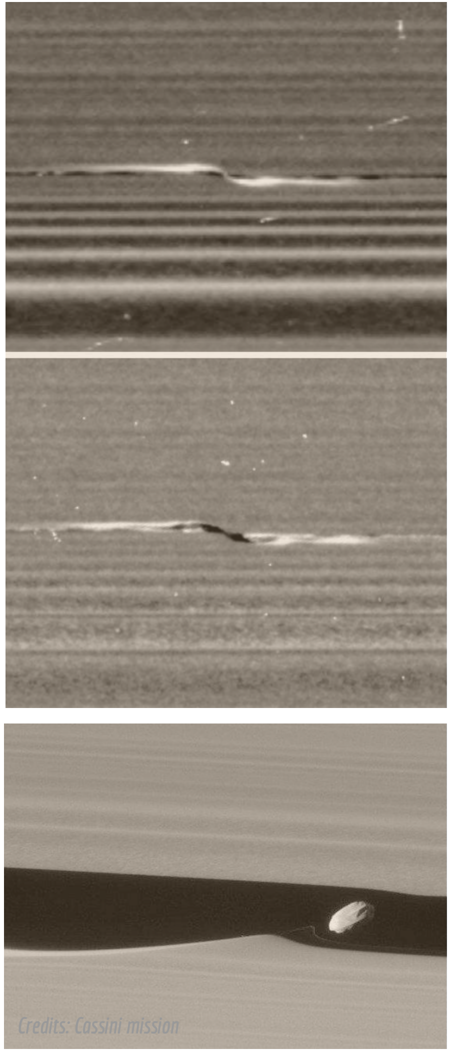
Are the observed structures evidence of ongoing planet formation?
Are these the effects of already formed planets?

Example: Saturn rings





Credits: Cassini mission



A characterization of solid dynamics/evolution in a protoplanetary disk is crucial to understand how planets form.

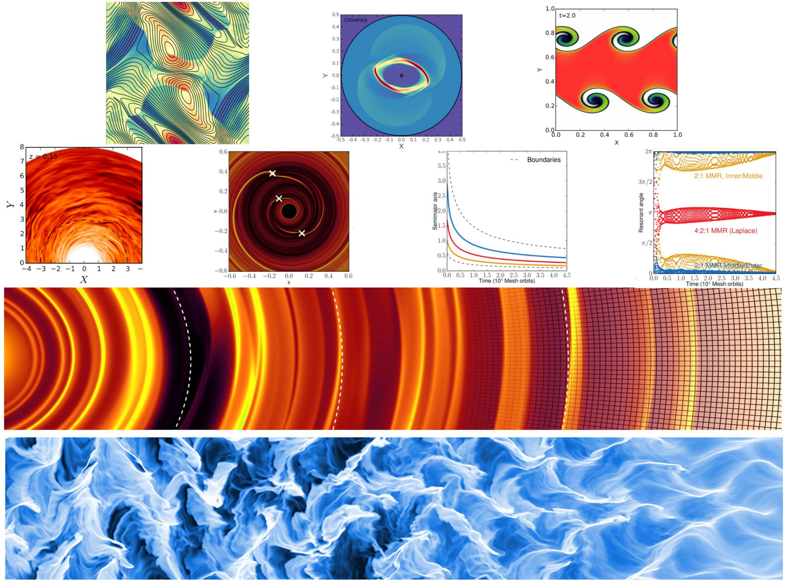
1. **Solids evolve in time, both in mass and size.**
2. **Disks are formed by a dust-size distribution.**
3. **Planets form embedded in a disk.**

Astrophysical fluid dynamics applied to protoplanetary disks

- Planet-disk interactions including
  - Radiation
  - Magnetic fields
  - Dust dynamics
  - Multi-planet systems
  - Self-gravity

- Dust dynamics in multi-species disks
  - Gas/dust instabilities

- Code development and Numerical methods
  - FARGO3D (see http://fargo.in2p3.fr/)



Present and future of the multi-fluid code FARGO3D

2019

Publicly released the multi-fluid feature

In collaboration with Leonardo Krapp.

2019

Dust diffusion Module

In collaboration with Philipp Weber and Leonardo Krapp.

2020

Poisson solver

In collaboration with **Christopher Andersen** and Peter Rodenkirch.

20XX

Parallelization by fluids
Nested meshes

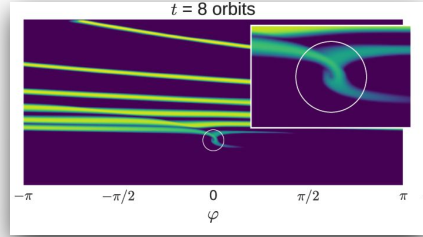
In collaboration with David Velasco and Leonardo Krapp.

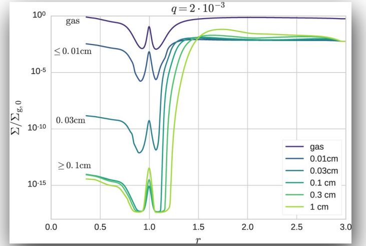
20XX

Dust evolution models?

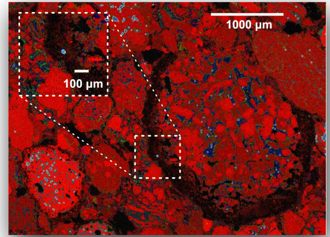
https://bitbucket.org/fargo3d/public

FARGO3D Multi-fluid

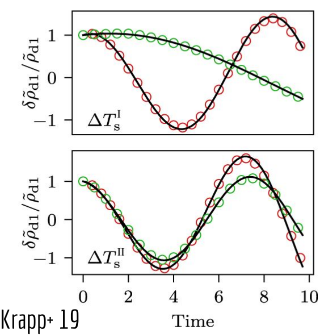




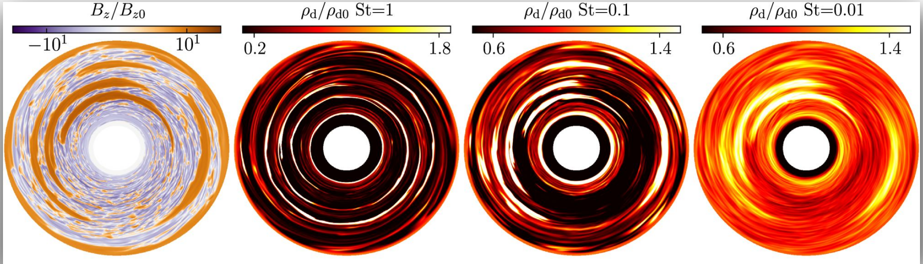
Weber+ 18



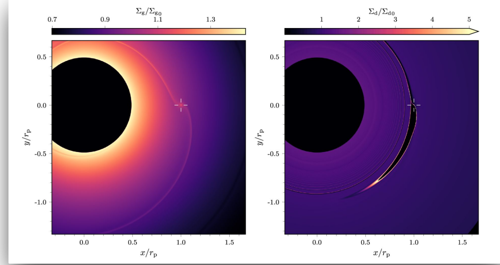
Haugbølle+ 19



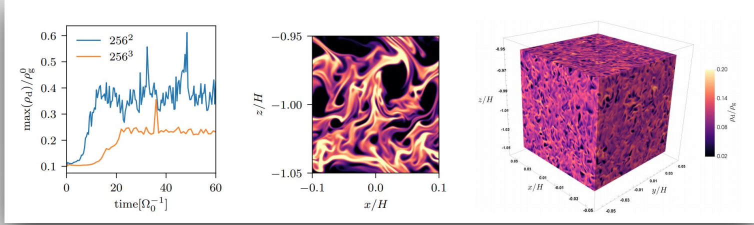
Krapp+ 19



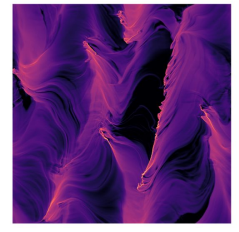
Krapp+ 18



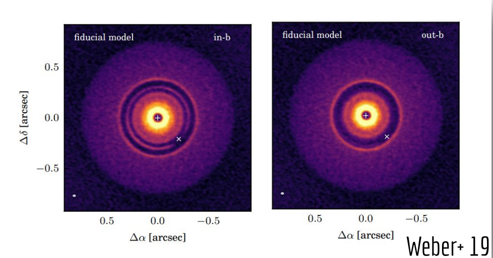
Benítez-Llambay+ 18



Krapp+ 20



Benítez-Llambay+ 19



Weber+ 19