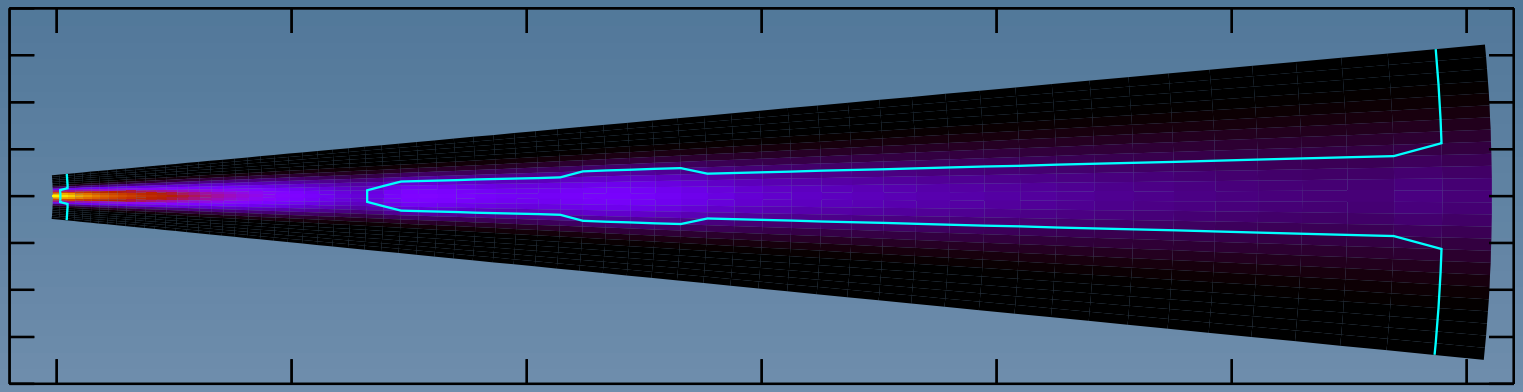
RHD simulations of layered disks

(R. Wünsch, M. Różyczka, H. Klahr)



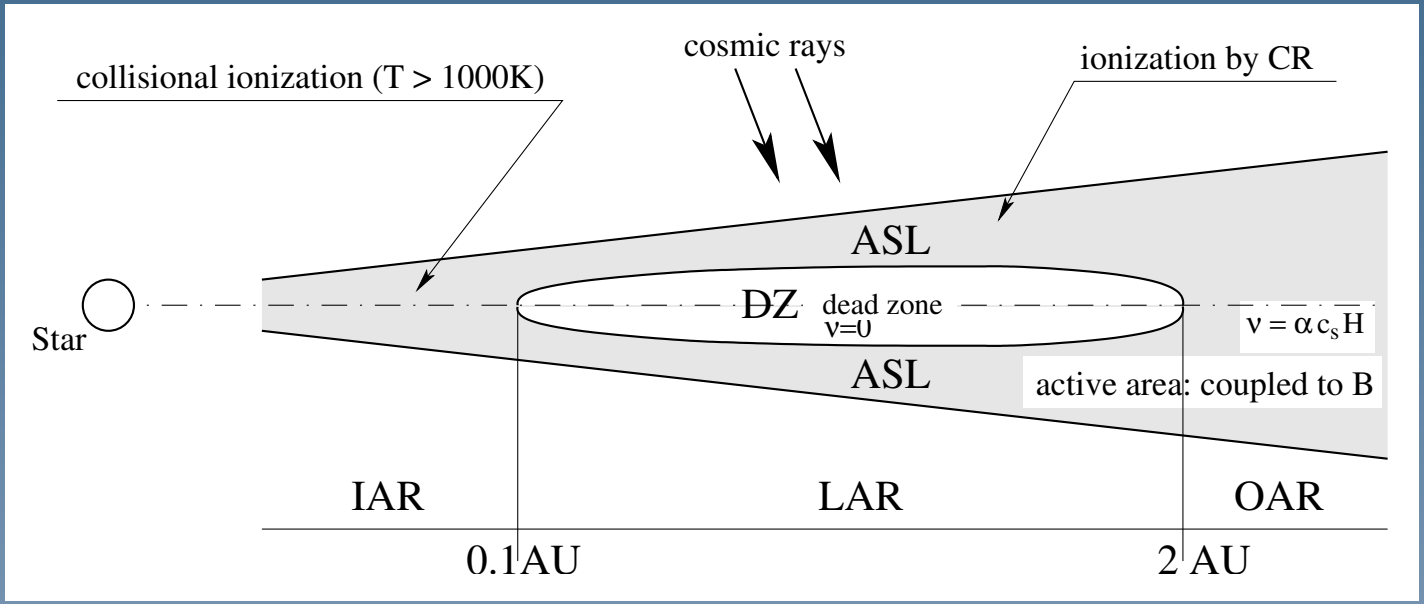
Wünsch, R., Różyczka, M., Klahr, H., 2005, MNRAS, in preparation
2-D models of layered proto-planetary disks: I. The ring instability

Outline:

1 Basic Idea of Layered Disk

2 Ring instability

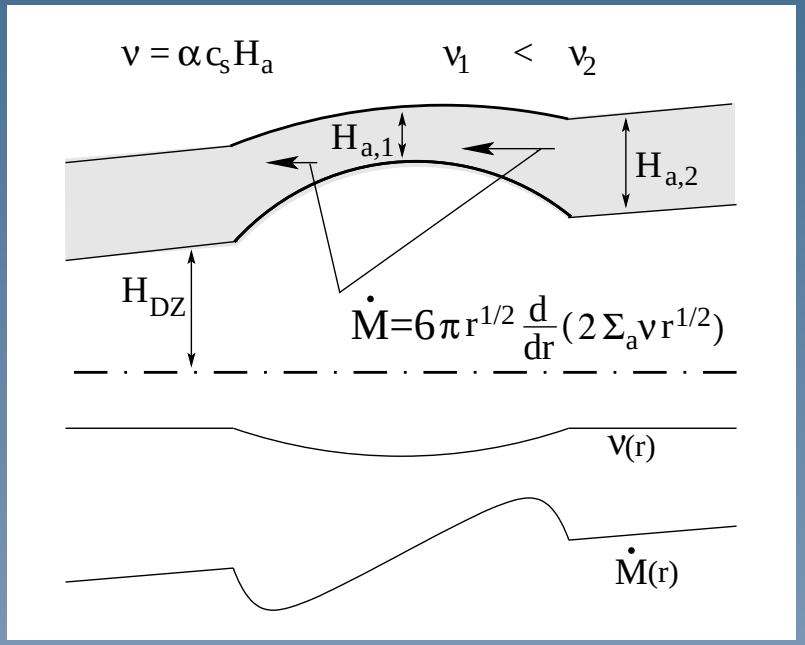
Layered-disk: basic idea (Gammie, 1996)

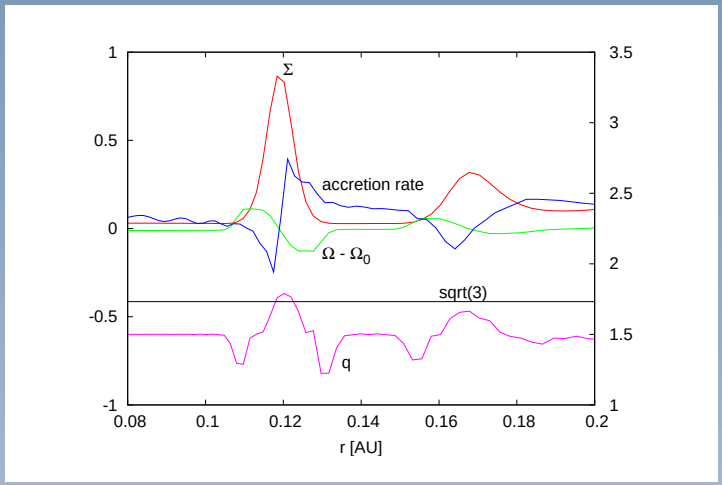


- angular momentum transfer - MRI (Balbus & Hawley, 1991)
- parts of the disk are not ionized enough to be well coupled to the magnetic field
- inner active region (IAR) - collisional ionization
- layered accretion region (LAR) - surface active layers (ASL) ionized by cosmic rays shield the dead zone (DZ) near the mid-plane
- outer active region (OAR) - low surface density, CR are able to ionize whole disk

Ring instability

- dead zone decomposes into rings
- ring instability mechanism:
  - *thickness of surface layer $H_{\rm a}$ depends on the dead zone thickness $H_{\rm DZ}$ (due to different vertical gravity)*
  - *$H_{\rm a}$ is smaller in the ring-like perturbation $\Rightarrow$ ν is smaller there, too*
  - *$\dot{M}$ depends on derivative of ν $\Rightarrow$ it is smaller in inner edge and higher in outer edge of the ring*
  - *enhanced mass accumulation in the ring $\Rightarrow$ positive feedback*





- rings may work as traps for the dust $\longrightarrow$ formation of planets
- rings may decay due to the hydrodynamic instability, if $q > \sqrt{3}$ $(\Omega \sim r^{-q})$

  (Papaloizou & Pringle, 1985)