Sgr A* eats G2 - implications for scintillations

Mark Walker
(Manly Astrophysics)

Comet C/2012 S1 (ISON)

Adam Block/Mount Lemmon SkyCenter/University of Arizona

Gillessen et al 2012

S2

G2 2011.3

G2 2008.3

G2 2004.5

1”

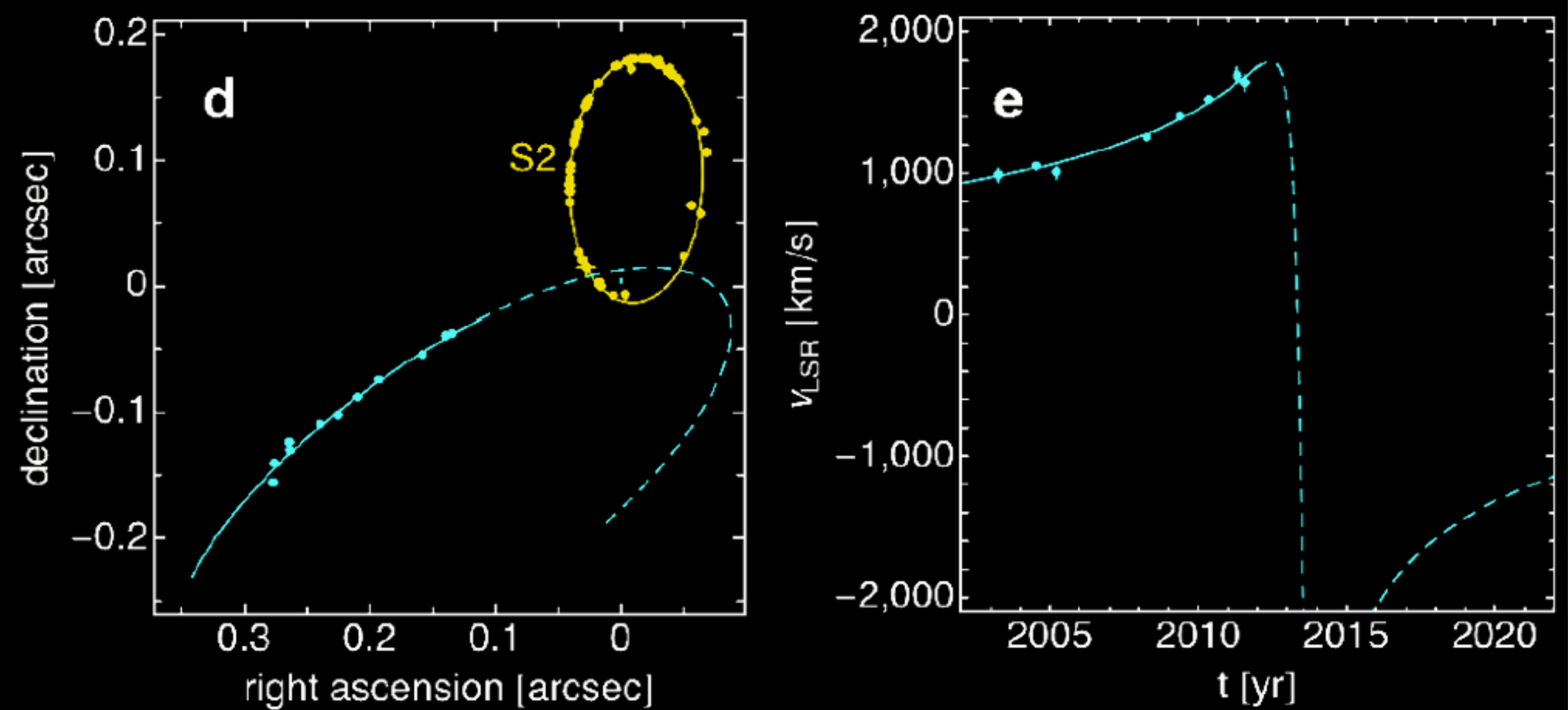
40 mpc

What might happen to G2 ...

Manly Astrophysics

M.Schartmann/MPE/ESO

The orbit of G2



Manly Astrophysics

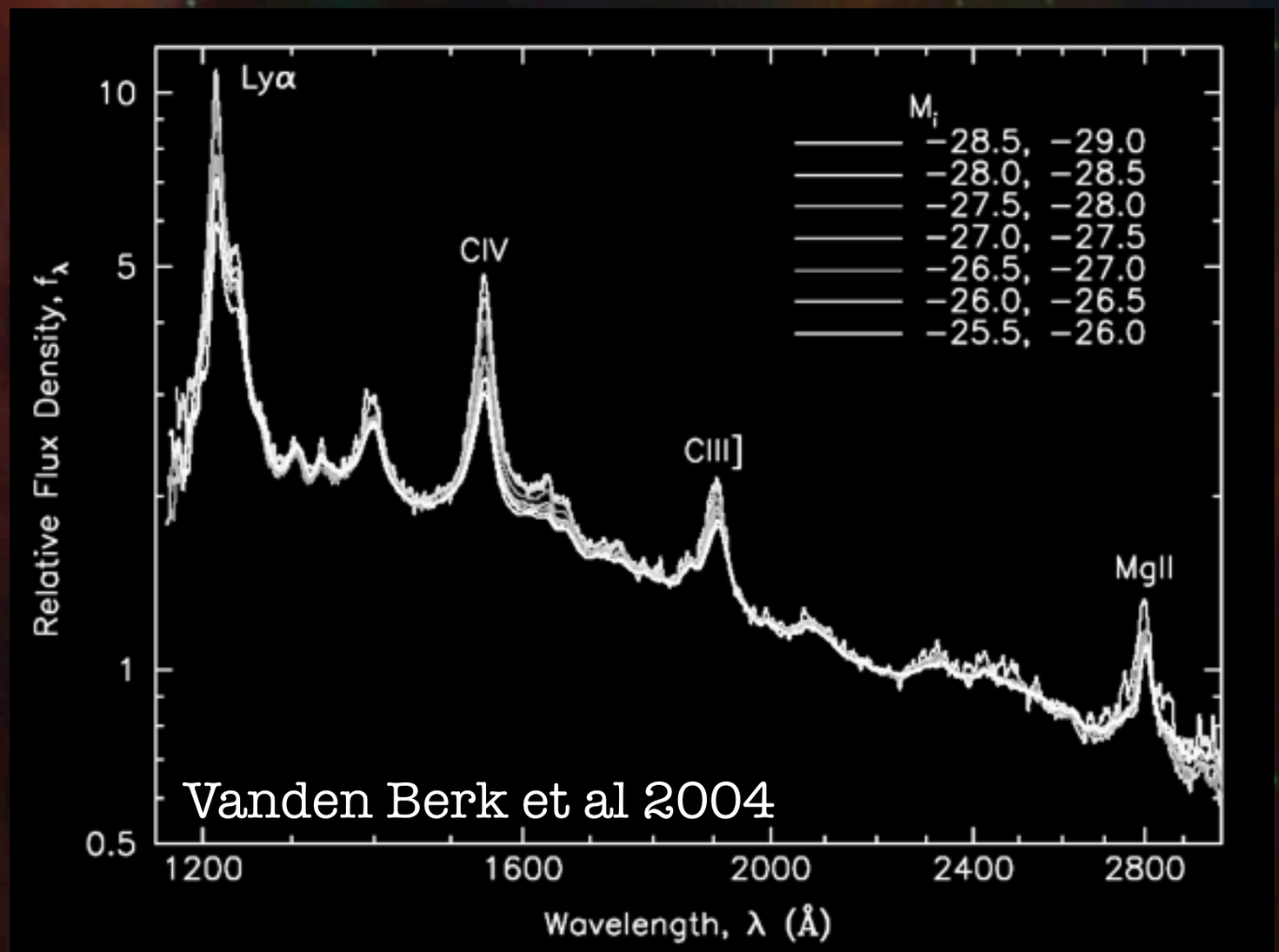
Gillessen et al 2012

Simplest interpretation of G2

- Origin, as for comets
  - "Oort cloud" of long-lived parent bodies
- Parents must be self-gravitating & stable
- Parents must not be too dense
  - UV radiation too weak to inflate a planet
  - Low temperature gas cloud
- Molecular clouds of mass ~ 10^{-5} $M_\odot$

Sgr A* is now our local AGN

- G2 is a single cloud moving at high speed
- Just add more clouds to get a quasar:
  - High continuum luminosity from accretion
  - Smooth, broad emission lines



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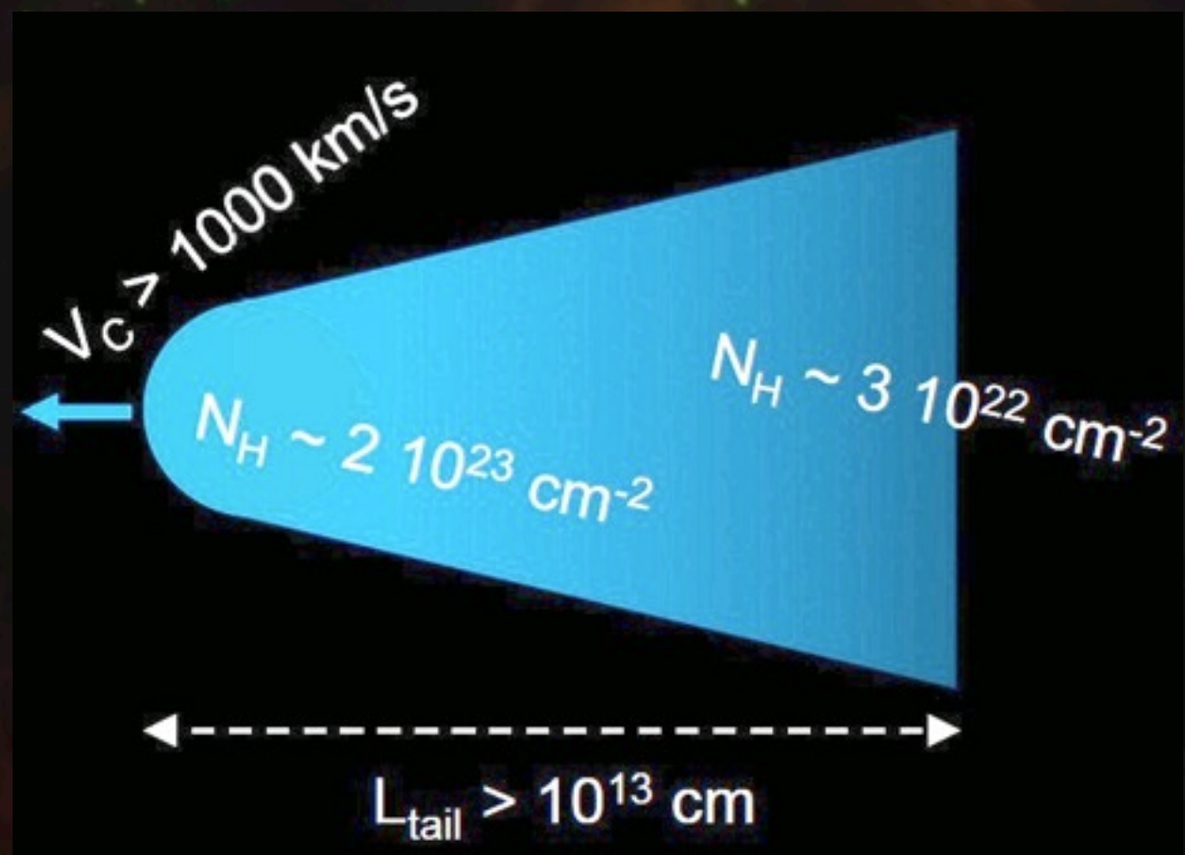

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- X-ray absorption events seen from individual BLR clouds (NGC1365: Maiolino et al 2010)
- Can identify the NLR with the "Oort Cloud"
- Nobody thought of modelling BLR clouds as a new population of self-gravitating objects?!

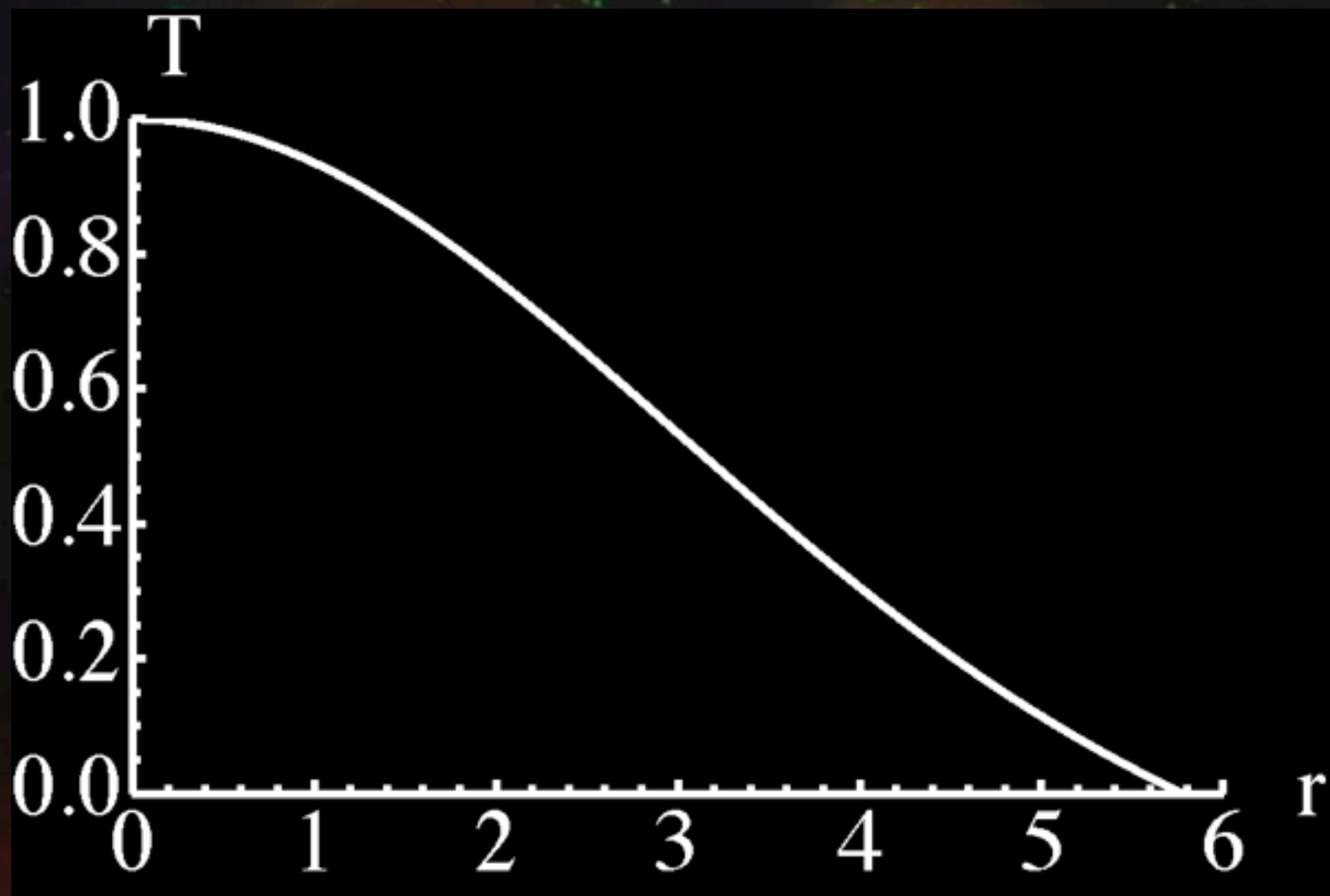
Modelling small molecular clouds

(with Mark Wardle)

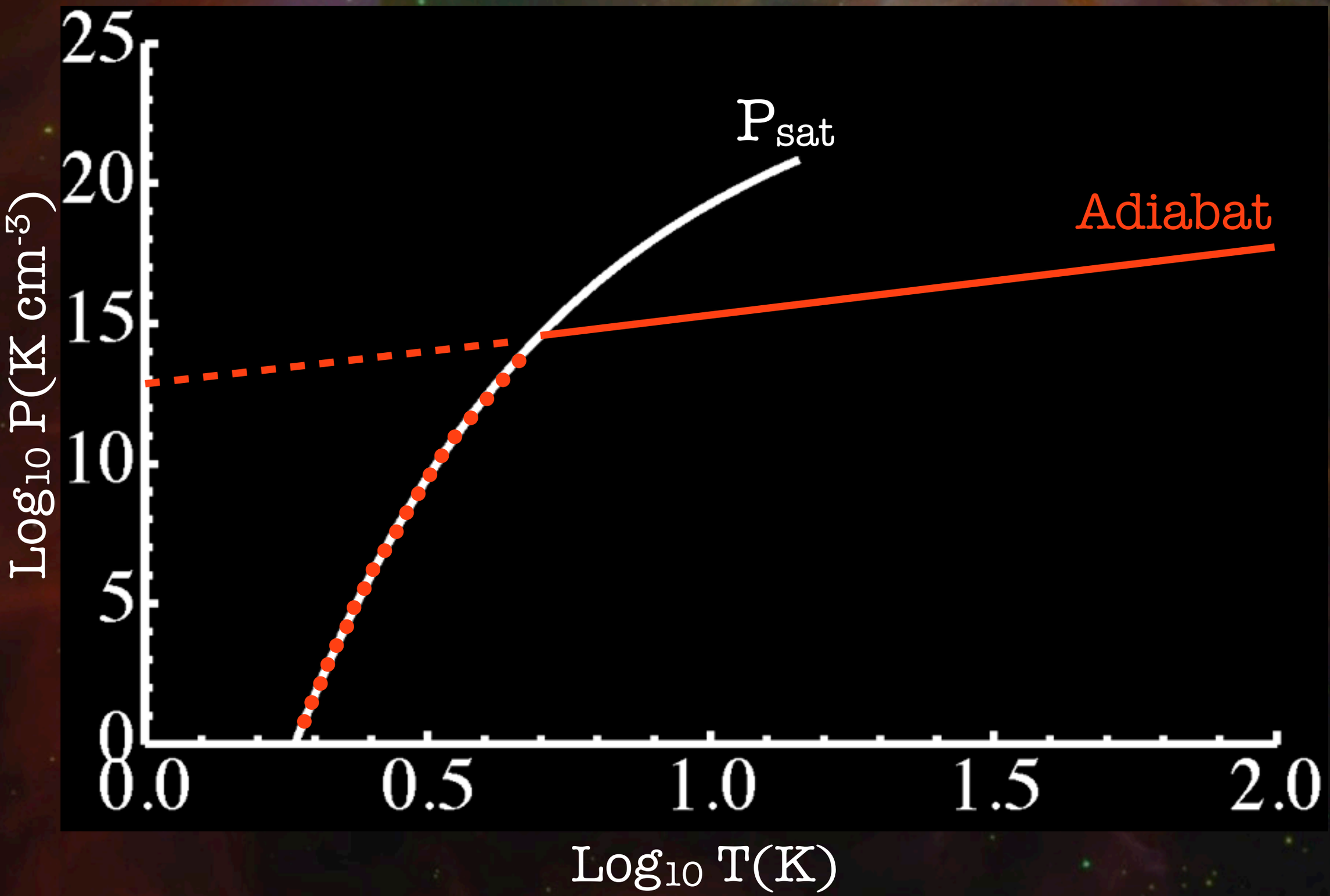
1. Composition: 75% H_2, 25% He
2. Spherical symmetry
3. Hydrostatic equilibrium
4. Low radiative efficiency → Adiabatic convection

Equation-of-state for ideal gas:

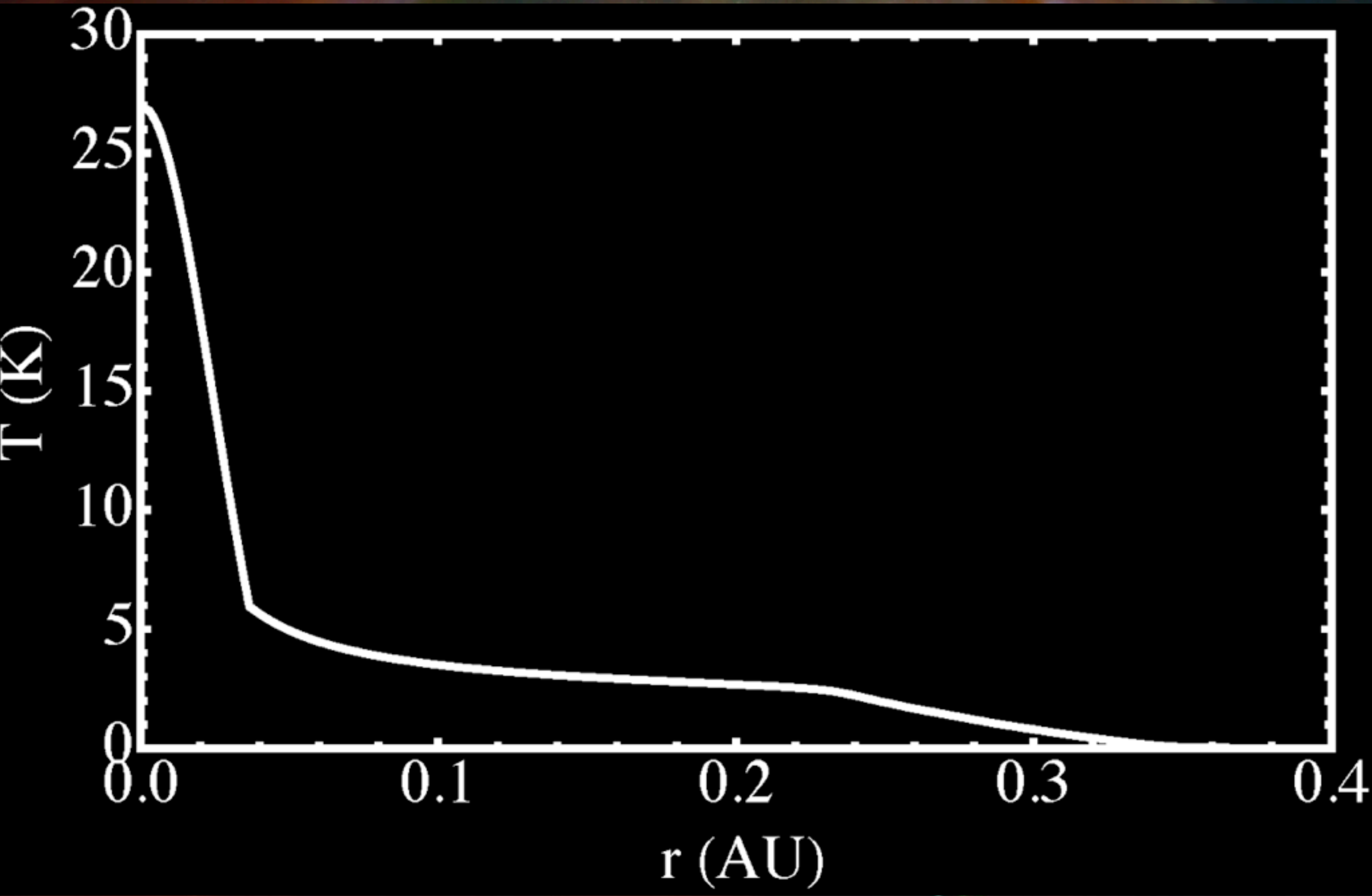
$$P \propto \varrho^{5/3}$$
$$\varrho \propto T^{3/2}$$
$$P \propto T^{5/2}$$



Solid-gas phase equilibrium for H_2



Example solution ($M = 10^{-5}\ M_\odot$)



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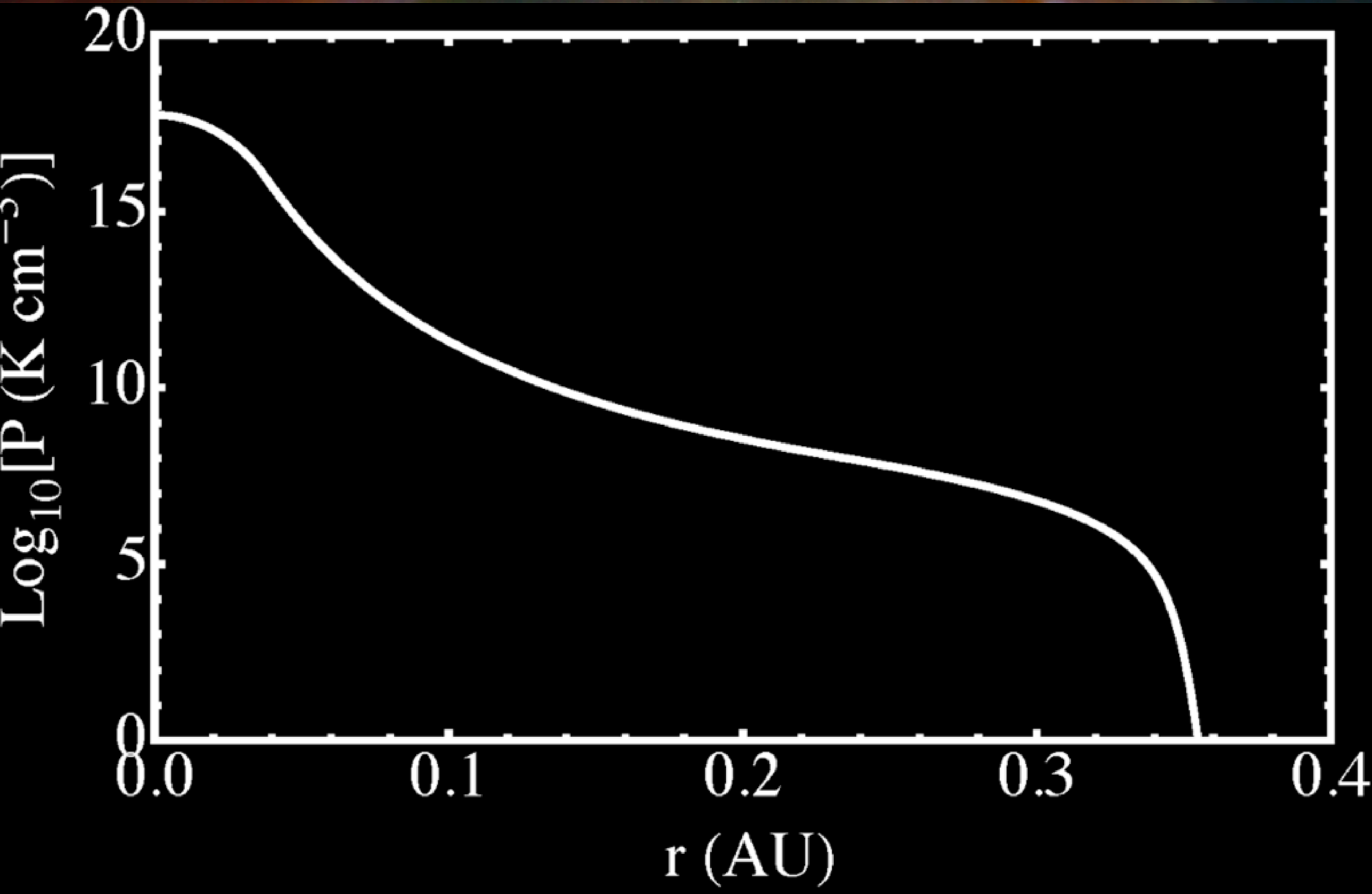
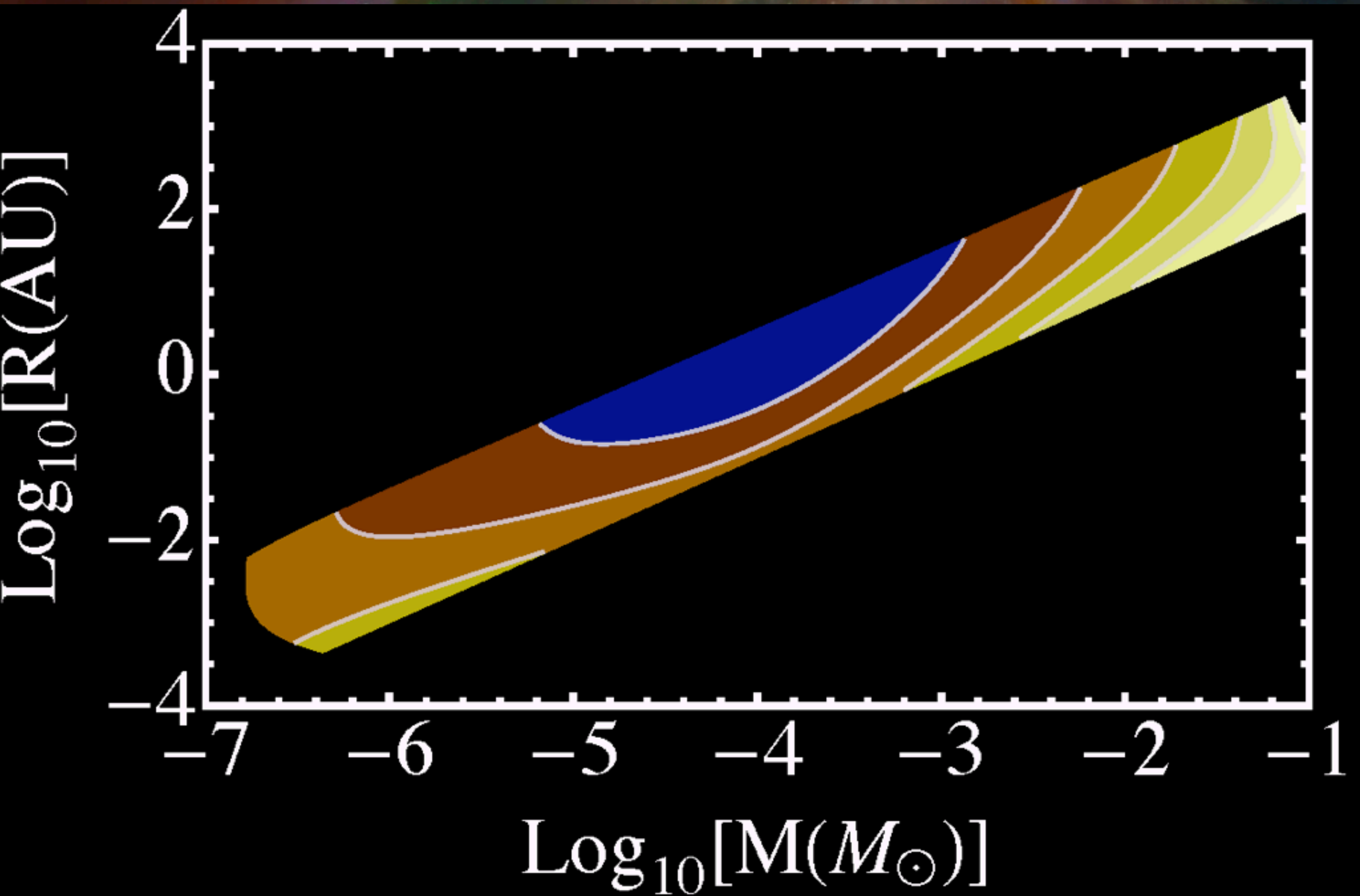


Solutions with minimal snowflake content



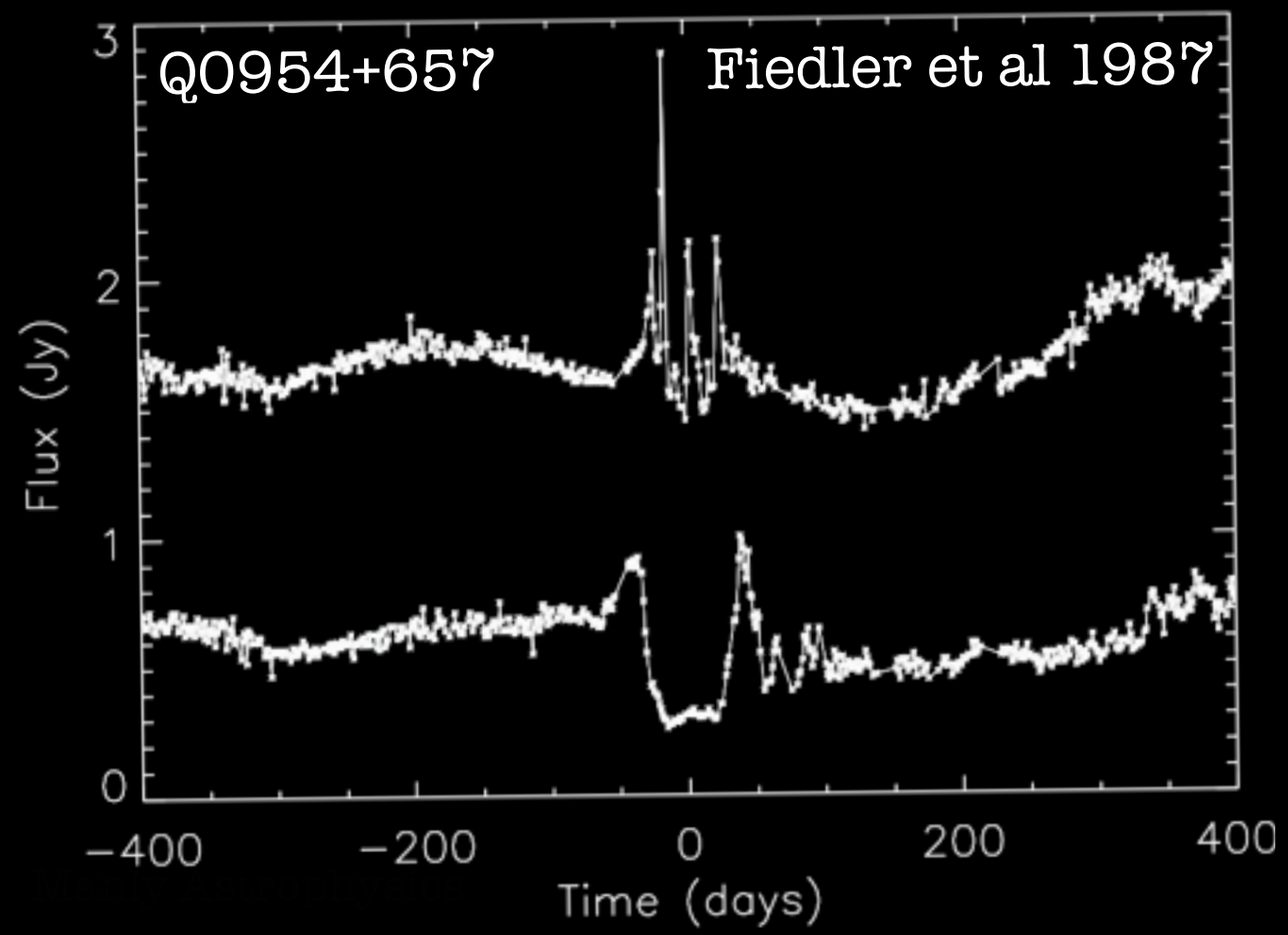
The Helix Nebula

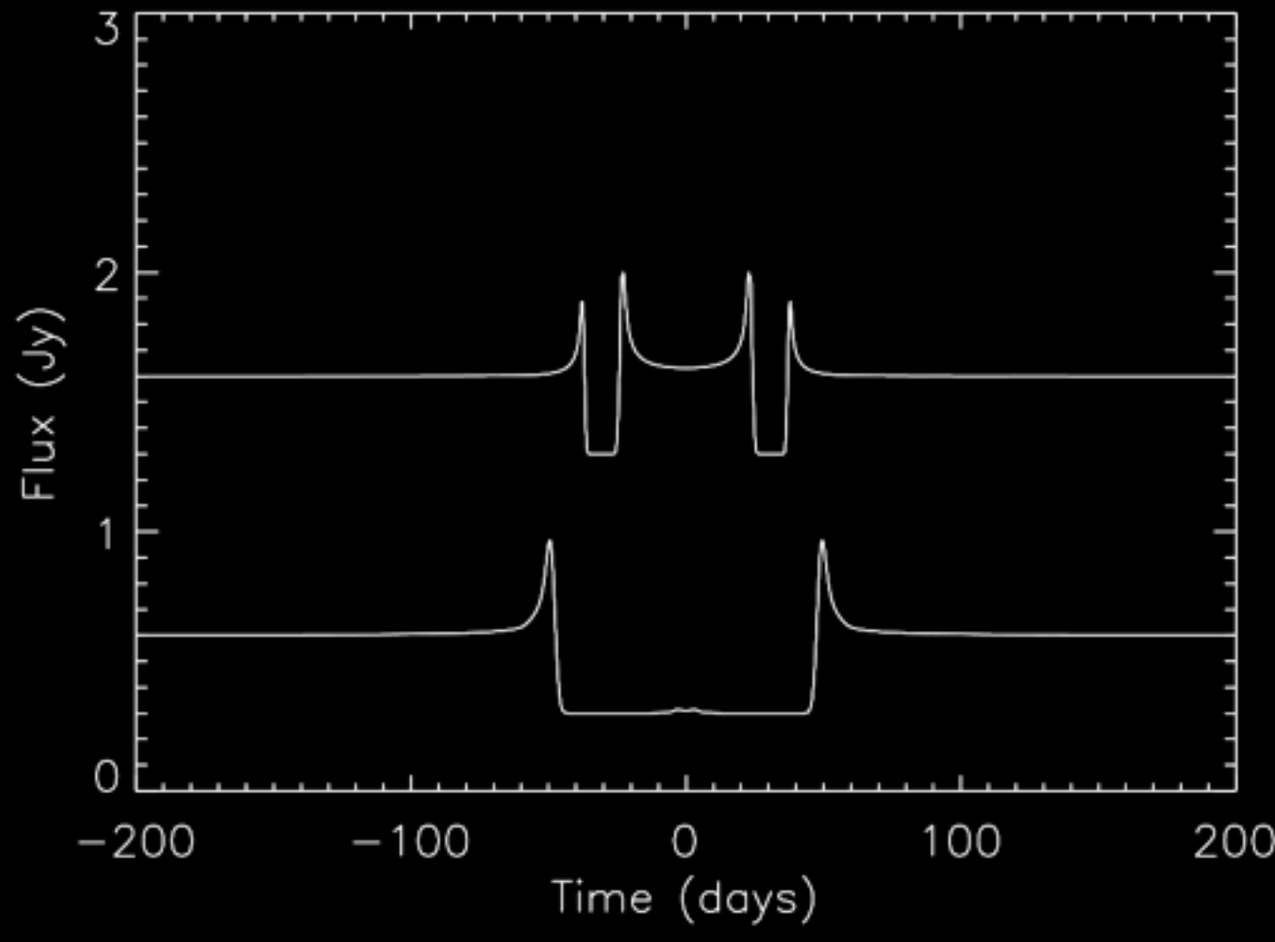
NASA/HST


The Helix Nebula (detail)
Tiny clouds are not unique
to the Galactic Centre

Implications for scintillations

Dense ionised gas:
strong radio lens
→ Fiedler Events





Implications for scintillations

(Also, Tyoma's Talk)

Plasma lensing at low frequencies

- Don't expect many "Fiedler Events" at low freq.
  - Lensing probability increases somewhat
  - But sources are much larger at low freq.
    → flux changes will be smeared out
    → unrecognisable events
    - Large flux changes only from nearby lenses
- A small amount of flux will be refracted through large angles
  - Multiple imaging of pulsars
    - Can detect & monitor via spectroscopy
    - But scattering in diffuse ISM smears signal

Summary

- G2 is the prototype BLR cloud
- Perturbed into current orbit from Galactic "NLR"
  - The NLR is an "Oort Cloud" of small, cold, self-gravitating molecular gas clouds
- Modelling shows such clouds are robust
  - H_2 snow plays a key role
- Supersonic clouds shock-heat the diffuse ISM
  - Lensing from surface layer of ionised gas → Fiedler Events
  - Scattering from the magnetotail
    - Ionised gas & charged H_2 dust
- Low-frequency studies of lenses not compelling