

A vibrant, multi-colored nebula or cosmic snow cloud, featuring swirling patterns of red, orange, yellow, green, and blue against a dark, star-filled background. The clouds have a wispy, ethereal appearance with some brighter spots and a dense, glowing core.

Cosmic Snow Clouds

Mark Walker

(Manly Astrophysics)

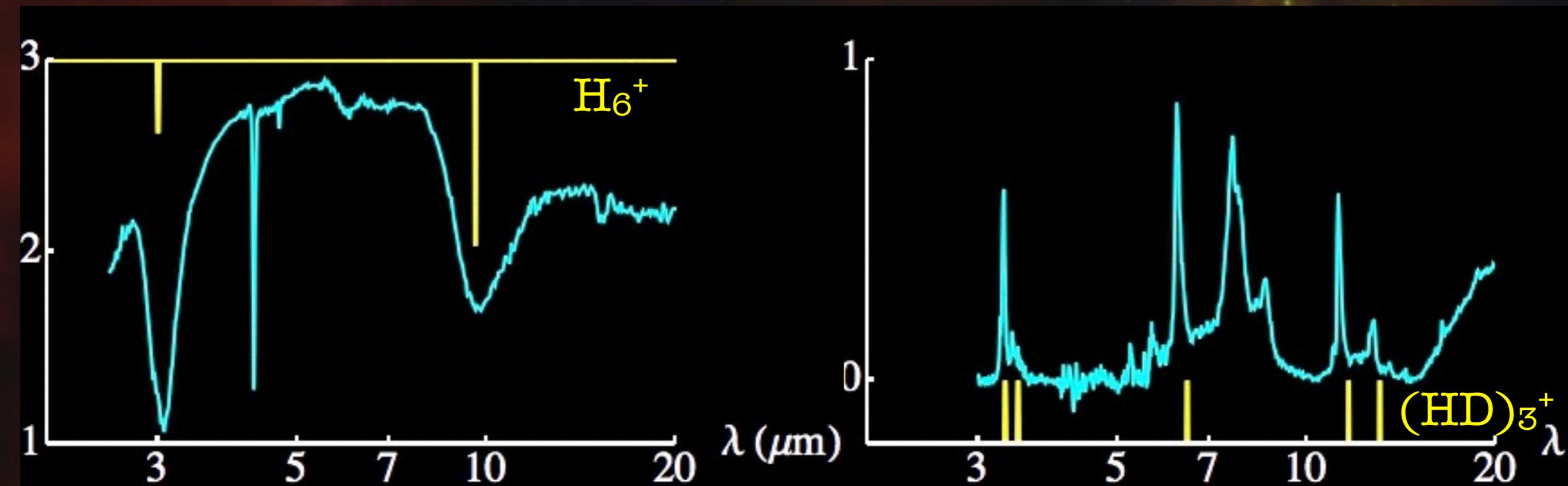
&

Mark Wardle

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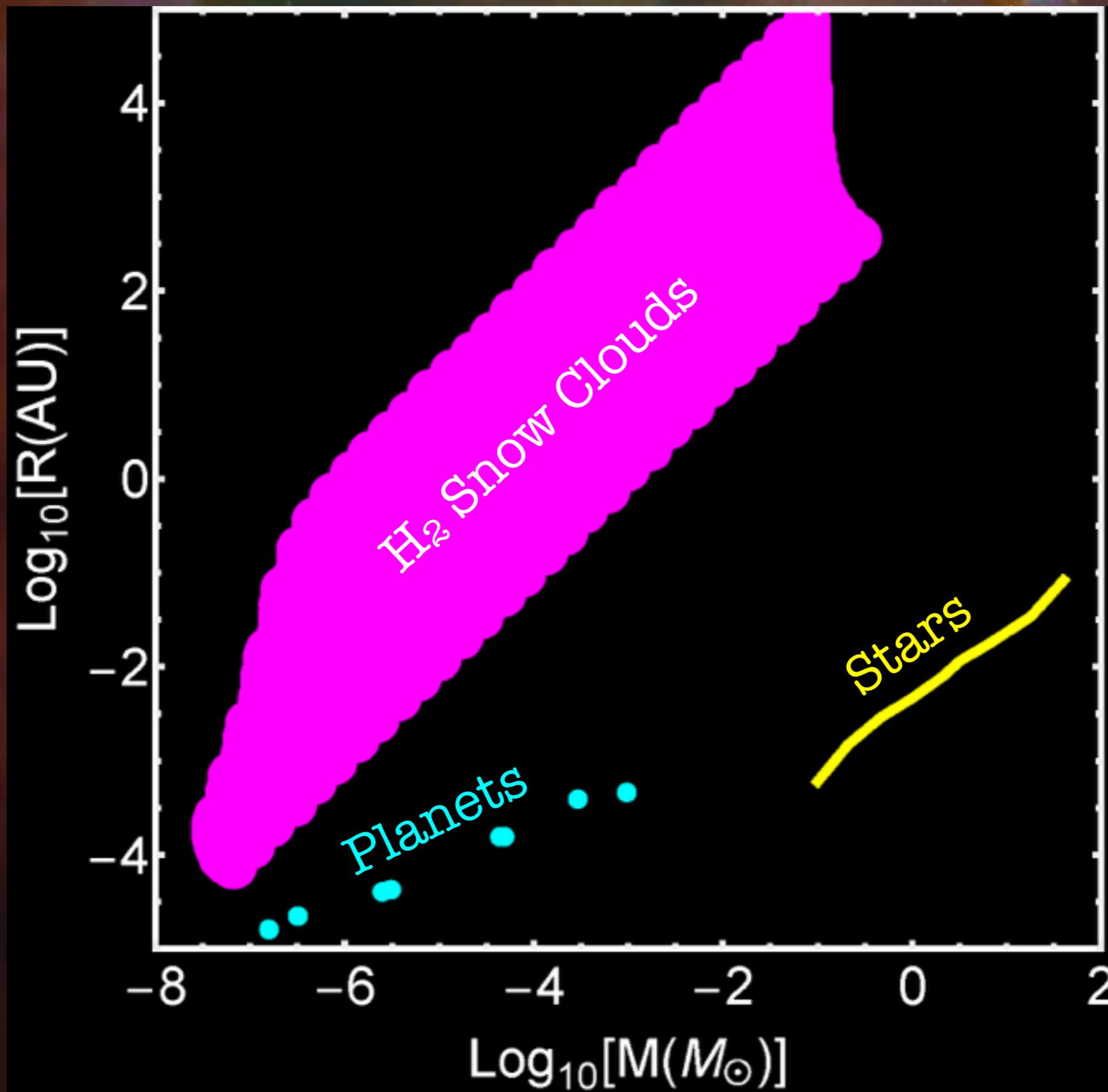
Aspects of H₂ Snowflakes

- Pure solid is volatile - cannot survive in ISM
- Charged grains much more durable (MW 2013)
- Pure solid is highly transparent in optical/IR
- Dominant spectral features from impurities
- Ionisation chemistry differs from gas phase
- “New” molecule : H₆⁺ (Lin, Gilbert & MW 2011)

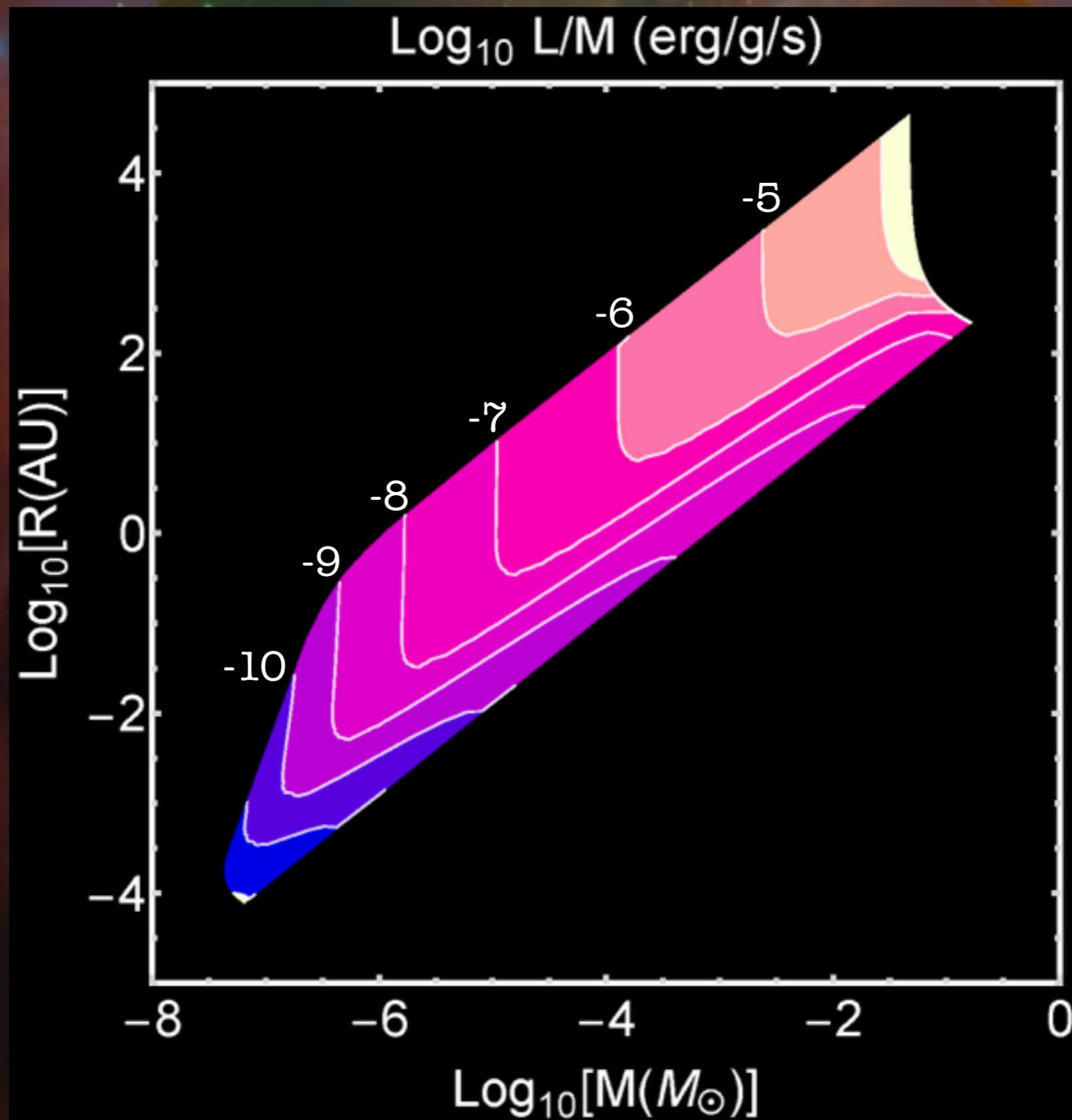


Low masses, but large radii

Pfenniger & Combes 1994
Gerhard & Silk 1996

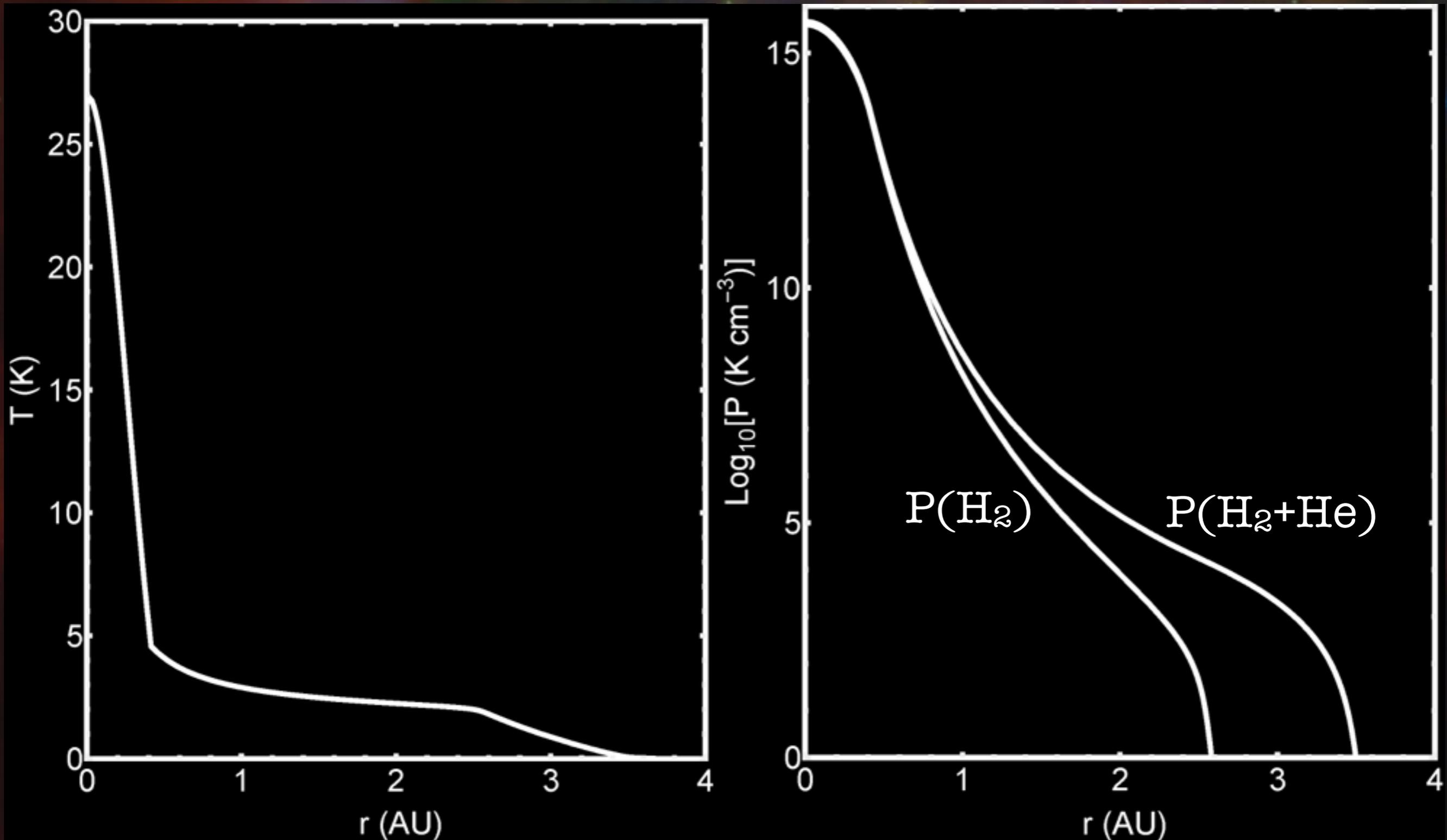


Snow clouds are very dark



High density, robust structures

Example with $M \approx 10^{-4} M_{\odot}$



These models may help to explain:

- Regions of super-strong radio-wave scattering in the ISM
 - Sizes $\sim 10^{1\pm 1}$ AU , number density $\sim \text{few} \times 10^3 \text{ pc}^{-3}$
- Cometary globules in Planetary Nebulae
 - Irradiation \rightarrow bloating + mass-loss via wind
 - Bow shock from wind-wind interaction
- G2 and Broad Line Clouds in Quasars
 - Irradiation \rightarrow bloating + winds + bow-shocks
 - Tidal distortion

Snow clouds in galactic nuclei

- Snow clouds are robust → long-lived
- Adapt Oort's comet model to G2 & Broad Line Clouds
 - Large reservoir of clouds + diffusion into loss-cone
 - Reservoir ↔ NLR in quasars
- Expect collisions between snow clouds and stars. Result?
- Most of each cloud's mass resides in a small core
 - Core could survive pericentre passage ?
- Tidal stretching (expansion) causes condensation of H₂
 - Disrupted material ends up being mainly dust ?
 - Opacity of dust ≫ Thomson opacity
 - Radiation pressure important even at $L \ll L_E$