Cosmic Snow Clouds

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Aspects of $\text{H}_2$ 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: $\text{H}_6^+$ (Lin, Gilbert & MW 2011)
Low masses, but large radii

$\text{H}_2$ Snow Clouds

Stars

Planets

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 $\sim 10^{11}$ AU, number density $\sim$ few $\times 10^3$ 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 ≪ L_{E*}