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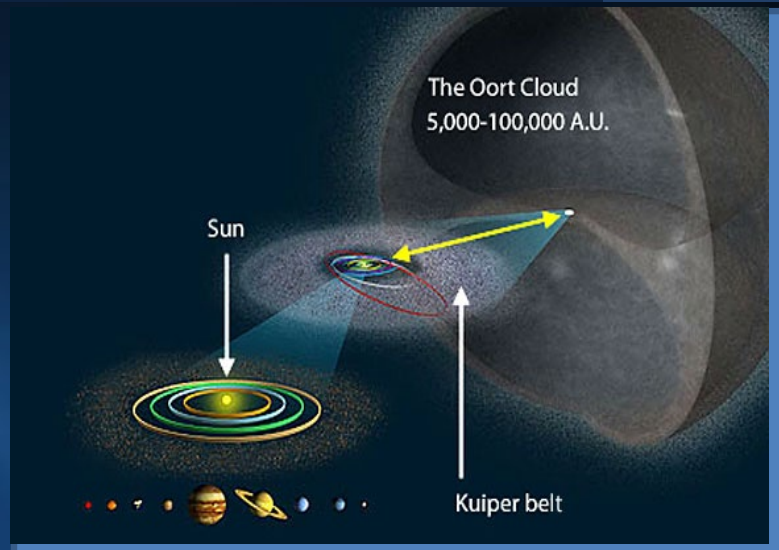
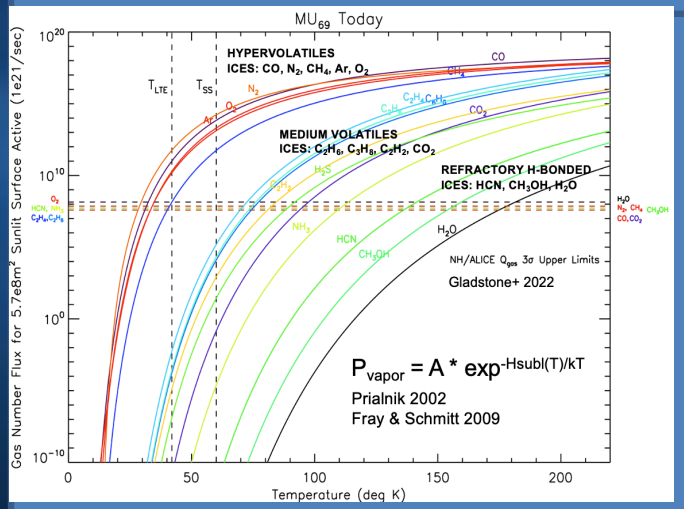
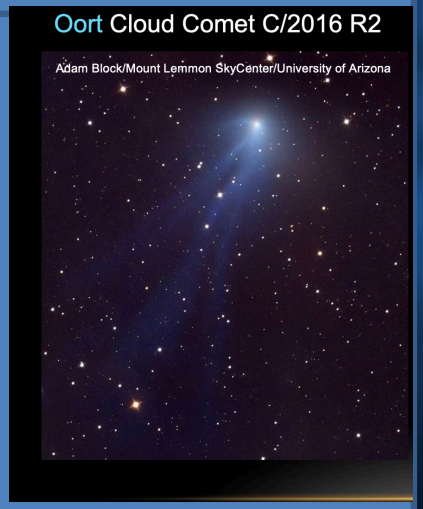
A Dearth of Bulk Hypervolatile Ices in Oort Cloud Comets



The Oort Cloud is a sphere of comets formed at 100 –2000 Myr by outward scattering of Kuiper Belt Planetesimals. It extends out to 10^5 AU, ~ ½ way to the nearest star, α Centauri





Ices in KBOs and Comets fall into 3 different categories of volatility. Cryogenic ices (red) like CO/N_2/CH_4 are not stable after 20 Myr except in a few special objects like C/2016 R2 (right) and C/2017 K2.

Using New Horizons Pluto system and Arrokoth flyby observations coupled with thermodynamic models, we show that hypervolatile ices like CO, N_2, and CH_4 in KBOs are rare and not stable after 20 Myr.

- Modern day comets all derive from the initial KBOs; this allows us to make predictions for the Oort Cloud.
- Hypervolatile-rich comets were the first objects emplaced into the Oort Cloud. Those passing through the inner system (such as *C/2016 R2)* provide direct measurement of CO, N_2, and CH_4 abundance ratios in the proto-planetary disk.
- Ultra-distant active comets like *C/2017K2* should be rare.
- Interstellar comet 2I/Borisov was likely CO rich because it was ejected onto an interstellar trajectory very early in its natal system's Oort Cloud formation.
- Population statistics counts of hypervolatile-rich vs. hypervolatile–poor Oort Cloud will guide models of early (< 20 Myr) planetary aggregation driven versus later (> 50 Myr) planetary migration driven emplacement of objects into the Oort Cloud.

Lisse, Gladstone, Young *et al. (*2022) *Planet Sci J*