Deuterium fractionation tracing the evolution of IRDC cores

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Survey Introduction

• A number of great work on **deuterium fractionation in IRDCs** is done already (e.g. Fontani et al. 2006, 2011, Chen et al. 2011, Miettinen et al. 2011, c.f. Matías Lackington's talk)

• We present a survey of **44 IRDC cores** across **10 clouds**
  • initially from Rathborne et al. (2006)
  • With ammonia temperature from Sakai et al. (2008):
    • **Nearby** (< 4.5 kpc)
    • **Massive** (> 100 M☉)
  • + three clouds from Rygl et. at (2010)
  • builds upon previous work (Chen et al. 2010, 2011)
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- **Observations** towards the cores:
  - N₂H⁺, N₂D⁺, C¹⁸O (3-2) with 10m SMT
  - Rygl et al. (2010) clouds with Nobeyama 45m in ammonia
  - *Herschel* archival data
Data analysis

(a) (1, 1)

NH$_3$ fits

(b)

Herschel SED

(c)

Dust temperature

Td, K

N(H$_2$), cm$^{-2}$

(d)

Column density

NH$_3$ fits

Td, K

N(H$_2$), cm$^{-2}$
Data analysis (cont.)

- Ammonia rotational temperatures
- Deuterium fractionation
- $N_2H^+$ (3-2) line width

- LoS-averaged dust temperatures,
- Column densities,
- Luminosities

NH$_3$ fits

(a) (1, 1)

(b) Herschel SED

LoS-averaged dust temperatures,
Column densities,
Luminosities
Data analysis (cont.)

Caveats

Different beam sizes of single dish data

*Herschel* analysis caveats:
- no background/foreground subtraction for Herschel maps
- different $\beta$ in different IRDCs
- warm SED components contamination

- Ammonia rotational temperatures
- Deuterium fractionation
- $N_2H^+$ (3-2) line width
- LoS-averaged dust temperatures,
- Column densities,
- Luminosities

* Bringing it all together...*
Results

- **Orange**: UC HII region
- **Red**: HMC
- **Green**: HMPOs
- **Yellow**: HMSCs

- Clear decreasing trends in deuterium fractionation against gas temperatures and line widths
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- **Orange**: UC HII region
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- Clear decreasing trends in deuterium fractionation against gas temperatures and line widths
- $R_D$ traces an evolutionary sequence, as revealed by the *Herschel* data comparison
- Better insight in pinpointing the early IRDC core evolution