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Mass Distribution of the Molecular Phase of the ISM

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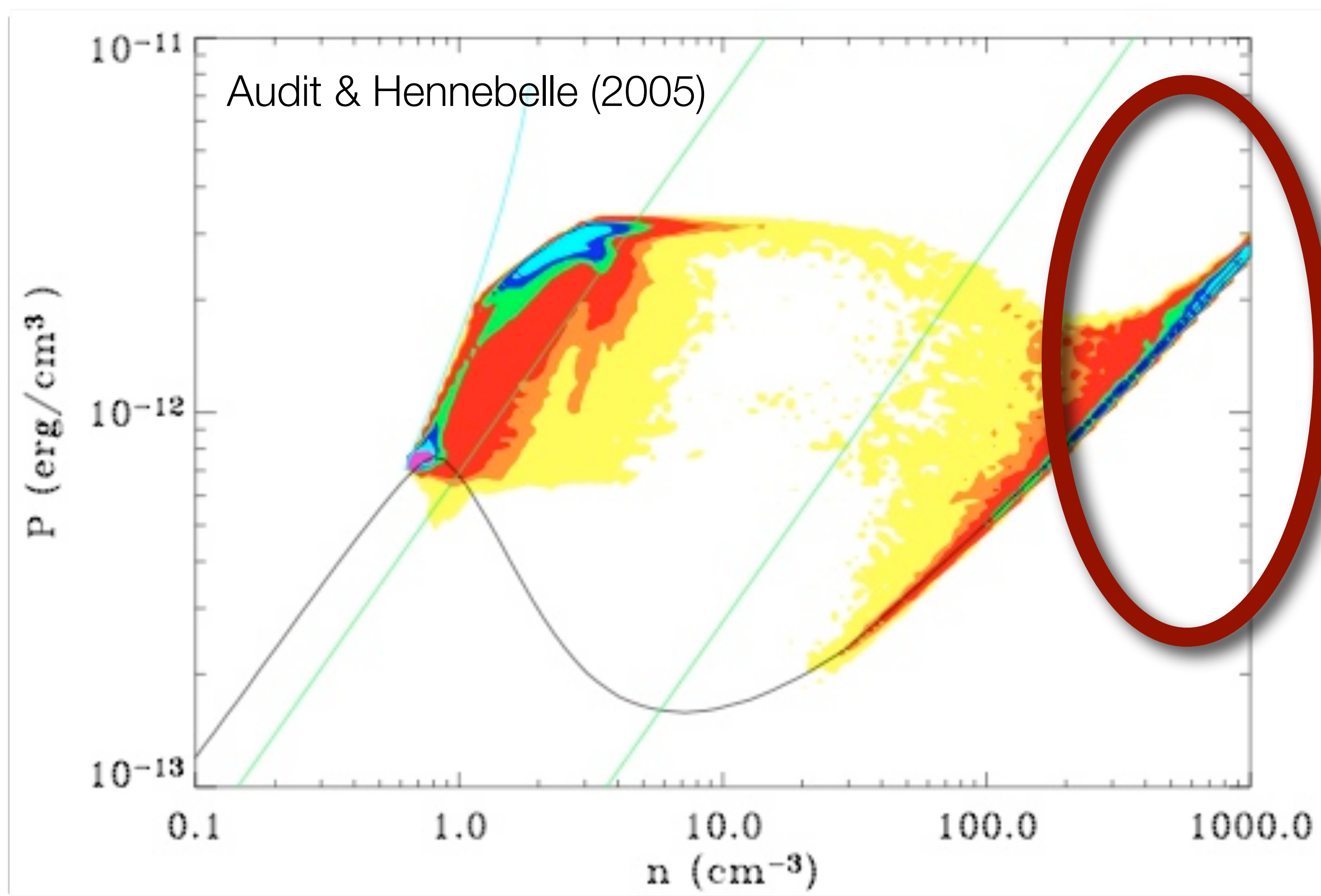
Dense gas in the ISM

M/T/B/P/... distributions
⇑
processes in the ISM

cold, molecular gas
⇓
star formation

cf., E. Vazquez-Semadeni's talk



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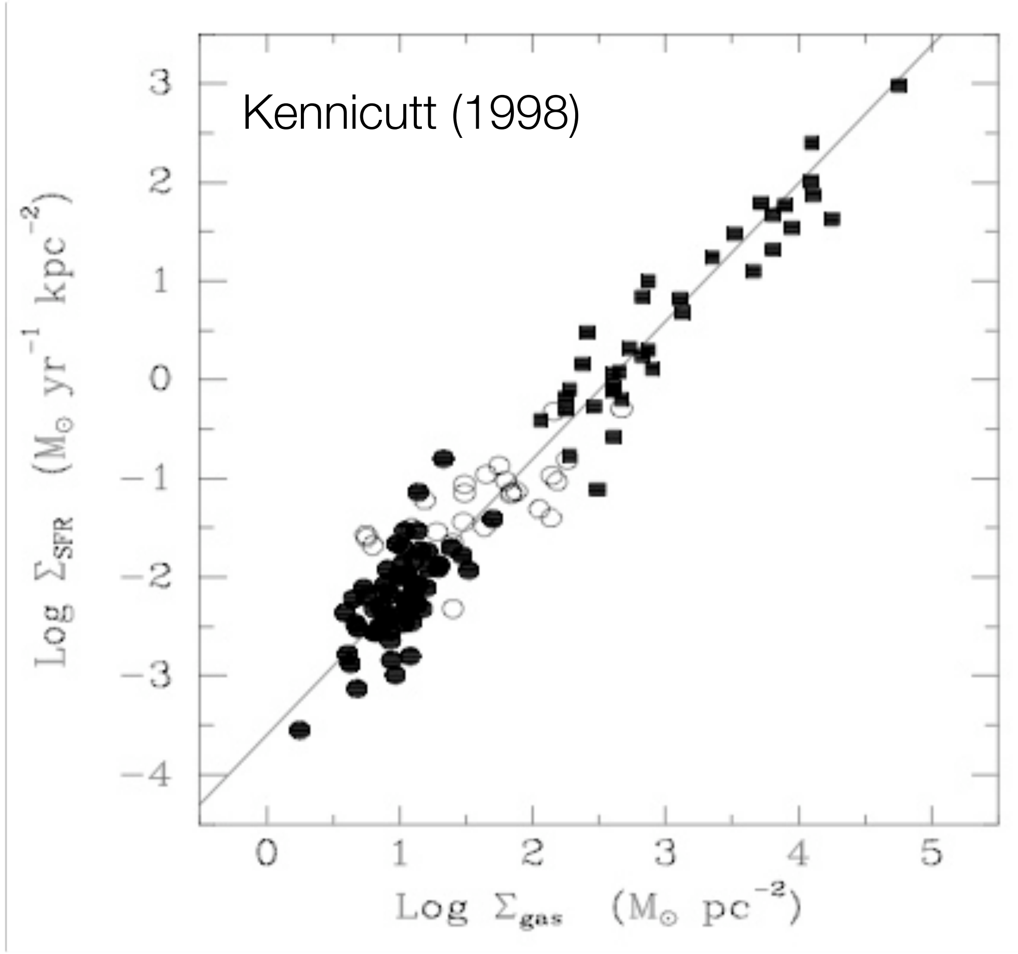
$$\Sigma_{SFR} \sim (\Sigma_{H2})^{\beta}$$

Kennicutt (1998)



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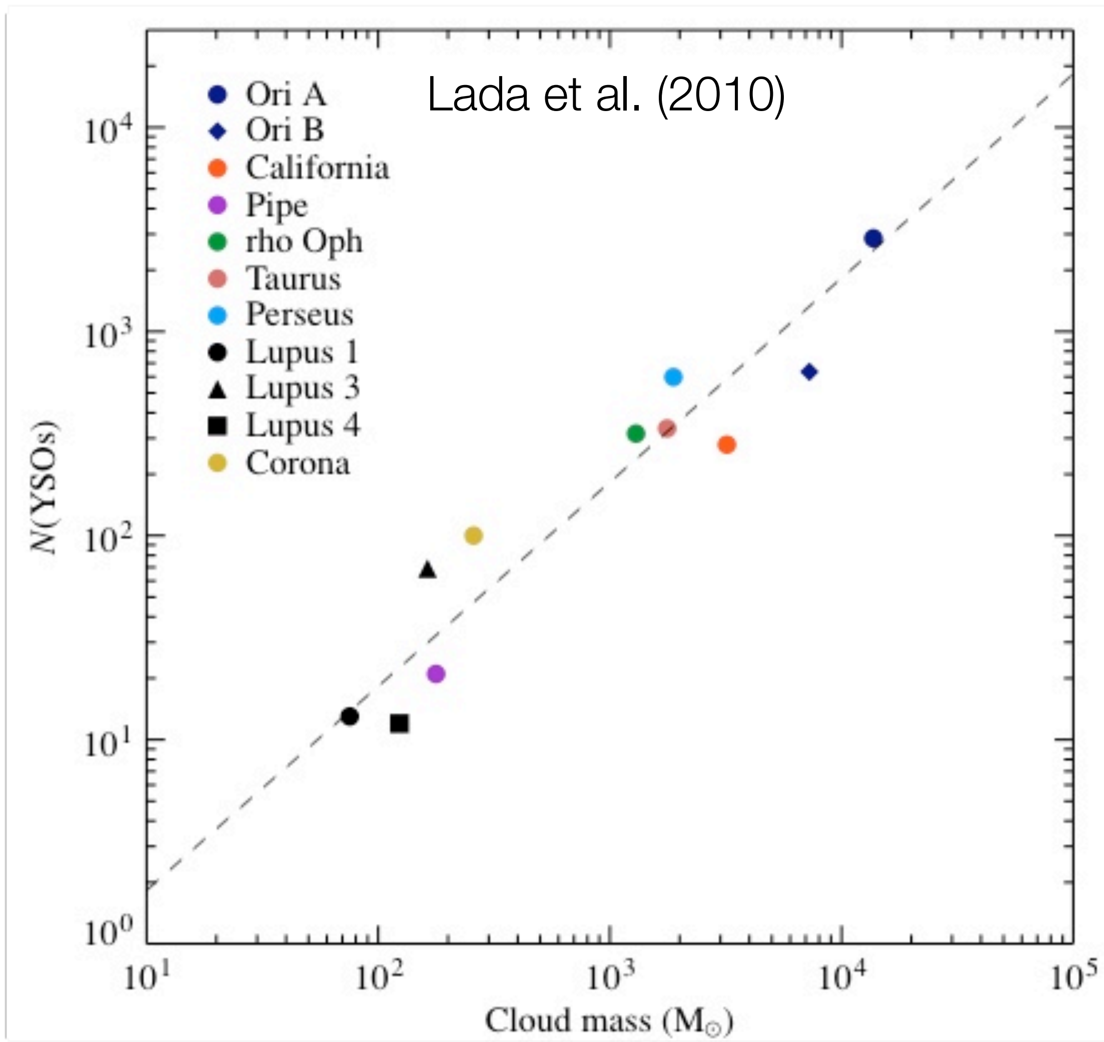


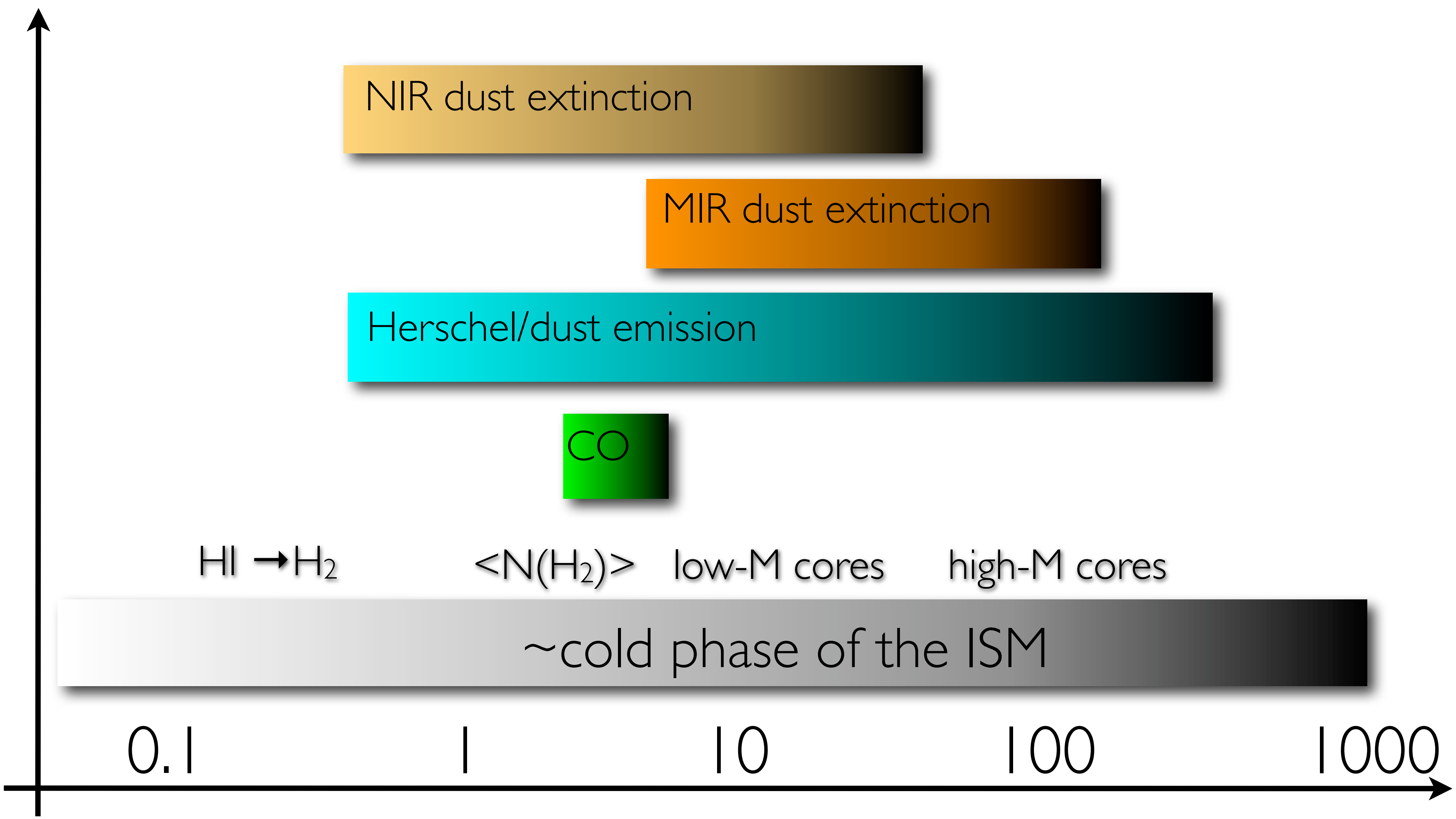
$\Sigma_{SFR} \sim (\Sigma_{H2})^{\beta}$ Kennicutt (1998)

$\Sigma_{SFR} \sim f_{dg}(\Sigma_{gas})^{\beta}$ Lada et al. (2012)

This talk:

1. **Observations:** Quantifying dense gas fractions of MCs with dust extinction.
2. **Theory:** What parameters set how much dense gas molecular clouds have?

1. Observing the Mass Distribution of the ISM?

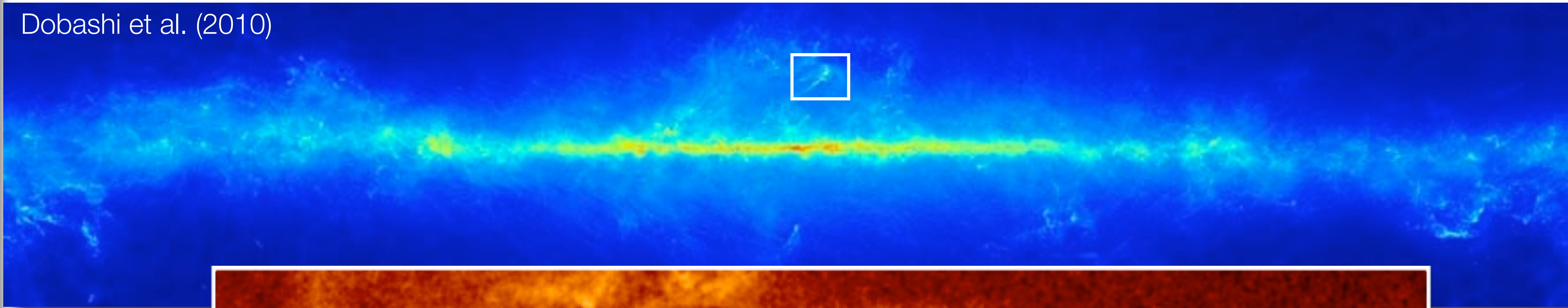


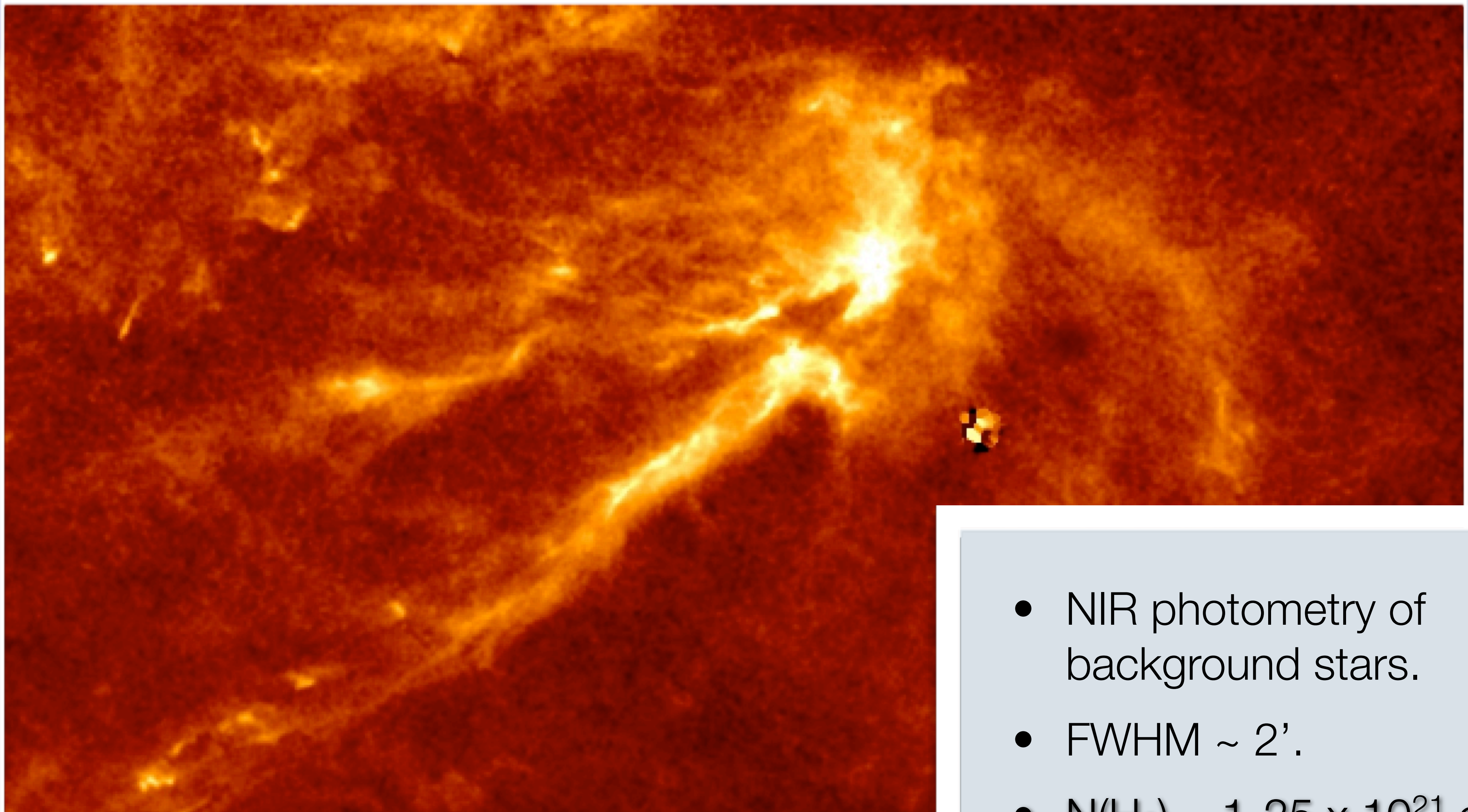
Column density

$N(H_2)$ [x 10^{21} cm^{-2}], or Av [mag]

Near-IR Dust Extinction

using 2MASS data



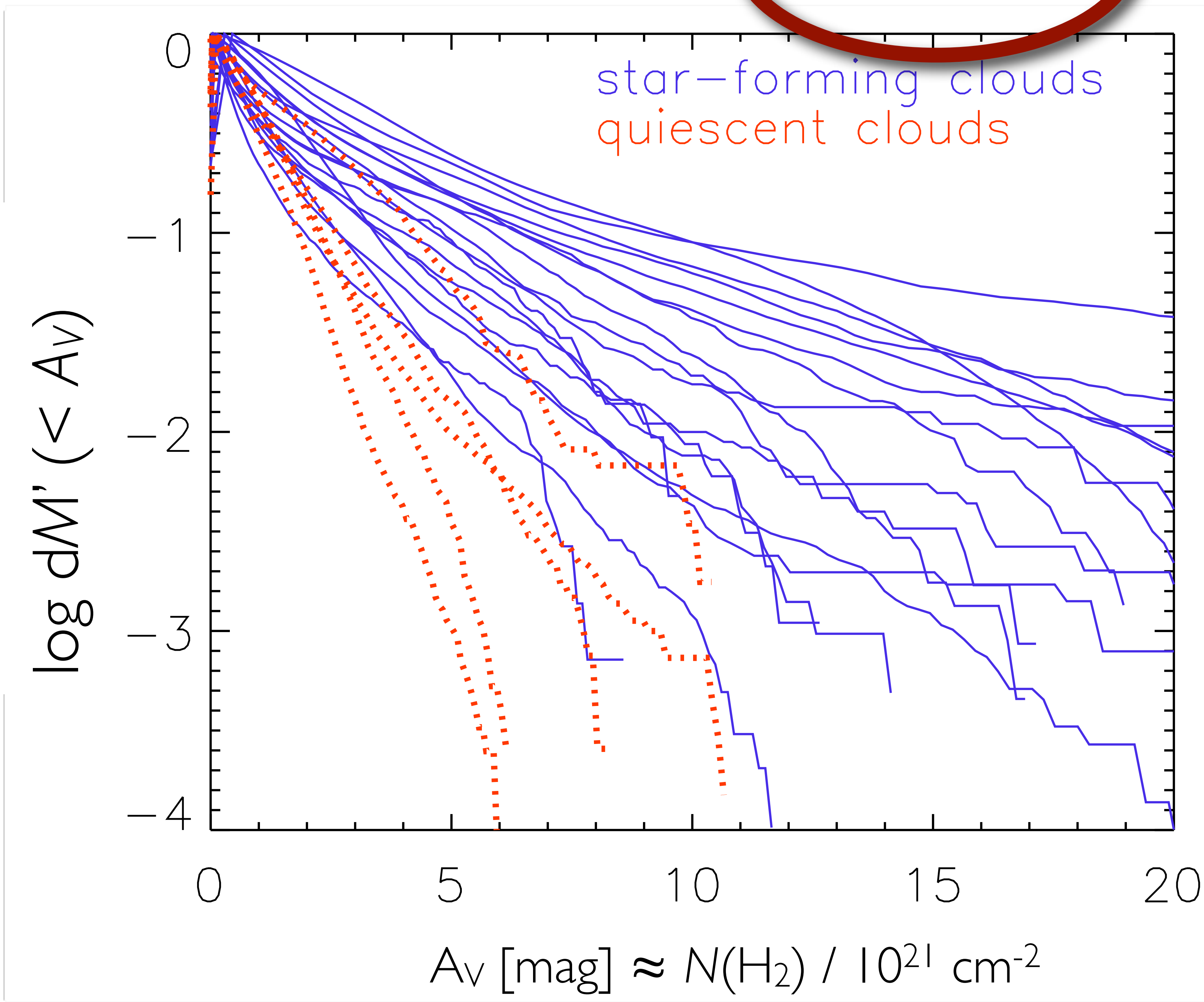


Kainulainen et al. (2009)

- NIR photometry of background stars.
- FWHM ~ 2'.
- $N(H_2)$ ~ 1-25 x 10^{21} cm^{-2}.

Dense Gas in Nearby Molecular Clouds

All (~20) molecular clouds within 500 pc distance:



Kainulainen et al. (2009)

low-mass

high-mass

From Solar neighborhood to Galactic environment?

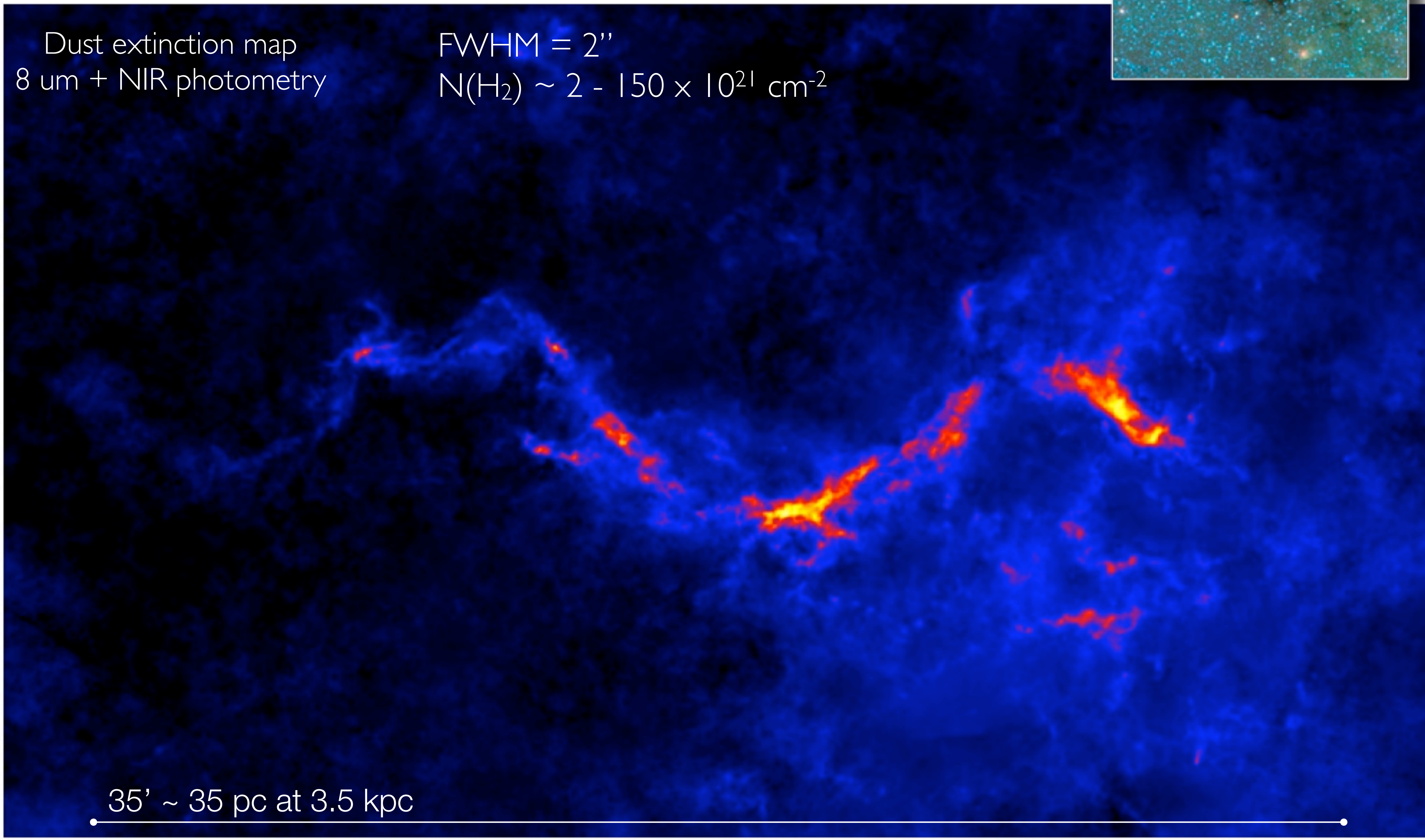
0.05 pc at 3.5 kpc is 3”

Combined NIR+MIR extinction mapping of IRDCs

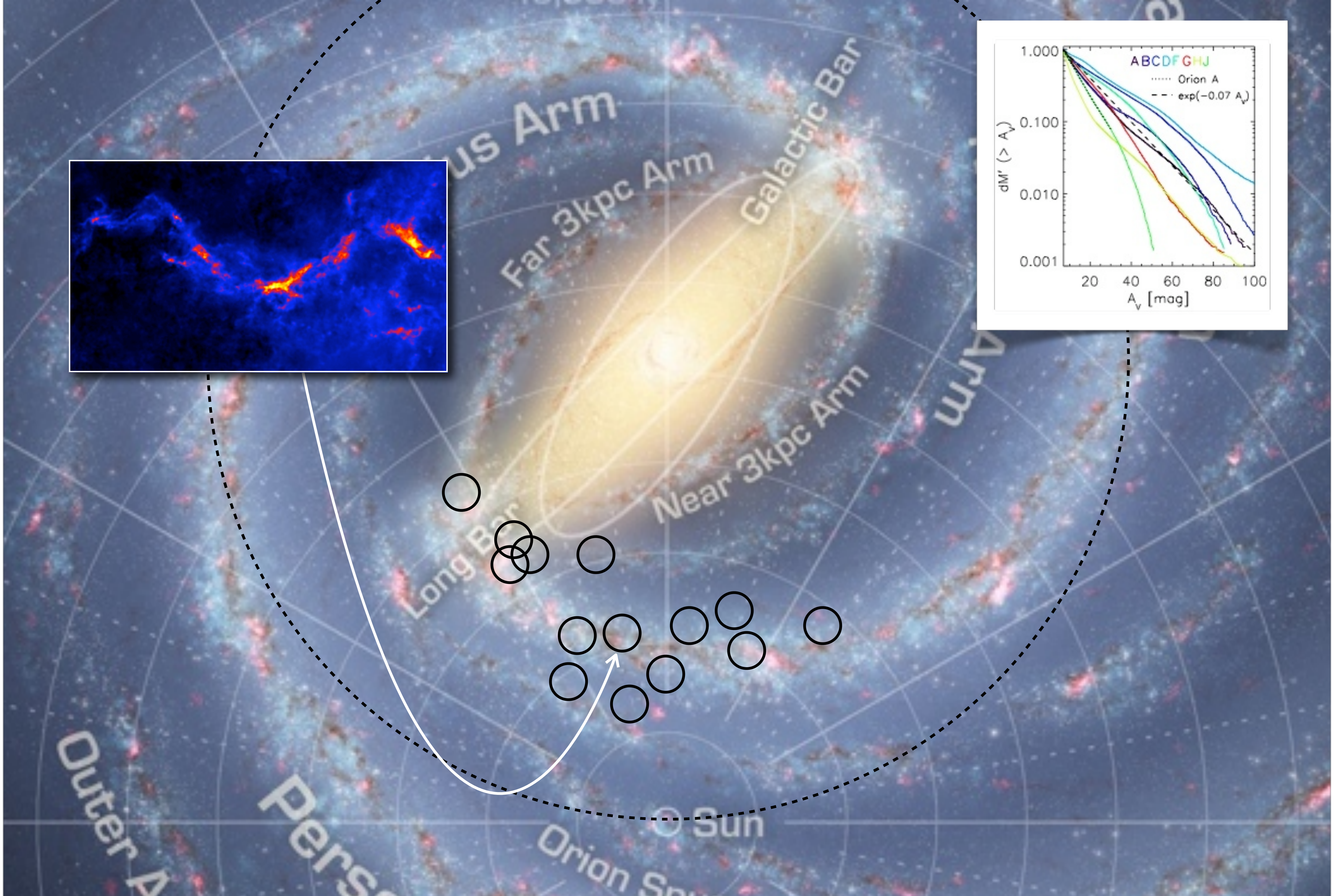
(Kainulainen et al. 2011; Kainulainen & Tan 2013)

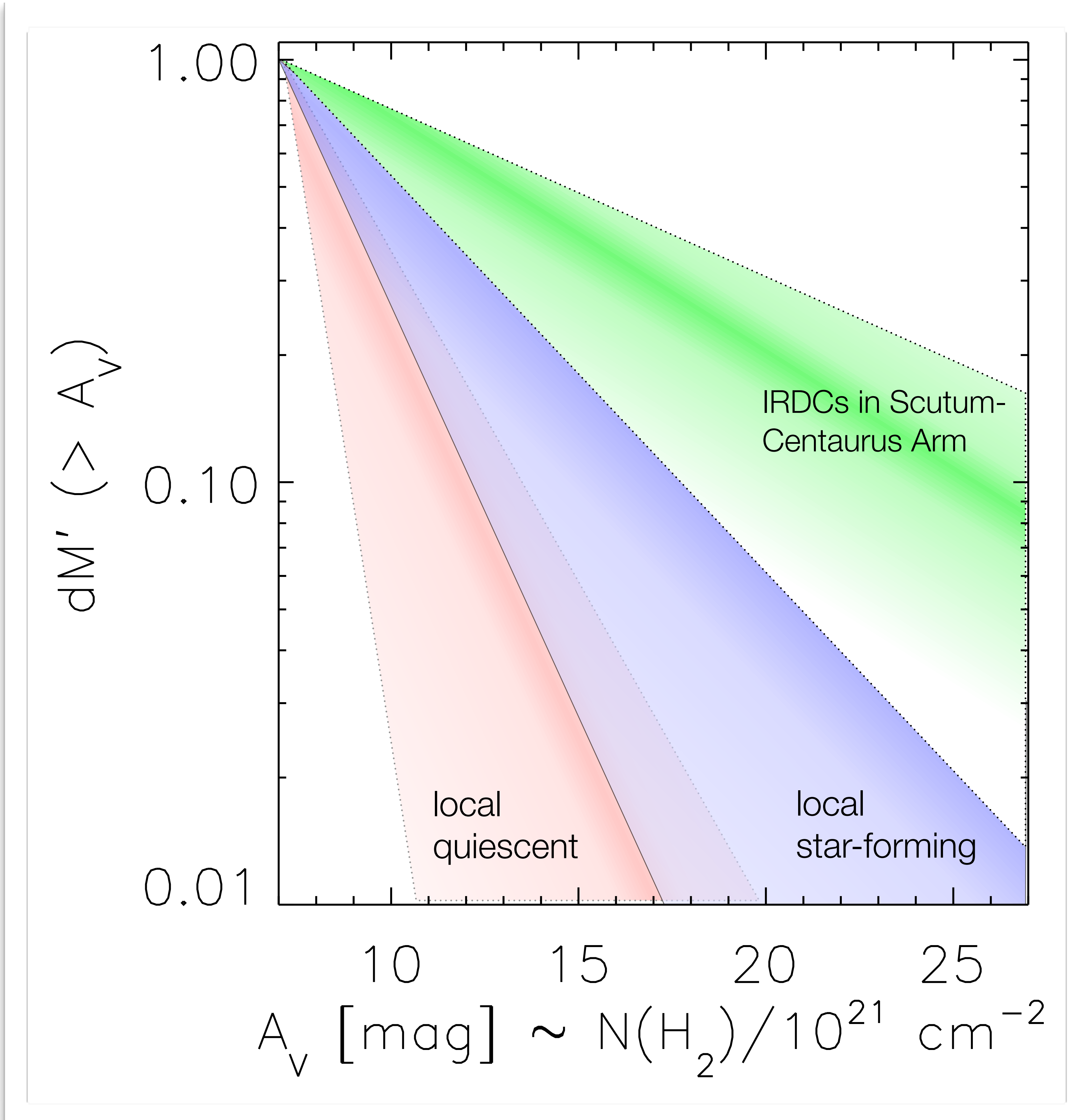
- Spitzer 8 um imaging data (shadowing features).
- NIR photometry of background stars.
- Retain Spitzer imaging resolution (2”)

Example: “The Snake”; D = 3.5 kpc



Kainulainen et al. (2013)

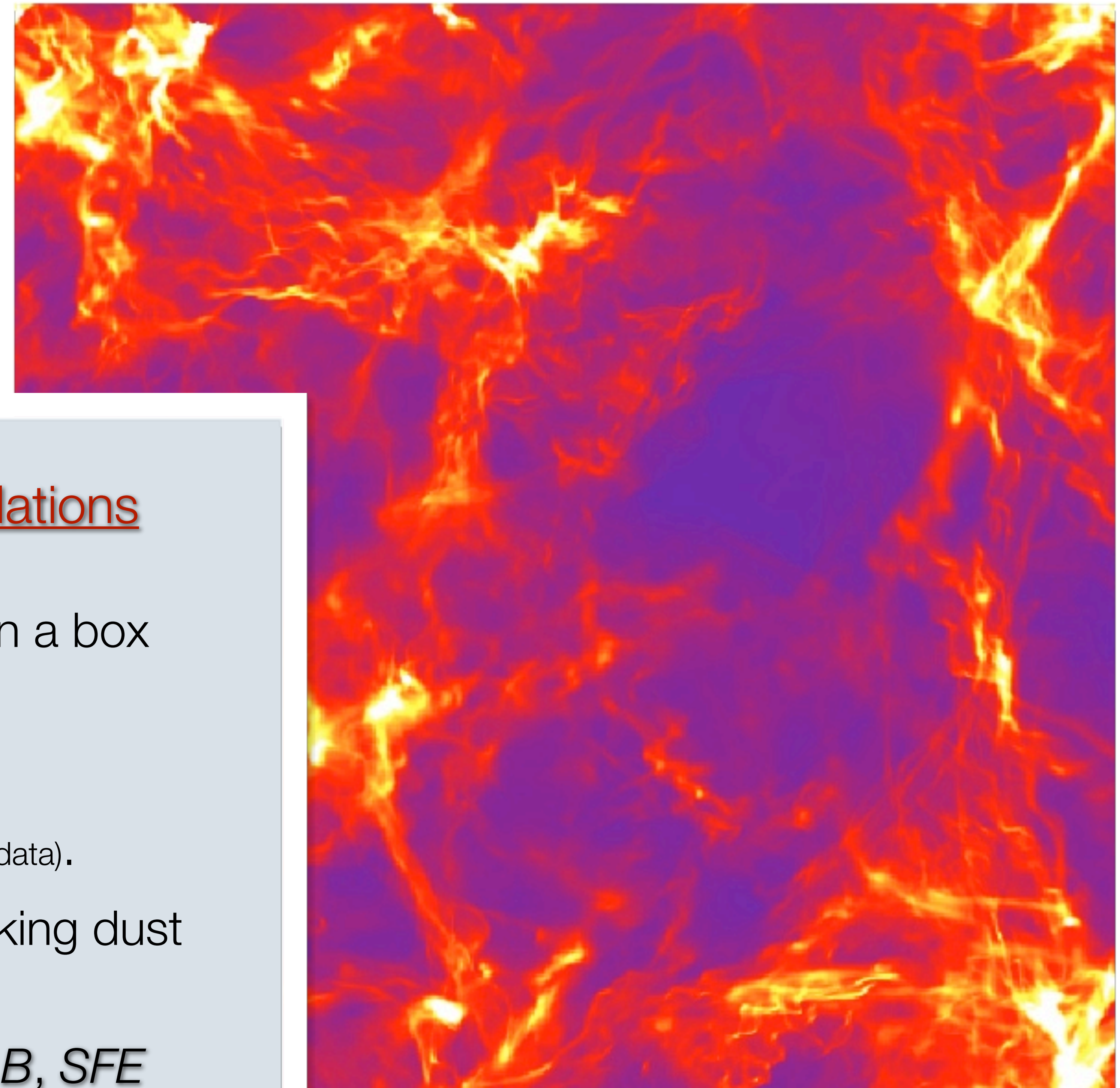

Galactic Bar
Far 3kpc Arm
Near 3kpc Arm
Long Bar
Sun
ABCDFGHJ
Orion A
exp(−0.07 A_V)
1.000
0.100
0.010
0.001
dM' (> A_V)
20
40
60
80
100
A_V [mag]



Adapted from: Kainulainen & Tan (2013), Kainulainen et al. (2013), Kainulainen et al. (2011)

2) What affects the amount of dense gas?

Kainulainen et al. (2013)



Federrath & Klessen (2012)

Analysis of numerical simulations

- Isothermal, driven turbulence in a box (Federrath & Klessen 2012).
- Gravity and sink particles.
- $\alpha_{vir} = 1$ (also tested w/ mean-normalized data).
- Simulated observations mimicking dust extinction mapping
- Varying: driving mode (*b*), *Ms*, *B*, *SFE*

→ simulated DGMFs

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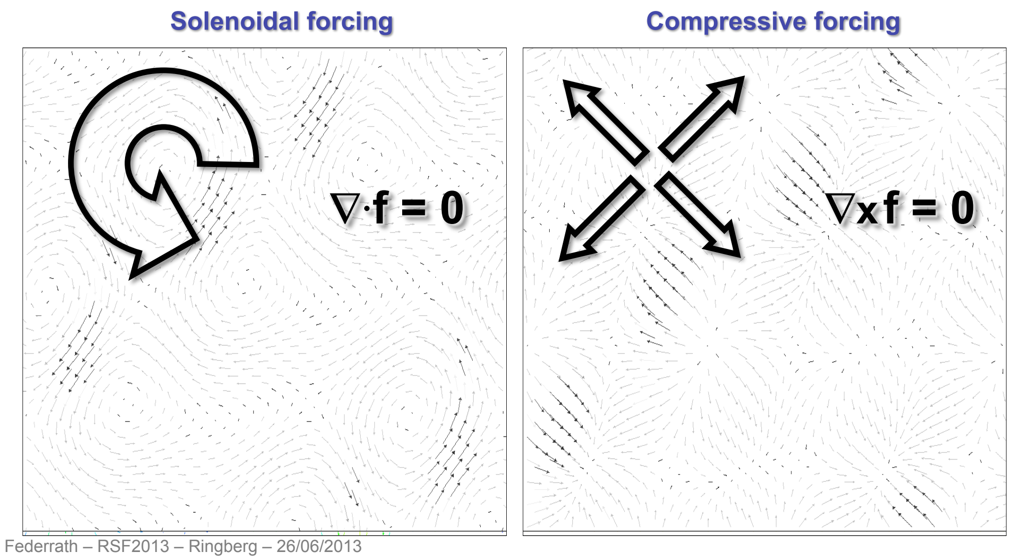

Solenoidal forcing: $b = 1/3$
Compressive forcing: $b = 1$

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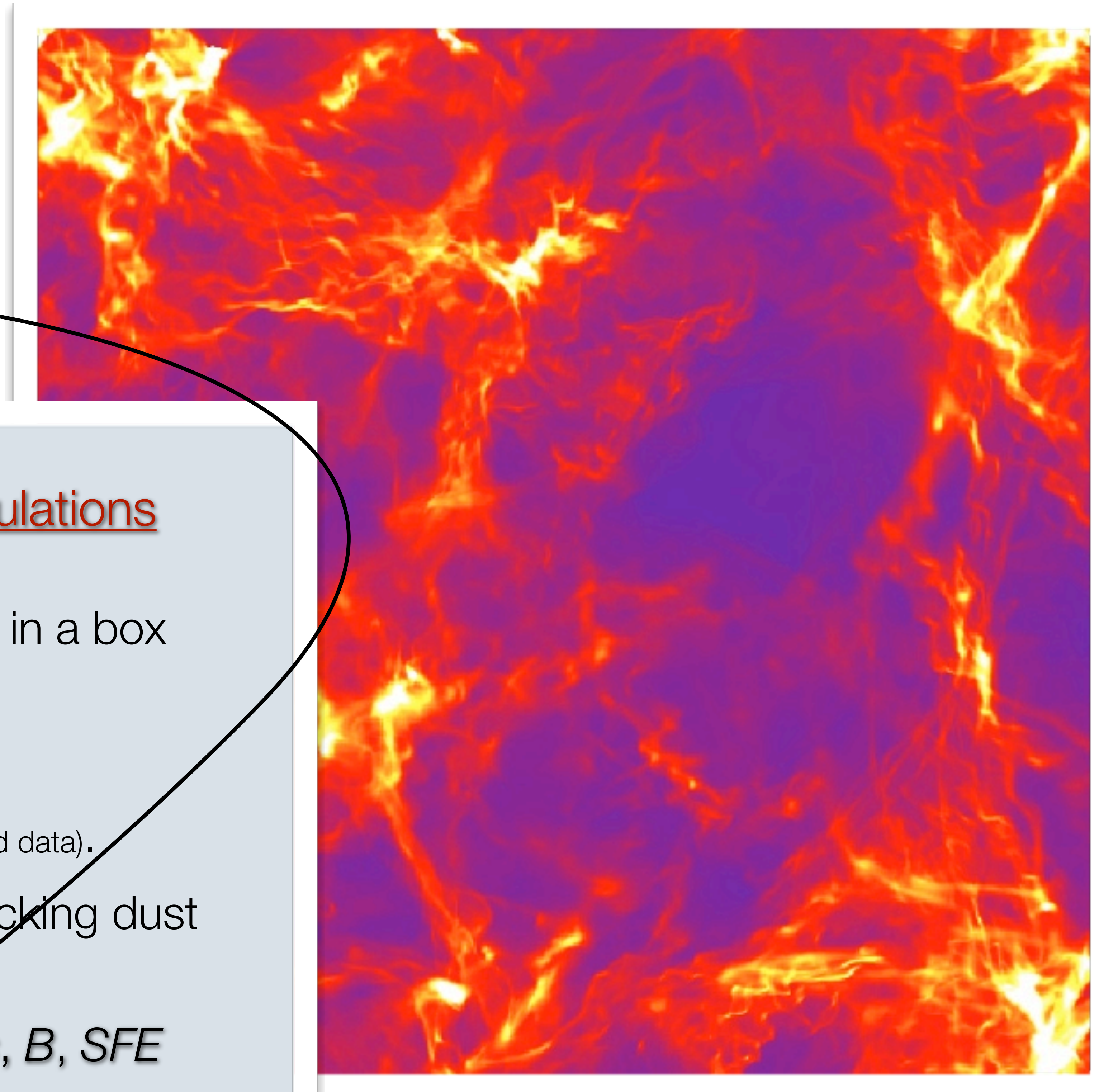
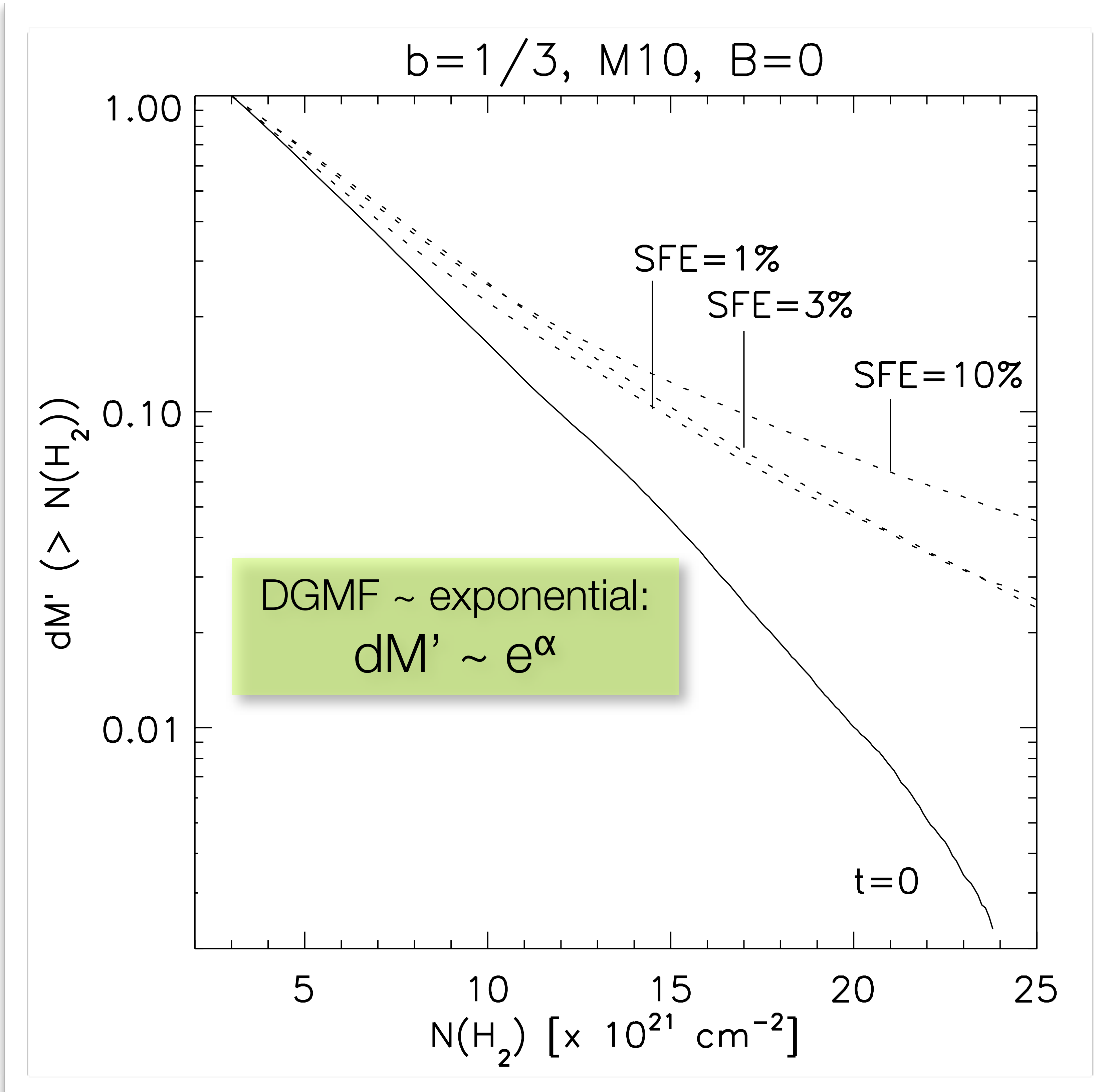
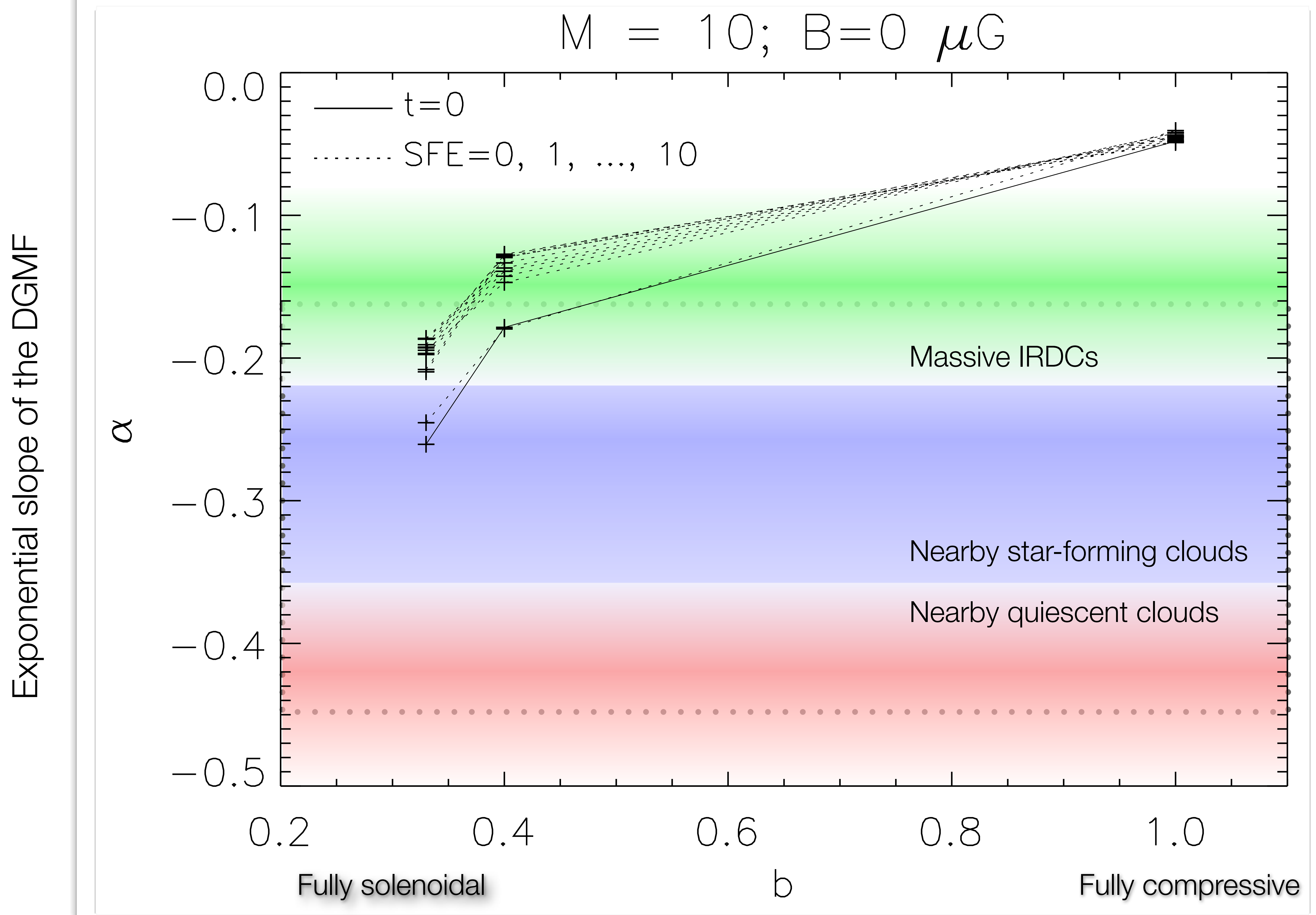


Federrath & Klessen (2012)

Example: "Observed" DGMFs from simulations

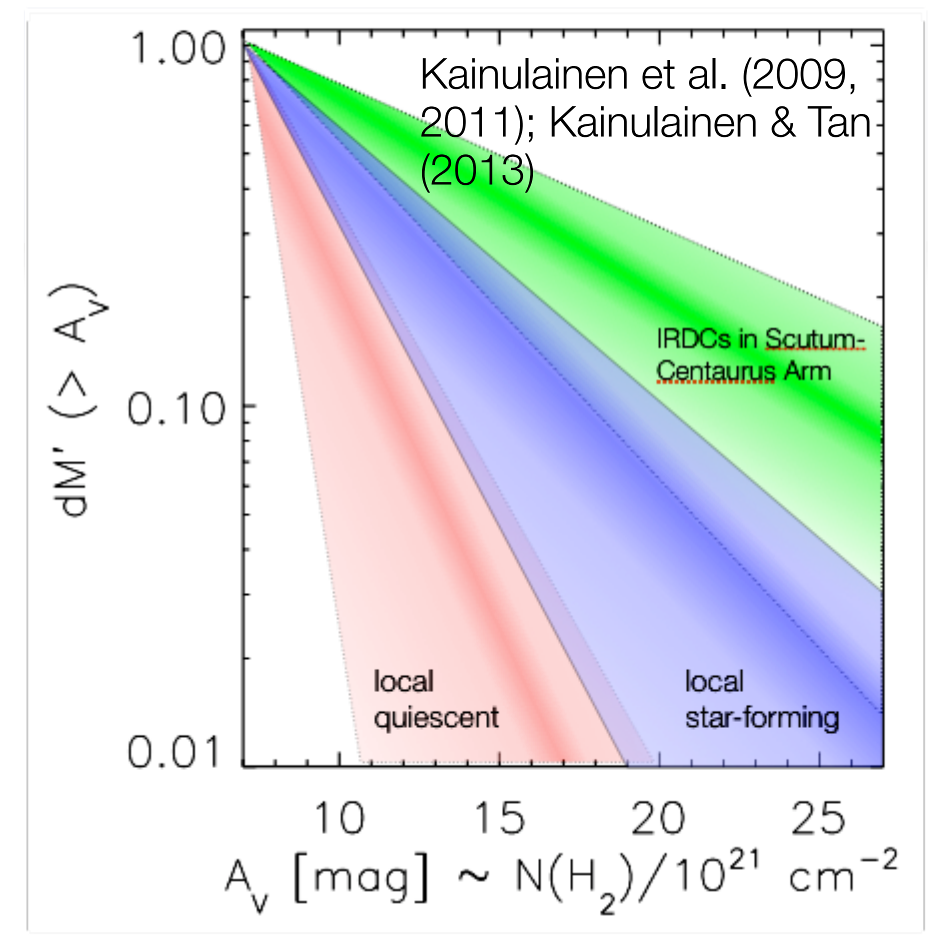


Kainulainen et al. (2013)



Kainulainen et al. (2013)

Summary: Dense Gas in the ISM



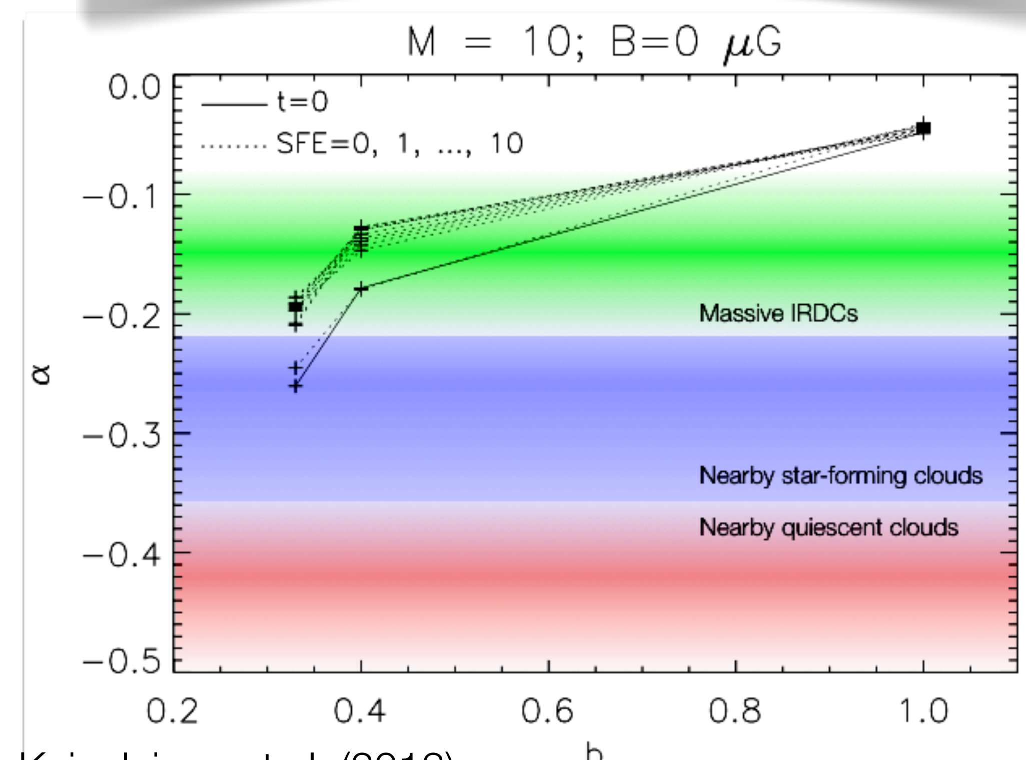
1) Observations:

- Effects of **SFE and environment** on f_{dg} (DGMF) (Kainulainen et al. 2009, 2011; Kainulainen & Tan 2013).
- High-resolution (2"), high-fidelity dust extinction mapping technique for IRDCs (Kainulainen & Tan 2013).

2) Predictions:

(Kainulainen et al. 2013; from iso-*T*, periodic box simulations)

- f_{dg} (DGMF) can be affected by average gas compression (over *SFE*, random variations, *B*, *Ms*).
- **Variations in compression are needed** to explain the observed range of DGMFs.
- Control of dense gas by the **Galaxy-scale (dynamical?) environment** (e.g., Hughes et al. 2013, Meidt et al. 2013 in M51).



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