

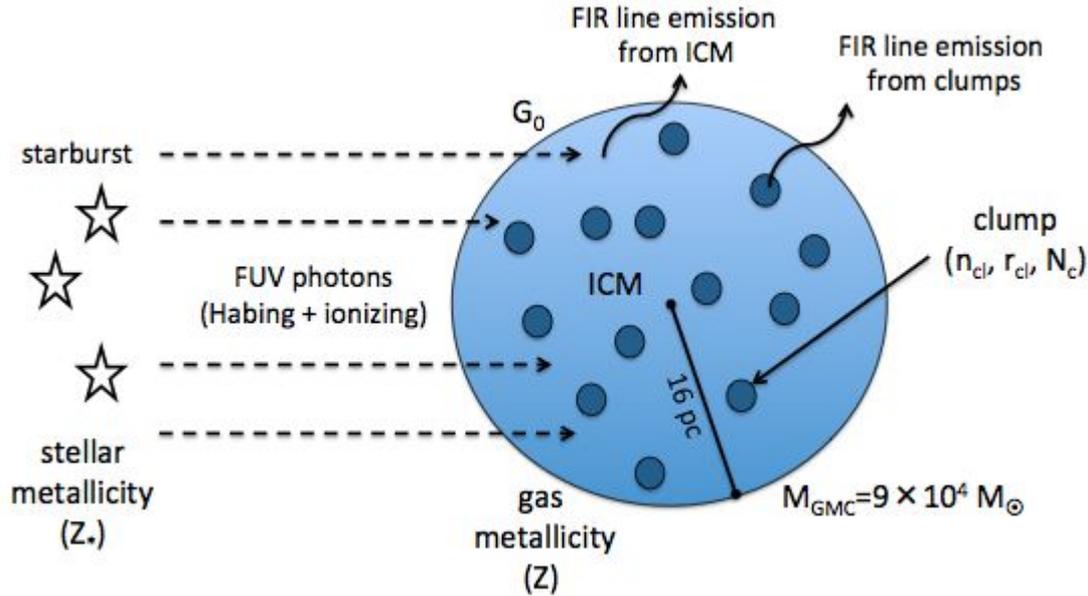
# Molecular clouds photoevaporation and FIR line emission

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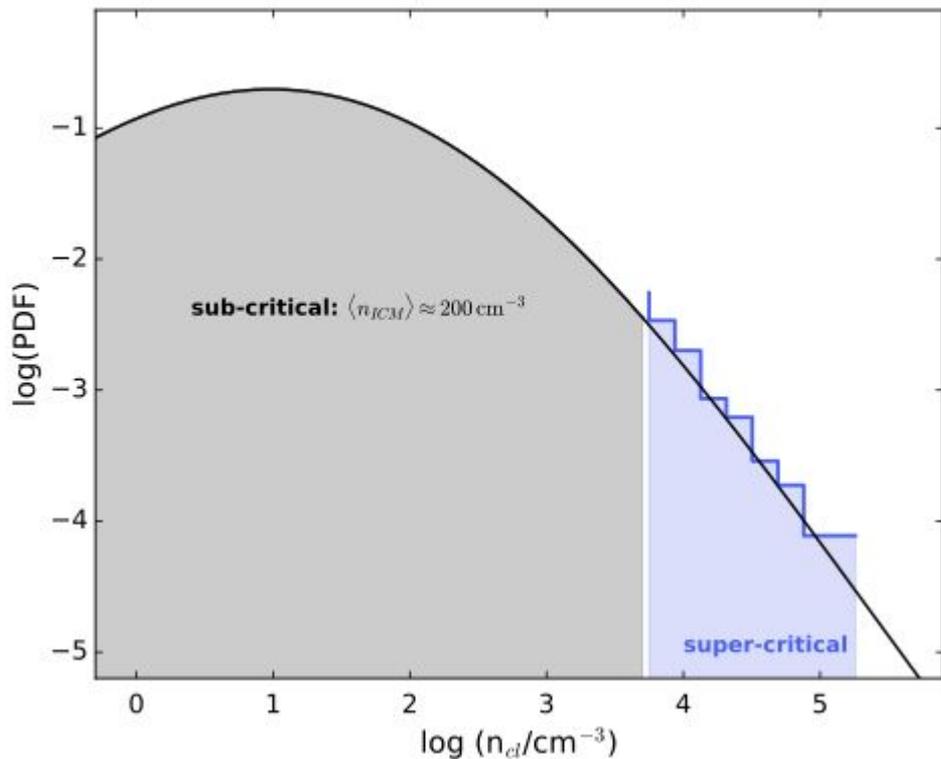
# GMC中でFIR lines はどう放射されるか？

- ・EUV (電離光子), FUV による光蒸発の時間変化を追う
- ・GMCの密度分布は観測的に知られる確率分布を仮定する
  - おおまかに, [CII], [OI], [OIII]の臨界密度以上かつ自己重力系の“clump”と, 臨界密度よりやや希薄な“inter clump medium (ICM)”の2成分
- ・一様な輻射場G0を仮定 (星なしのGMC)
- ・密度, G0, 金属量 を与えてCloudy に (各時刻の) line luminosity や PDR column density を計算させる
- ・光蒸発による mass の時間変化は解析解に従う (Gorti & Hollenbach 2002)。
- ・ガス/ダスト比については言及なし

# Sketch of the GMC model



# Density distribution



$$p_s ds = \frac{1}{(2\pi\sigma_s^2)^{1/2}} \exp \left[ -\frac{1}{2} \left( \frac{s - s_0}{\sigma_s} \right)^2 \right]$$

$$\sigma_s^2 = \ln \left( 1 + b^2 \mathcal{M}^2 \frac{\beta}{\beta + 1} \right).$$

$$s_0 = -\sigma_s^2/2$$

$$s \equiv \ln(\rho_{cl}/\langle \rho \rangle)$$

# Sub-critical / super critical の區別

$$L_{box} = 32 \text{ pc}, \quad M_{box} = 9 \times 10^4 M_{\odot}$$

1. Randomly extract i-th clump density,  $n_{cl,i}$ , from PDF
2. If  $n_{cl,i} < n_{tail}$  reject, and repeat the extraction.
3. If  $n_{cl,i} \geq n_{tail}$  the clump is super-critical.
4. Calculate clump radius as  $r_{cl,i} = \lambda_J(n_{cl,i}, T_0)$ .
5. Calculate the clump volume  $V_{cl,i} = 4/3\pi r_{cl,i}^3$ .
6. Iterate steps 1-4 until  $\Sigma_i V_{cl,i} = V_{tail}$ .
7. Clump total mass:  $M_{tot,cl} = \Sigma_i \frac{4}{3}\pi m_p n_{cl,i} r_{cl,i}^3$ ,
8. ICM total mass:  $M_{ICM} = M_{GMC} - M_{tot,cl}$ .
9. ICM mean density:  $\langle n_{ICM} \rangle = M_{ICM} / (m_p V_{ICM})$ .

$$p_s \propto \rho_{cl}^{-\kappa}$$

$$M_{GMC} = 9 \times 10^4 M_{\odot}$$

$$r_{GMC} = 16 \text{ pc}$$

$$s < 3.8 \equiv s_{tail}$$

$$V_{tail} = V_{GMC} \int_{s_{tail}}^{\infty} p_s ds$$

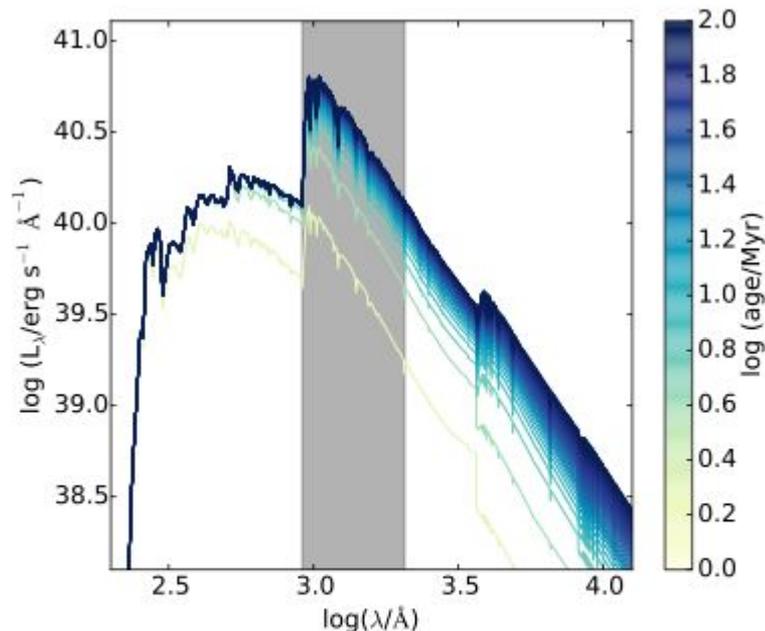
$$V_{ICM} = V_{GMC} - V_{tail}$$

# Radiation field

Star burst 99 でIMFを積分したSED

定常状態になるまで (-100Myr),

Habing band は増加し続ける.



**Figure 3.** Spectral energy distribution (SED) of the radiation field produced by stars with  $Z_* = 0.2 Z_\odot$  as a function of time elapsed from the onset of the star formation. We assume a continuous SFR of  $1 M_\odot \text{ yr}^{-1}$ . The gray shaded region highlights the Habing band.

# GMC の光蒸発の時間進化

PDRとそうでない領域の

Column density 比

$$\eta_0 \equiv \frac{n_{cl}^0 r_{cl}^0}{N_0},$$

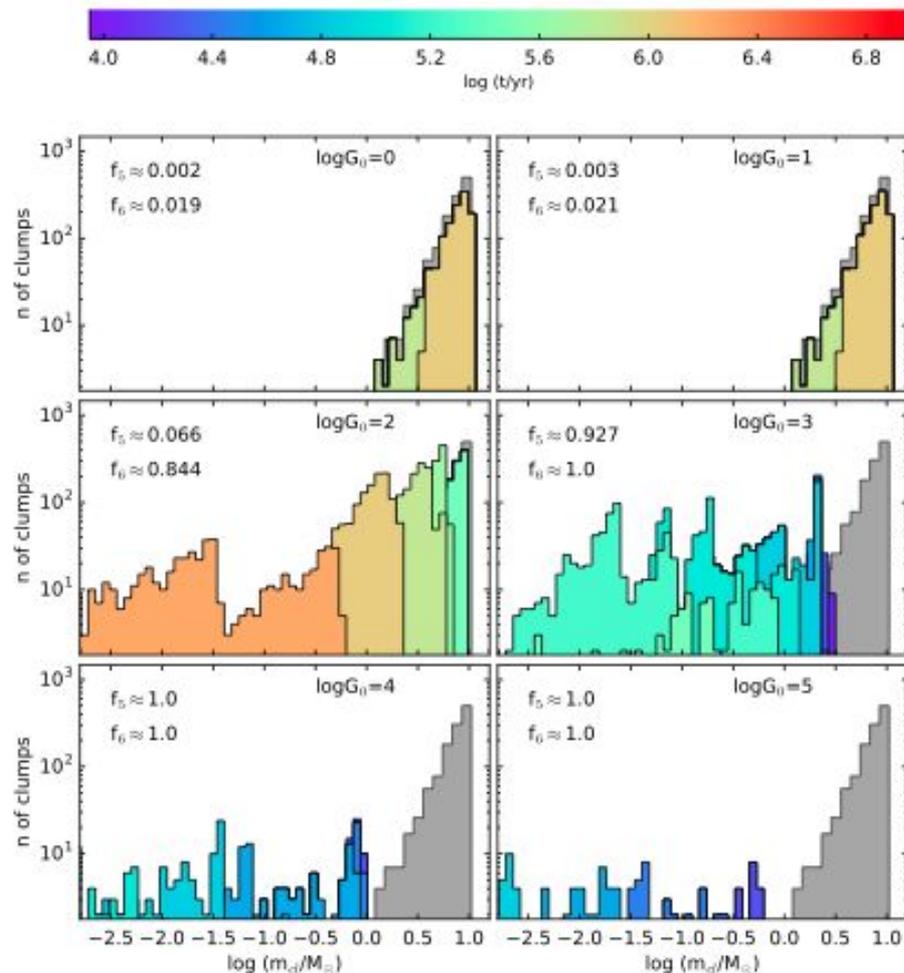
温度比 (音速比)

$$\nu \equiv c_{PDR}/c_c.$$

で特徴づけられるそう (Gorti & Hollenbach 2002)。

これに必要な諸量はcloudy で計算.

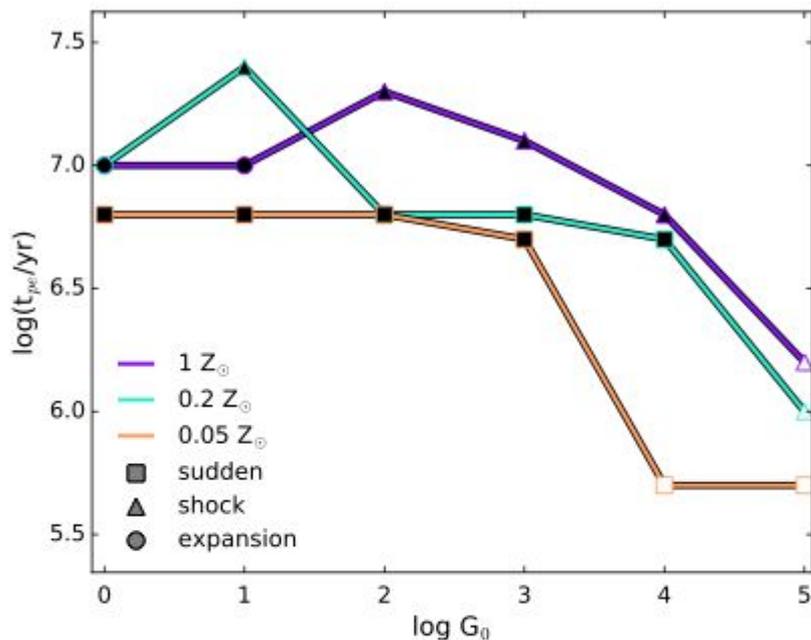
# 光蒸発による 質量分布の変化



# Photoevaporation timescale

Shock による高密度化が

蒸発を抑制する (▲のところ).



**Figure 7.** GMC photoevaporation time ( $t_{pe}$ ) as a function of the Habing flux,  $G_0$ , impinging on the cloud, and GMC metallicity. Results for  $Z = Z_{\odot}$ ,  $0.2 Z_{\odot}$ ,  $0.05 Z_{\odot}$  are plotted with purple, cyan, orange lines, respectively. The squares (sudden), triangles (shock), and circles (expansion) denote the different photoevaporation channels (see Fig. 4). Filled (empty) black symbols indicate that photoevaporation is dominated by FUV (EUV) photons.

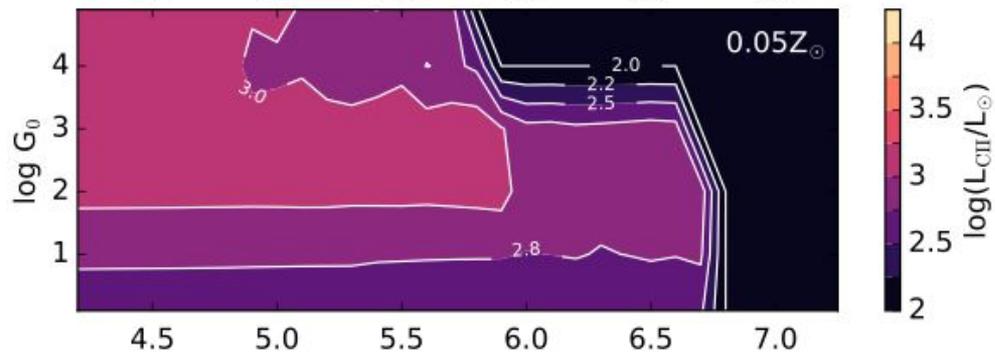
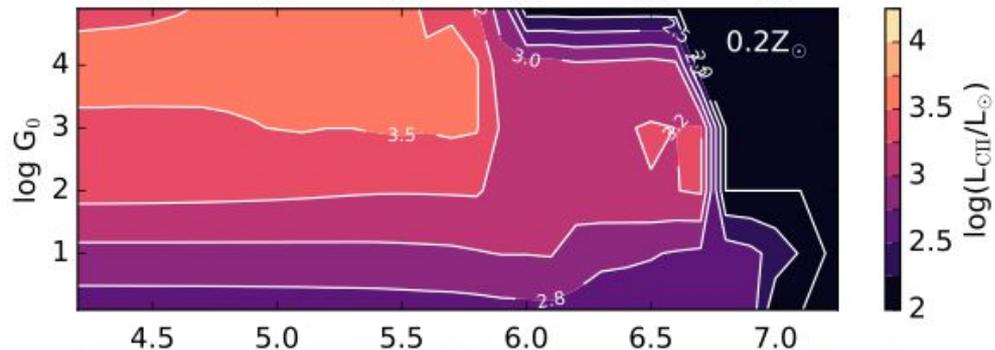
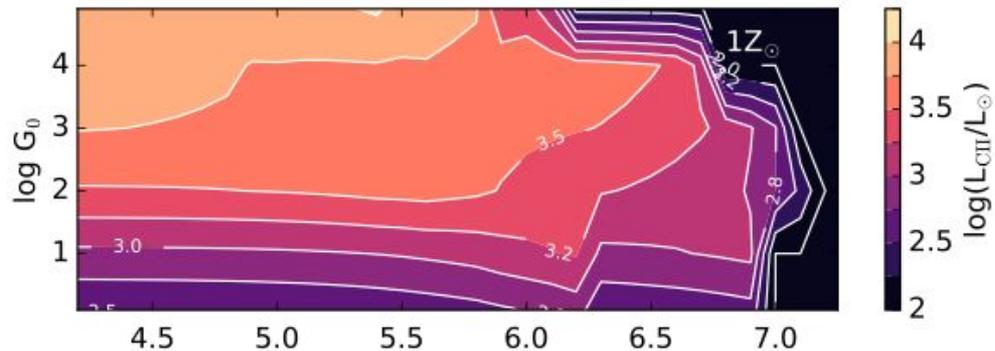
# 結果 [CII]

結局 ICM の領域しか

放射されない。

$G_0 \uparrow \Rightarrow L[\text{CII}] \uparrow \uparrow$

金属量  $\downarrow \Rightarrow L[\text{CII}] \downarrow \downarrow$



# 結果 [OIII] / [CII] 比

金属量が下がると,

EUVが高密度領域まで

入ってこれる

OIII abundance  $\uparrow\uparrow$

これによって,

Inoue et al. 2016 を再現

