DEEP-Theory group meeting Monday 25 January 2019

Viraj Pandya - Aligned prolate galaxies paper submitted

Christoph Lee - progress using Deep Learning to find clumps in CANDELS images

CGM discussion by Bill Mathews, Bob Williams, & Clayton Strawn

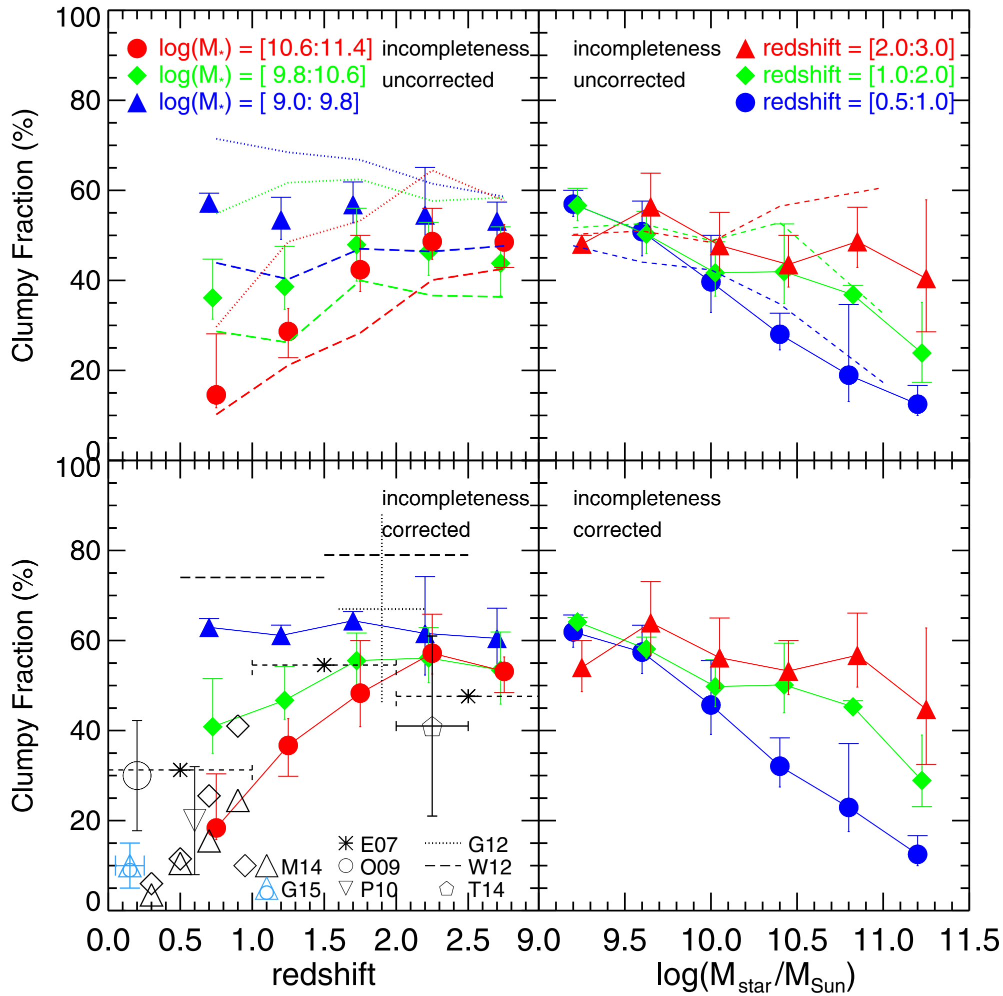
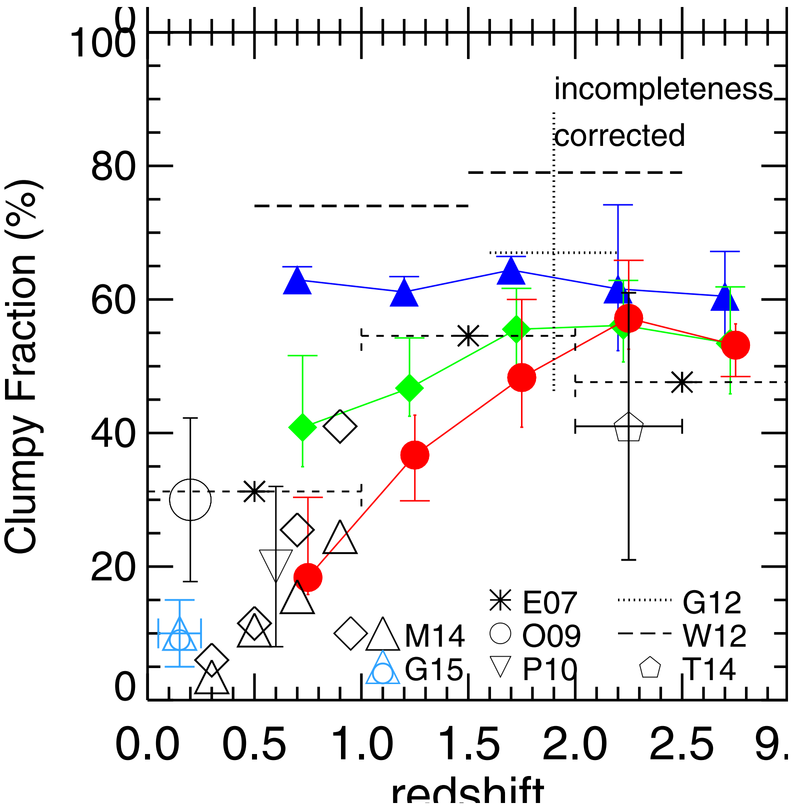
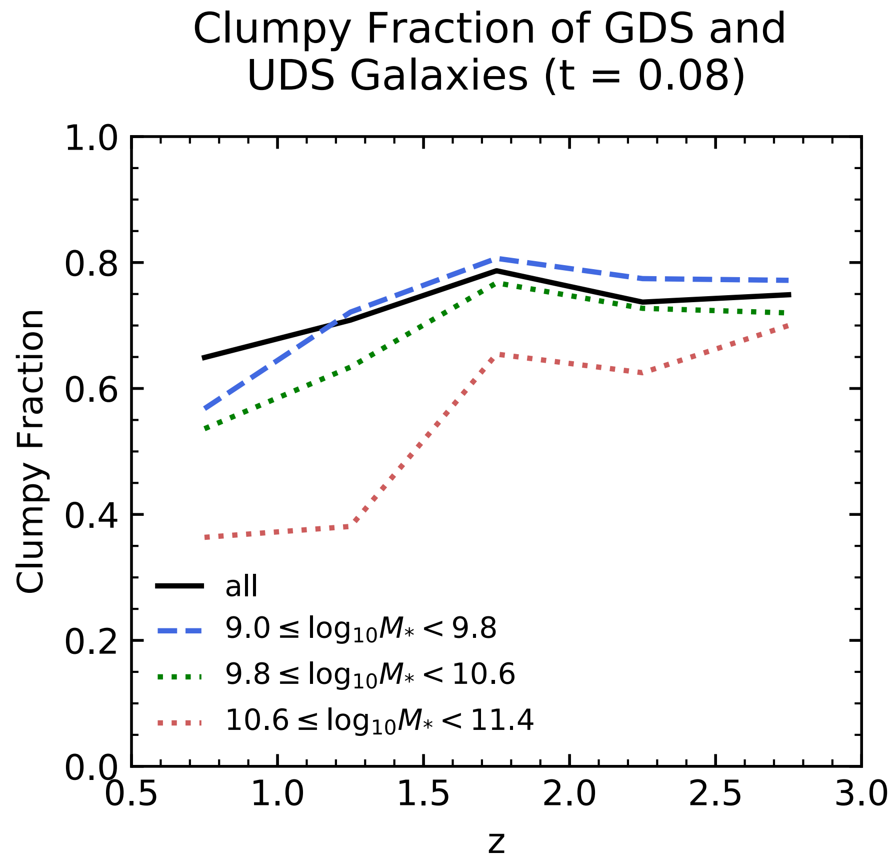


Figure 10. Fraction of star-forming galaxies with at least one off-center UV clump in different redshift and M_* bins. The upper panels show the results without correcting for the detection incompleteness, while the lower panels show the results with correcting for the incompleteness through Equation (2). Each colored point is the error-weighted average of the GOODS-S and UDS results. The hats of the upper and lower error bars of each data point have different lengths: the longer hat shows the fraction of GOODS-S, while the shorter one shows that of UDS. The errors of GOODS-S and UDS fractions are not shown, but the relative errors between the two fields can be inferred from the distances of each data point to the two hats of its error bar. In the upper left panel, dashed and dotted lines show $f_{\rm clumpy}$ under an aggressive ($L_{\rm blob}/L_{\rm galaxy} = 0.05$) and a conservative ($L_{\rm blob}/L_{\rm galaxy} = 0.1$) clump definitions, respectively. The color of each dashed or dotted line matches the color of the symbols to show its M_* range. In the upper right panel, dashed lines show $f_{\rm clumpy}$ measured through comparing real galaxies with redshifted fiducial galaxies to take into account the clump/blob blending effects (see Section 7.1 for details). In the lower left panel, several measurements of $f_{\rm clumpy}$ from other studies are also plotted. The summary of the previous results is given in Table 1.

Yicheng Guo + 2015



Christoph Lee



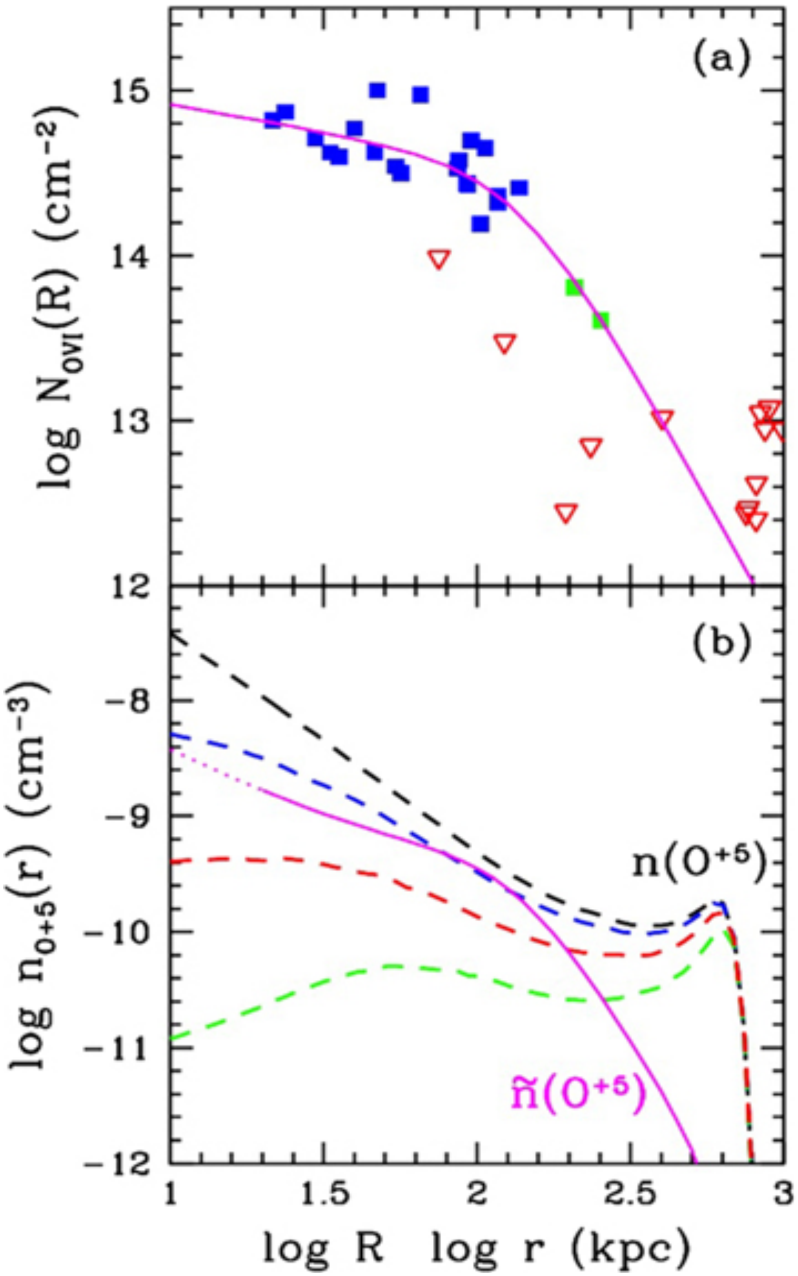
Circumgalactic Conumdrums:

Bill Mathews

1)OVI columns and oxygen mass
in ~Milky Way galaxies

2)Influence of cosmic rays

2)Cooling time is too short



OVI columns observed
in MW-type galaxies

Solve Abel's equation
for space density of O^{+5}

Total oxygen mass ~ 10^9 M_{sun}

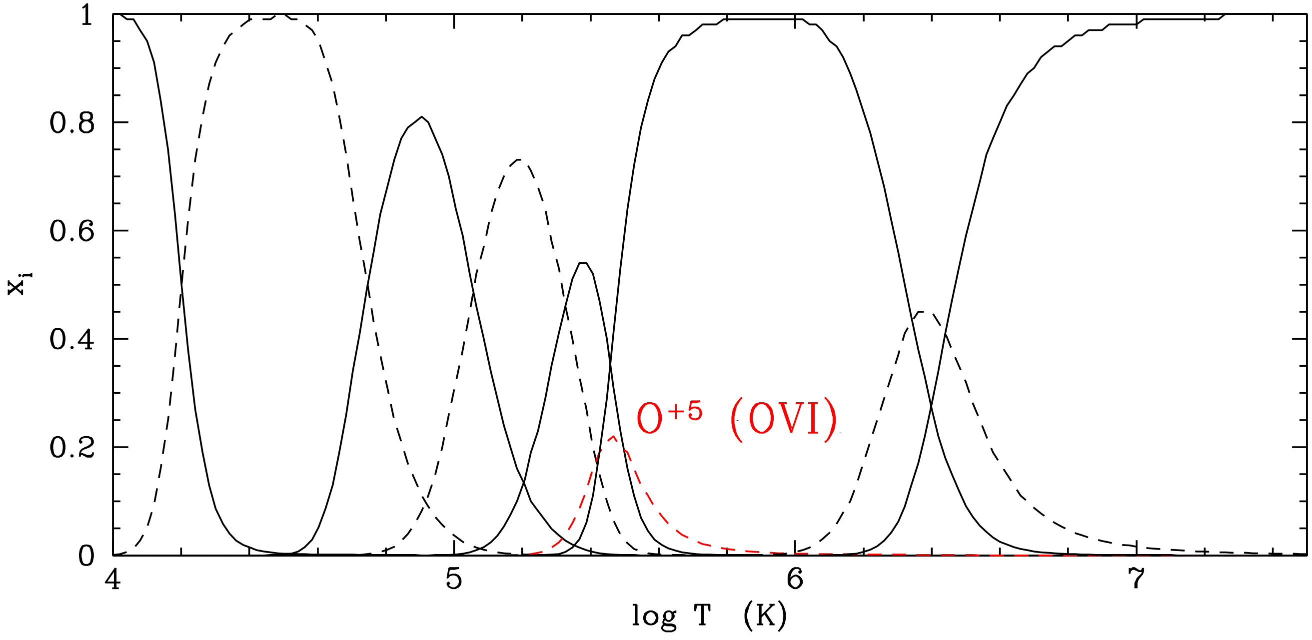
Two CMG questions:

1) How did 10^9 M_{sun} of oxygen get out to r = 100 kpc?

2) How does it stay out there if it cools by radiation losses?

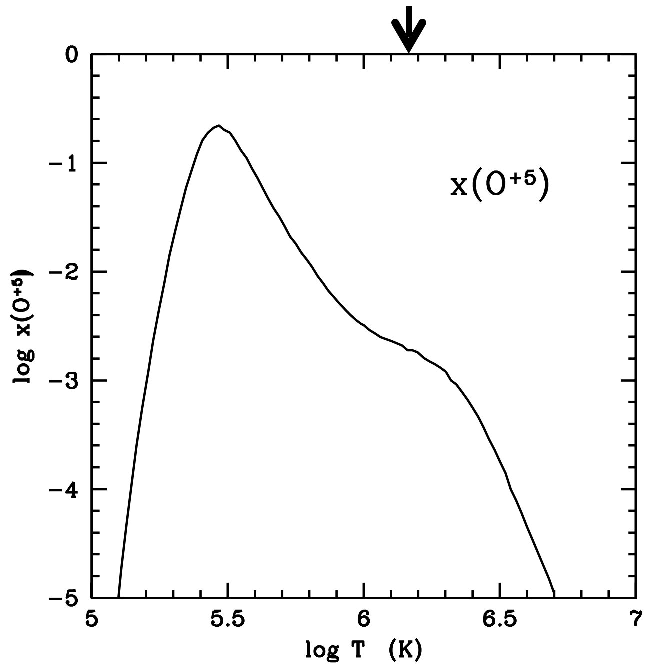
CIE = collisional ionization equilibrium

oxygen ions



virial temperature of MW halo $M_h = 10^{12.2}\ M_{sun}$

10^6 K



$\rho_{O+5} = \rho_O * x(o^{+5})$ or $\rho_O = \rho_{O+5} / x(o^{+5})$

gas temperature can be lowered with cosmic rays

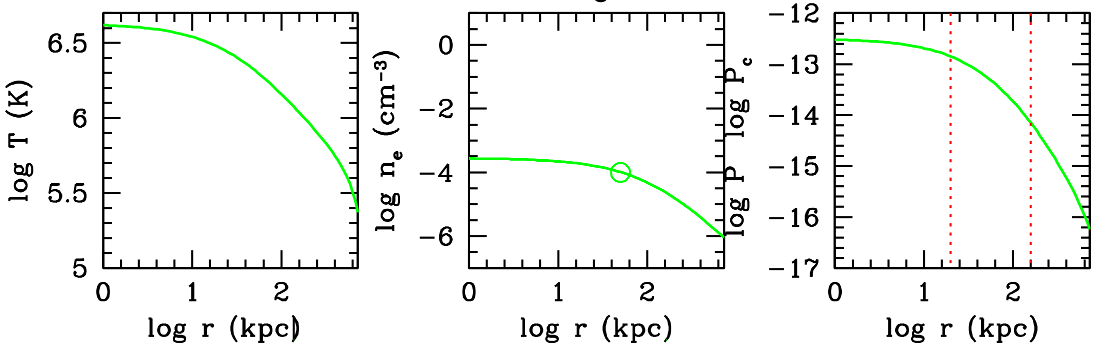
For MW-like galaxies $M_* = 10^{10.4}$ $M_h = 10^{12.2}$:

assume post-feedback gas density profile

from hydrostatic equilibrium determine temperature & pressure profiles

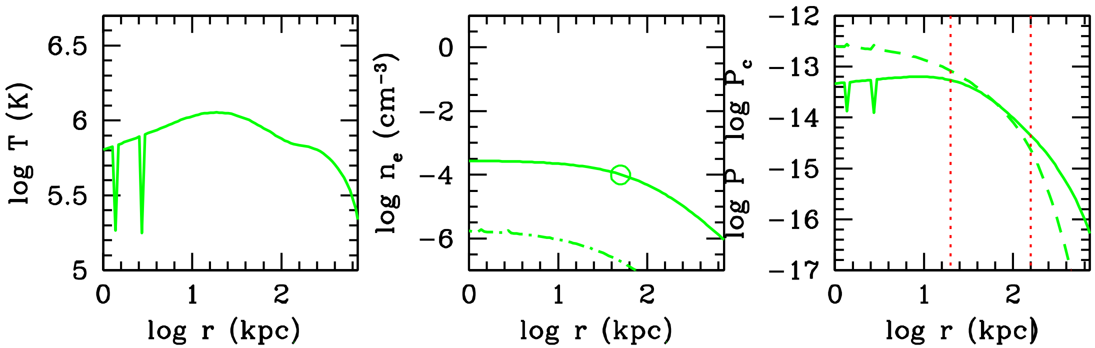
no cosmic rays:

temp $\quad$ n_e $\quad$ pressure



with cosmic rays: assume $E_{cr} = 10^{50}$ ergs with each 6 M_{sun} of oxygen

lower T!



cr diffusion time:

$\kappa_{diff} = r^2/t = 10^{29}$ $\qquad$ $t_{diff} = (100\text{kpc})^2/10^{29} = 3 \times 10^{10}$ yrs

CGM radiative cooling time depends on T and is nearly independent of ρ

$$t_{cool} = \frac{\frac{3}{2}P}{n_e n_H \Lambda^*(T,z)} = \frac{\frac{3}{2}(\frac{k}{\mu m_p})\rho T}{(\rho/m_p)^2 \Lambda(T,z)}$$

If $z \gtrsim 1$ **then**

$$\Lambda(T,z) = \Lambda_{HHe} + z * \Lambda_m(T) \approx z * \Lambda_m(T)$$

then with $z = z_{ox}$ **and** $\Lambda_m = \Lambda_{mcc}$

$$t_{cool} = \frac{3}{2}(\frac{k m_p}{\mu})\frac{T}{\rho z_{ox} \Lambda_{mcc}(T)}$$

For a fully ionized gas

$$\rho = 1.17 n_e m_p \quad and \quad \rho_H = 0.711\rho$$

The total density of all oxygen ions is

$$\rho_O = \frac{\rho_{O+5}}{x_{+5}(T)} \quad and \quad \rho_{O+5} = 16 m_p \tilde{n}_{+5}(r)$$

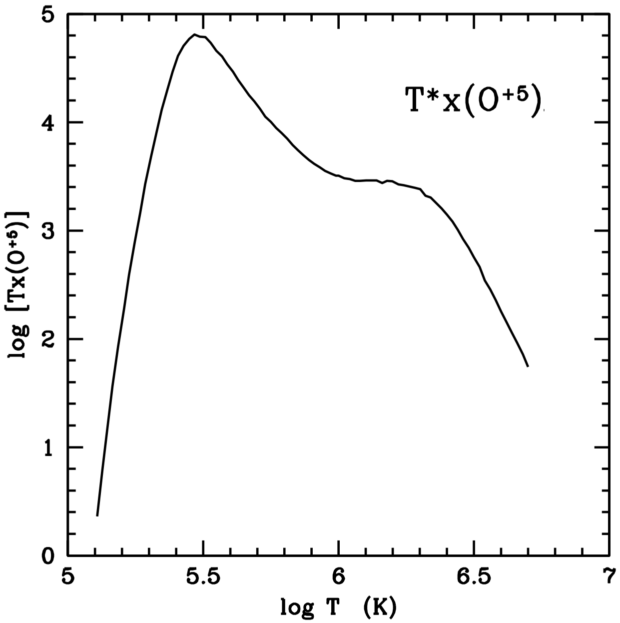
Consequently, since $z_{ox} = (n_{ox}/n_H)/A_{O,solar}$

$$\rho z_{ox} = \frac{m_p}{0.711 A_{O,solar}} \frac{\tilde{n}_{+5}(r)}{x_{+5}(T)}$$

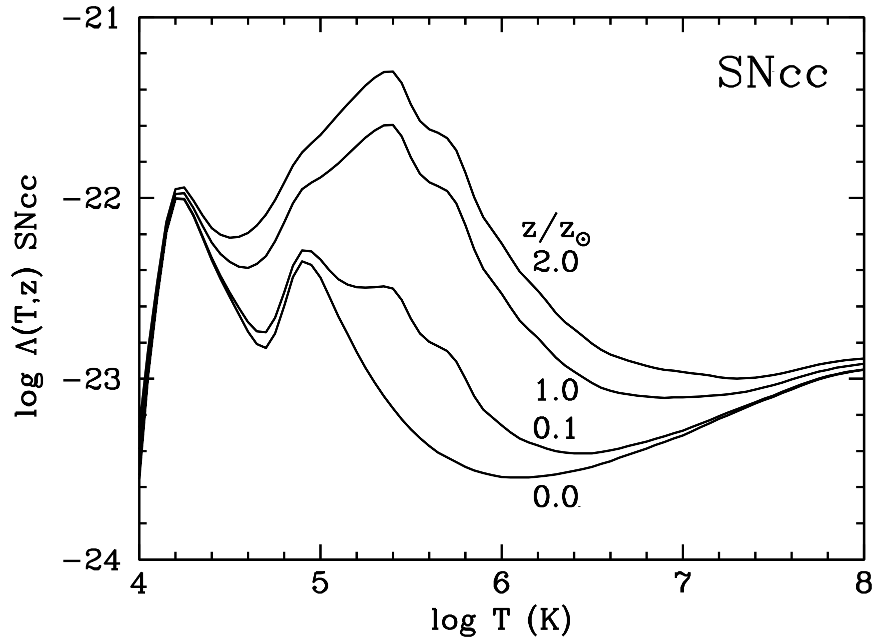
and the radiative cooling time is

$$t_{cool} = \frac{3}{2}\frac{k}{\mu} 0.711 A_{O,solar} \cdot \frac{1}{\tilde{n}_{+5}(r)} \frac{T x_{+5}(T)}{\Lambda_{mcc}(T)}$$

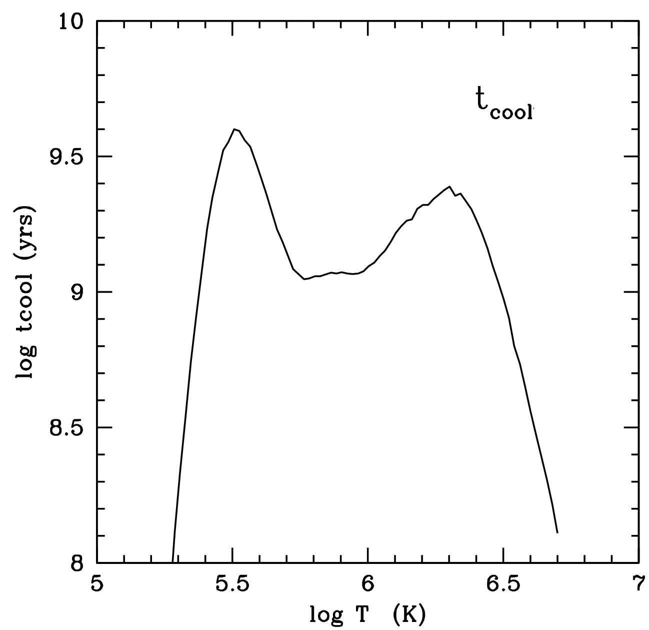
$T\,x_{+5}(T)$



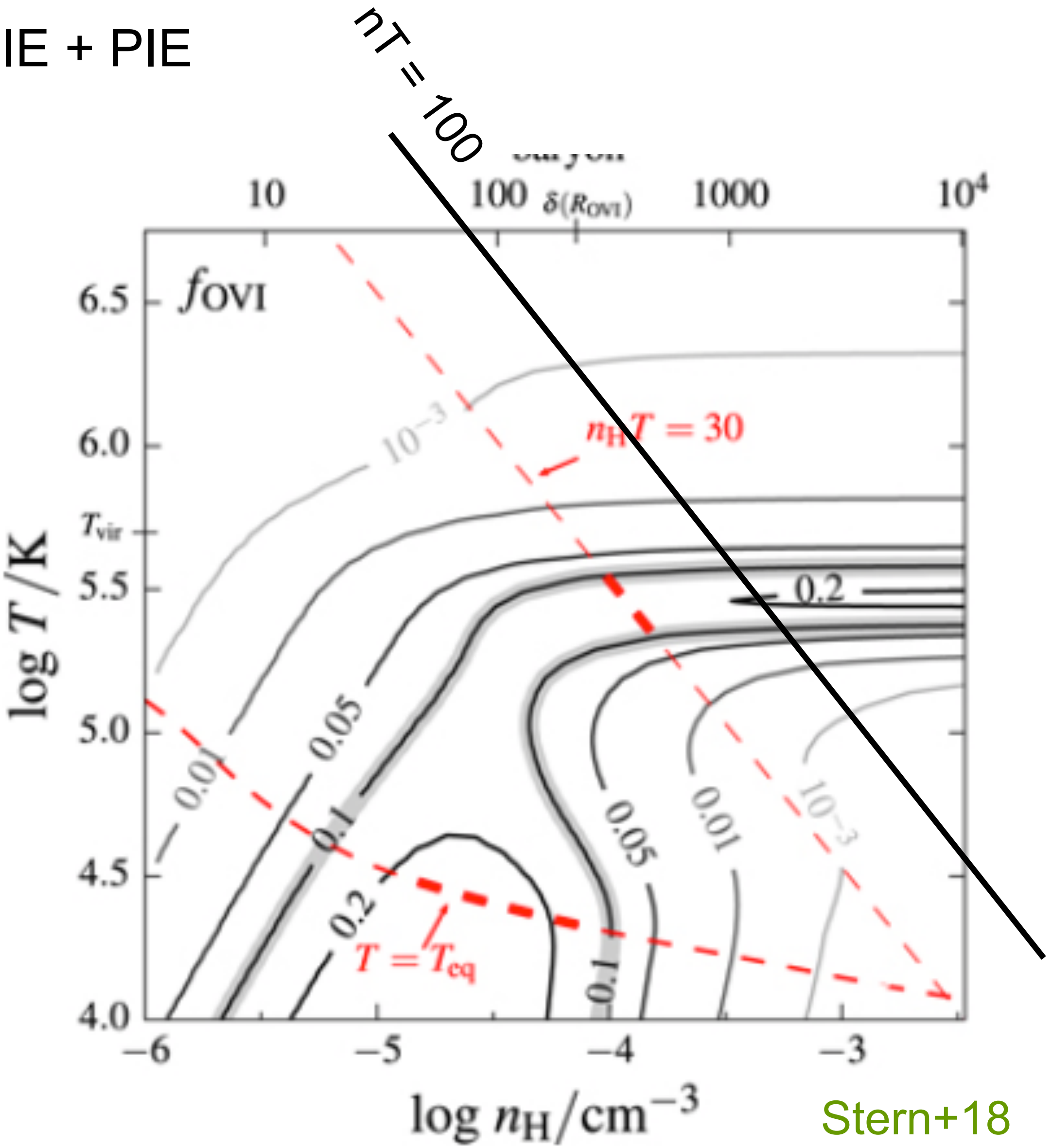
$\Lambda_{cc}(T)$



Maximum CGM cooling time is only ~3 Gyrs



$x_{+5}(n,T)$ for CIE + PIE



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