

$$\frac{10pc}{\rho} = 1000cm^{-3}$$

$$\frac{T}{\rho} = 1.67e-21g.^{-3}$$

$$\frac{100}{\rho} = 1.67e-24g.^{-3}$$

$$\frac{T}{\rho} = 1e5$$

$$\frac{L_0}{V_0} = \frac{3e19 = 10pc}{3e10sec^{-1}}$$

$$\rho_0 = 1.67e-24g.^3$$

$$t_0 = \frac{L_0}{V_0} = 10^9sec = 32yrs$$

$$P_0 = \rho_0 V_0^2 = 1.5e-3dyn.cm^{-2}$$

$$T_0 = \frac{V_0^2 m_p}{k_b} = 10^{13}$$

$$\frac{??}{\dot{y}} = 0$$

$$\frac{1000atoms.cm^{-3}}{\tau} = nL\sigma_T \simeq 6.65e-3$$

$$(1) \quad \frac{\sigma_T}{6.65e-25cm^2} = ??$$

$$(2) \quad t(\rho e) = -\Lambda^*(n, T) = -n^2 \Lambda(T)$$

$$\frac{\Lambda}{\Lambda(T)} = ??$$

$$\frac{ergs.^3s^{-1}}{n} = \frac{\rho}{\mu m_u}$$

$$\frac{T}{n} = \frac{100K}{10^3protons.cm^{-3}}$$

$$\frac{1.38e-16ergs.K^2k_bT}{\tau_c} = \frac{16ergs.K^2k_bT}{n^2\Lambda(T)} = \frac{2k_bT}{n\Lambda(T)} \simeq 10^8s \simeq 3yrs$$

$$(3) \quad \frac{10^5yrs}{P} \sim \frac{\rho T}{\rho T} = 0$$

$$\frac{0}{y} = 0$$

$$\frac{0}{y} = 0$$

$$\frac{0}{y} = 0$$

$$\frac{??}{70K} = 0$$

$$\frac{??}{\dot{y}} = 0$$

$$Vt = -\frac{P}{\rho}$$

$$(4) \quad c_s = \sqrt{\gamma \frac{P}{\rho}}$$

$$(5) \quad \gamma = \frac{5}{3}$$

$$\frac{??}{s} = 1.2km.s^{-1}(MC)$$

$$\frac{c_s}{s} = 38.7km.s^{-1}(ISM)$$

$$\sim 0.75^{1/2} = 0.8$$

$$\frac{1km.s^{-1}}{y} = 0$$

$$\tau_R = \frac{R}{c_s} \simeq 7.5yrs$$

$$(6) \quad \frac{??}{\Lambda(T)} = \text{Simplified Non-Equilibrium Cooling}$$

$$w_{i/r}$$

$$w_{i/r} = c_i \times 13.6 \times 1.6e - 12 f_n + c_r \times 0.67 \times 1.6e - 12 (1 - f_n) \frac{T}{11590}$$

(10)

$$\frac{c_r}{c_i} =$$

$$\frac{2.6e-11}{\sqrt{T}}c_i =$$

$$\frac{1.08e-8\sqrt{T}}{13.6^2}e^{-\frac{157890}{\sqrt{T}}}$$

$$x_{H_I}$$

$$x_{H_I} =$$

$$\frac{0.1}{x_{H_I}} =$$

$$\frac{0.9}{g} =$$

$$\frac{0}{g} =$$

$$\frac{0}{10K}$$

$$\frac{??}{??}$$

$$\frac{g}{g} =$$

$$\frac{0}{8Myrs}$$

$$\frac{8Myrs}{????}$$

$$\frac{??}{x_{H_I}}$$

$$x_{H_I}{}_{2,(He,CO)}.$$

Molec-
lar
Hy-
dro-
gen
Non-
Equilibrium
Cool-
ing
(H2
COOL)

$$\begin{array}{l} x_{H_{II}} \\ x_{H_2} = \\ \frac{H_I}{n_{H_I}} x_{H_I} = \\ \frac{n_{H_{II}}}{n_{H_2}} x_{H_2} = \\ \frac{n_H}{n_H} = \\ n_{H_I} + \\ n_{H_{II}} + \\ 2n_{H_2} \\ - - > \\ H^+ + \\ 2e^- k_1 = \\ 5.84e-11\sqrt{T}e^{-157809/T} \\ H^+ + e^- - > H + h\nu k_2 = \\ 2.6e-11\sqrt{T} \\ H_2 + e^- - > 2H + e^- k_3 = \\ 4.4e-10T^{0.35}e^{-102000/T} \\ H_2 + H^- > 3H k_4 = \\ 1.067e-10T_{eV}^{2.012}e^{\frac{-4.463}{T_{eV}}(1+0.2472T_{eV})^{3.512}} \\ H_2 + H_2 - > H_2 + 2H k_5 = \\ 1.0e-8e^{-84100/T} \\ H + H^- > [dust]H_2 k_6 = \\ 3.0e-17\sqrt{T_2}(1+ \\ 0.4\sqrt{T_2}+ \\ 0.2T_2+ \\ 0.08(T_2)^2) \\ T \\ T_{eV} \\ T_2 = \\ \frac{T}{100} \\ k_i \\ cm^3s^{-1} \\ S_i = n_it = \sum_{j,k} k_{j,k}n_jn_k - n_i \sum_j k_{i,j}n_j \end{array}$$

(11)

$$\begin{array}{l} S_i \\ k_{j,k} \\ i \\ j \\ k \\ k_{i,j} \\ i \\ j \\ X_{it} = -u \cdot X_i + S_i \end{array}$$

(12)

$$\begin{array}{l} -u \cdot \\ X_i \\ S_i \\ \Lambda_{CI} \\ \Lambda_{RR} \\ \Lambda_{rotvib} \\ \Lambda_{diss} \\ 2, \\ (gas- \\ grainprocess)\Lambda_{grain} \end{array}$$

(13)

$$\begin{array}{l} \Lambda = \Lambda_{CI} + \Lambda_{RR} + \Lambda_{rotvib} + \Lambda_{diss} + \Lambda_{grain} \\ [H] \\ A_{-8} \\ 10 \\ ?? \\ 100K \\ 3e3K \\ ?? \\ y = \\ 0 = \\ y = \\ 0 = \\ 0 \\ 30K \\ 100K \\ 30K \\ 100K \quad N \quad x_H x_H x_{H_2} \\ 0.1 \quad 0 \quad 0.9 \end{array}$$