Non-Equilibrium Chemistry & Cooling

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I: Chemical Model

Introduction

Species:

- Ions - H, He, N, C, O, Ne, Mg, Si, S, Fe (137 in total)
- Molecules - H_2, CO & intermediate species (20 in total)

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- Molecular hydrogen
- Recombination cooling
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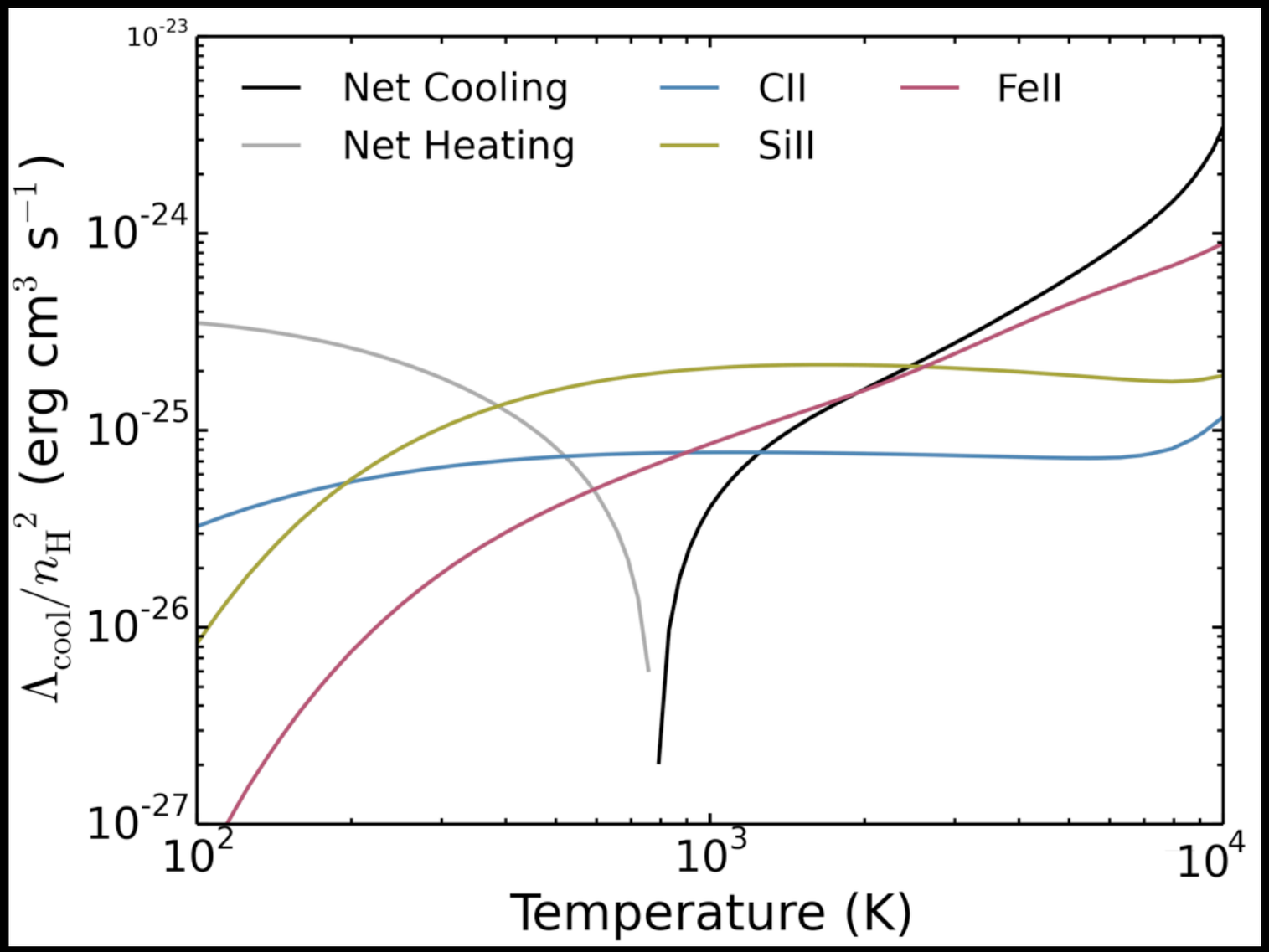
Heating:

- Photoheating
- Photoelectric dust heating
- Cosmic Rays

Equilibrium Cooling

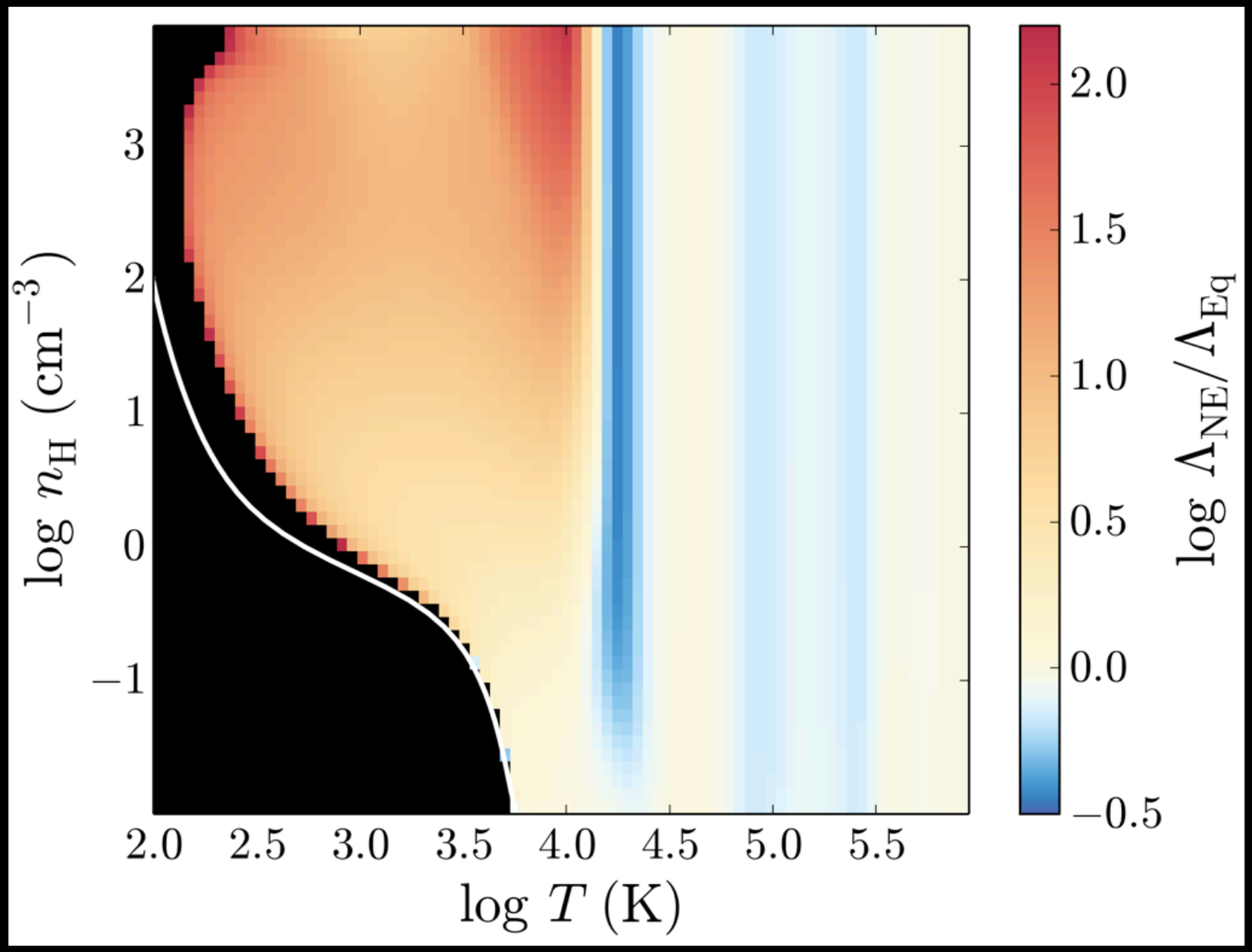
Haardt & Madau (2001) extragalactic UVB; n_H = 1 cm^{-3}



Non-Equilibrium Cooling

Gas cooling isochorically from T = 10^6 K

- Solar metallicity
- Haardt & Madau (2001) UV background



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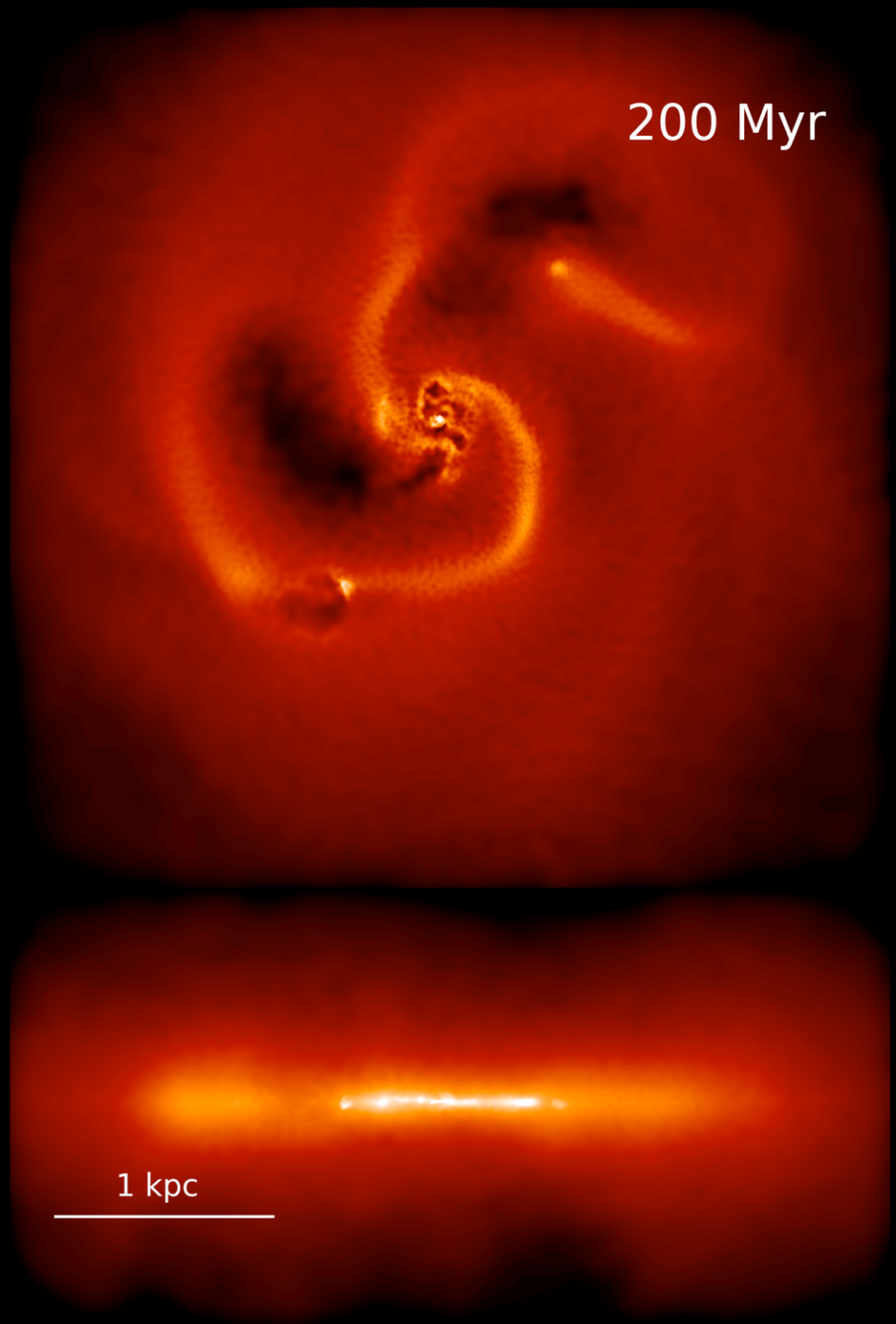
II: Simulations

Isolated Disc Galaxies

- Tree/SPH code Gadget3 (Springel 2005).
- Thermal SN feedback (Dalla Vecchia & Schaye 2012).
- $M_{200} = 10^{10}\ M_{sol}$.
- $m_{gas} = 750\ M_{sol}$.
- $Z_{init} = 0.1\ Z_{sol}$.

Gas evolution:



Isolated Disc Galaxies

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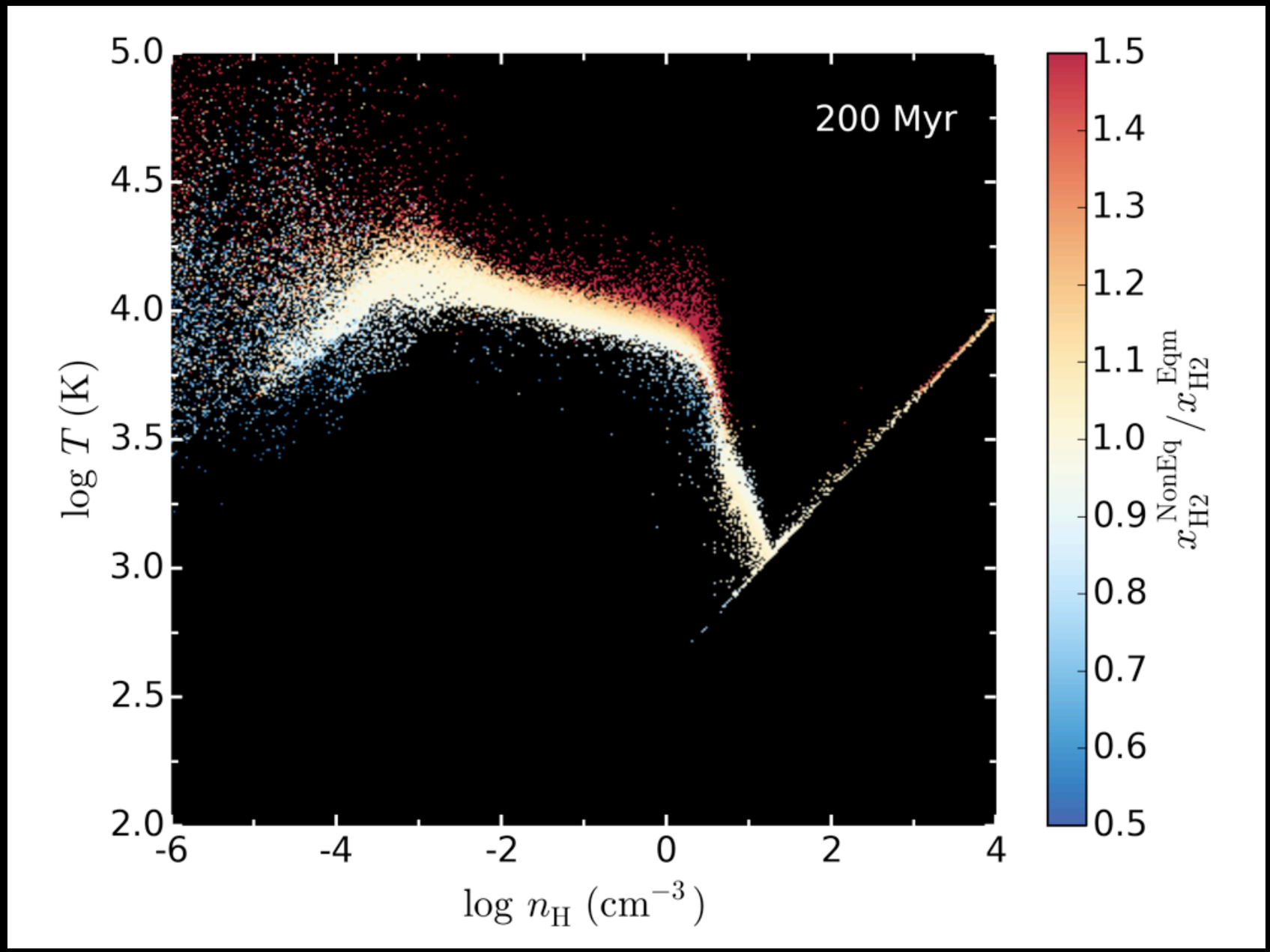
Non-equilibrium abundances: H2



Summary

I: Chemical Model

- Important coolants include CII, FeII, SiII, OI & H2.
- Recombination lags can enhance the cooling rate below 10^4 K by up to two orders of magnitude.

II: Simulations

- We can track gas cooling rates in non-equilibrium.