

## Interstellar Phase Transitions Stimulated by Time-dependent Heating

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<http://akpc.ucsd.edu/ThermalInstability>

# Time-dependent UV heating rate

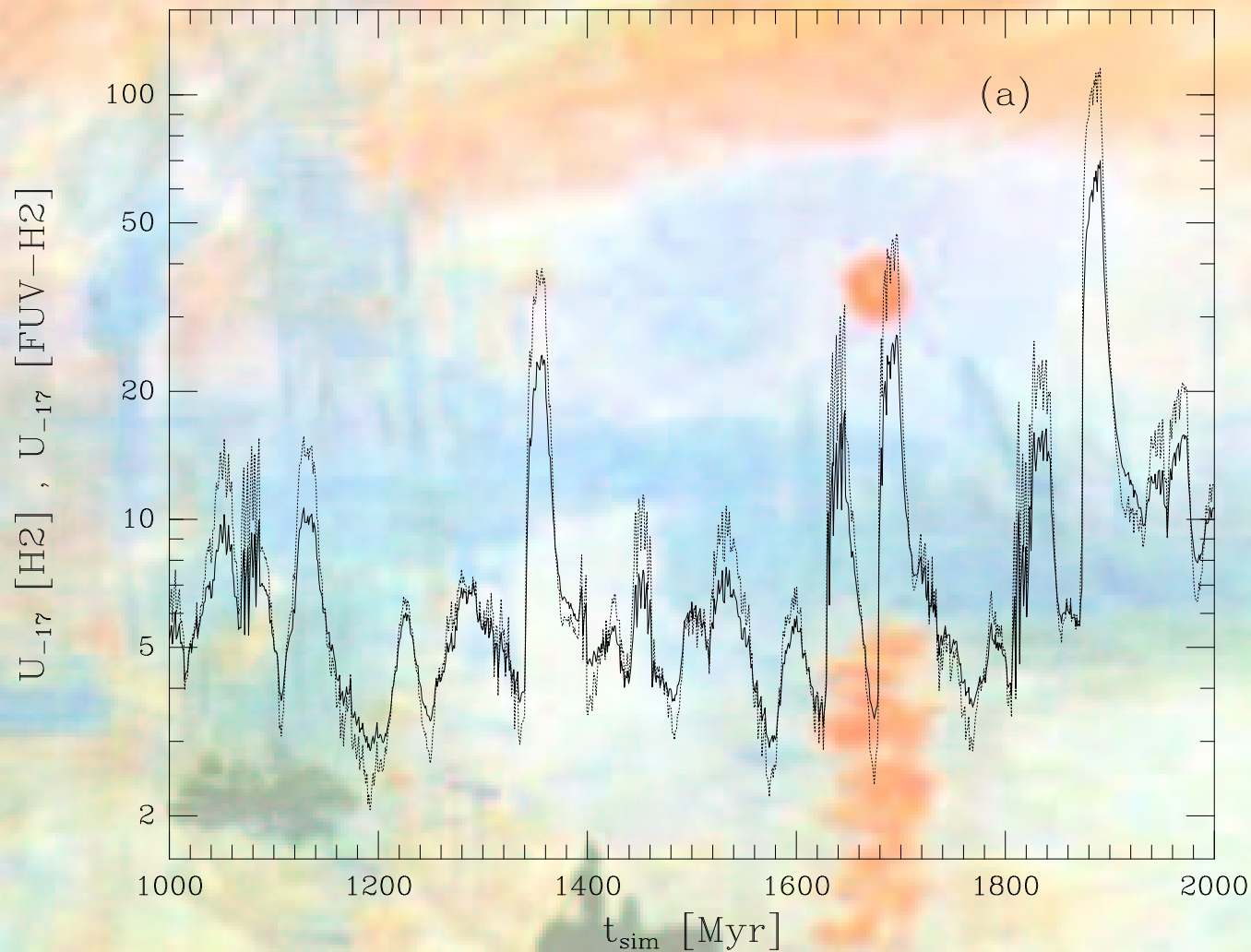


Figure 1: Time evolution of the energy density in the  $[1100 - 2070\text{\AA}]$  band  $U_{\text{FUV-H}_2}$  (continuous line) and in the  $[912 - 1100\text{\AA}]$  H<sub>2</sub> band  $U_{\text{H}_2}$  (dotted line) [Parravano et al. (2002)]

# How does it work?

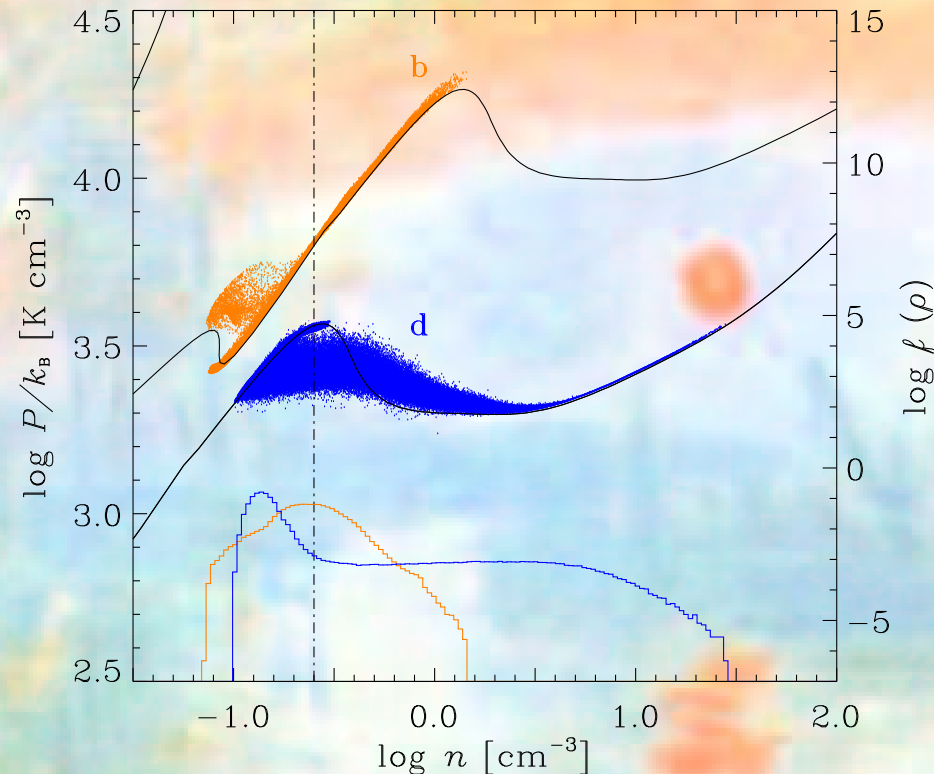


Figure 2: Scatter plots of gas pressure vs. gas density at  $t = 2.88$  Myr and  $4.0$  Myr (snapshots  $b$  and  $d$  in Fig. 3). Solid lines show thermal equilibria at high and low heating states. Dash-dotted line shows the mean gas density. Corresponding density PDFs are plotted at the bottom (see scale to the right).

# What does it look like?

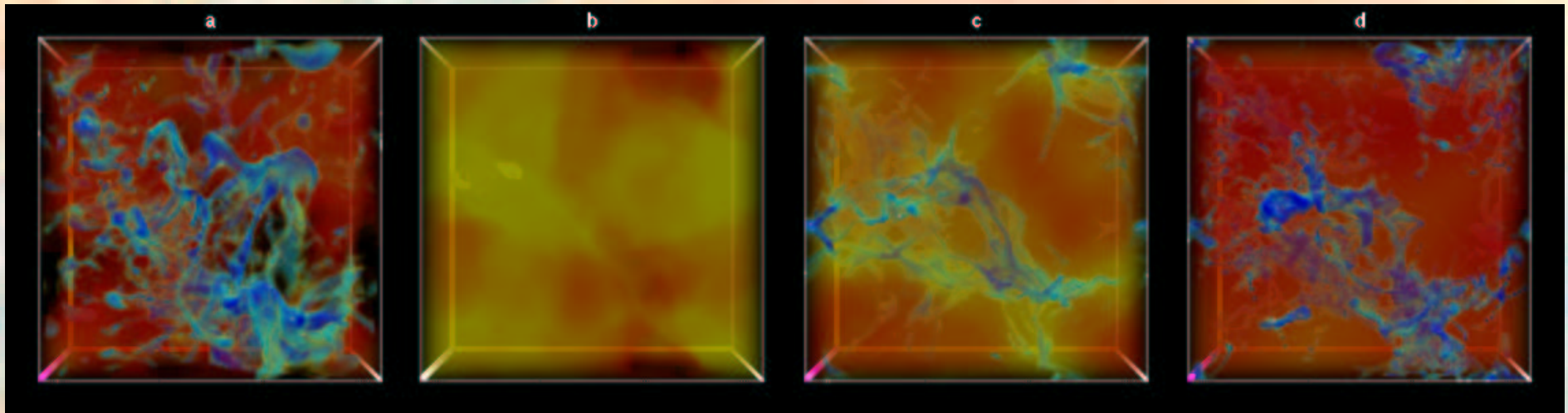


Figure 3: Gas density field (perspective volume rendering). (a) turbulent multiphase gas at  $t = 2$  Myr, (b) relaxed state at a high heating rate with no cold phase present,  $t = 2.8$  Myr, (c) violent relaxation to an equilibrium with reduced heating, seeds for the new population of cold clouds are forming along caustics in the stable warm phase,  $t = 3.24$  Myr, (d) partially relaxed state at a low heating rate,  $t = 4$  Myr (20 pc box,  $128^3$  grid points).

# What does it look like?

Movies:

- ☞ low mean gas density
- ☞ high mean gas density

The log density color coding (low mean density):

- the most dense blobs,  $n > 8 \text{ cm}^{-3}$ , are blue
- less dense gas,  $n \in [3, 8] \text{ cm}^{-3}$ , is light blue to green
- warm gas at  $n \in [0.5, 3] \text{ cm}^{-3}$  is yellow to red
- low-density gas ( $n < 0.5 \text{ cm}^{-3}$ ) is transparent

# Time evolution of global variables

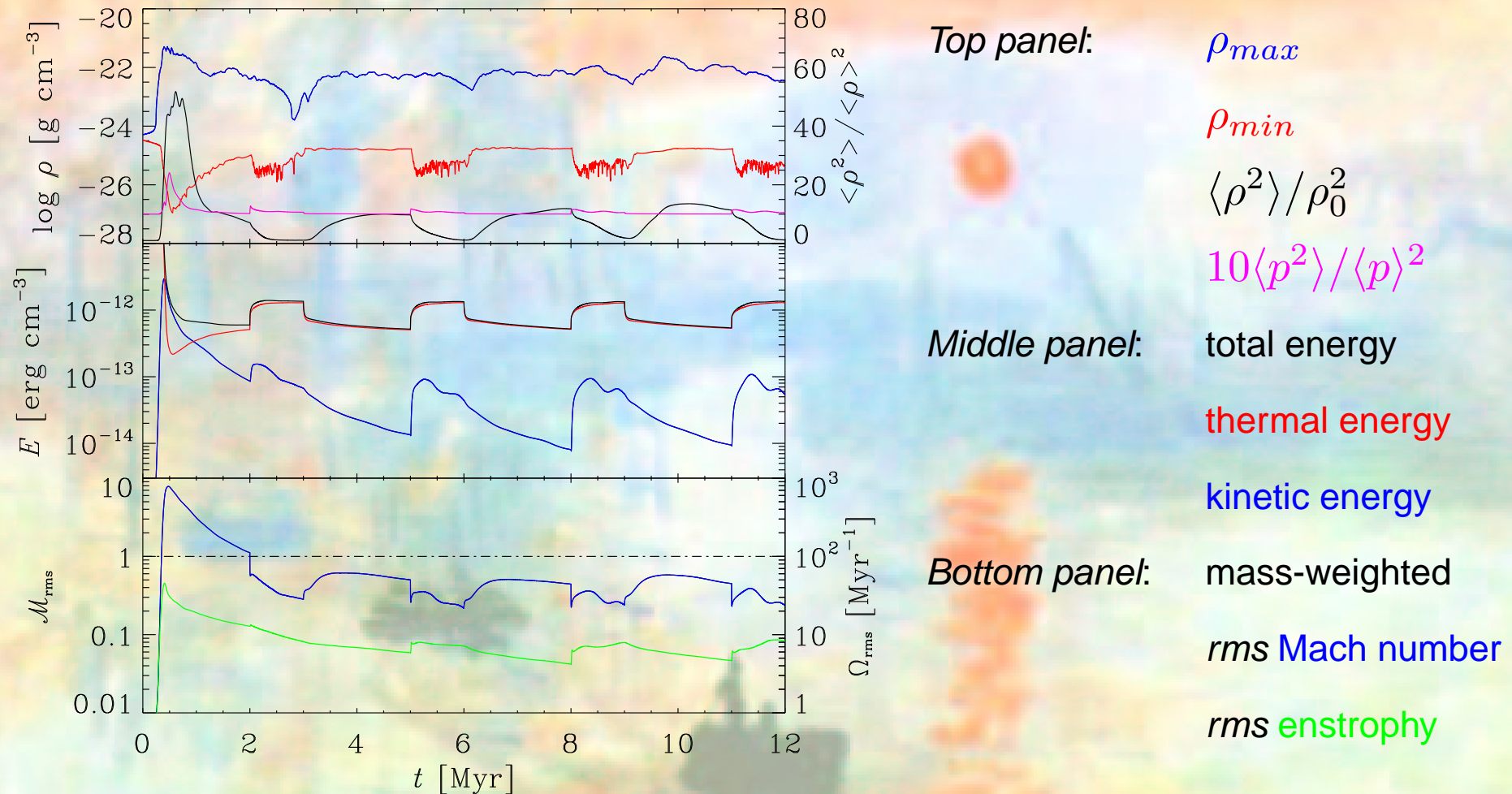
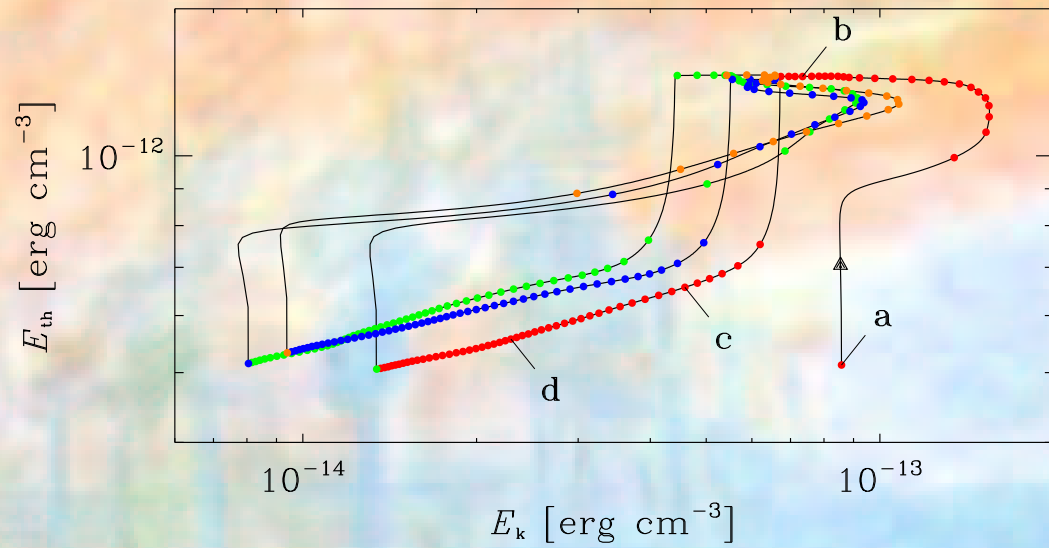


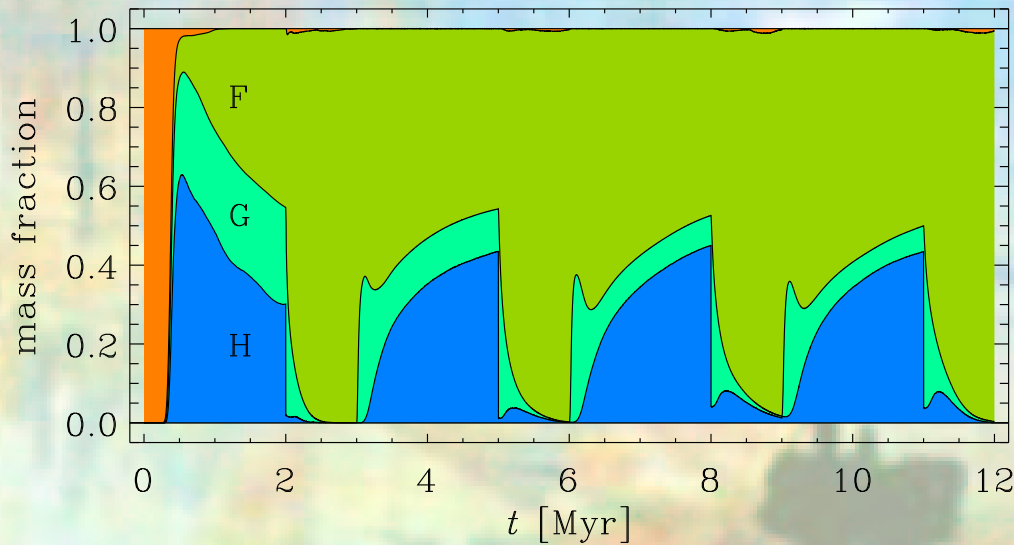
Figure 4: Global gas dynamic quantities.

# Thermal forcing & phase content



Top panel:

- Cycle 1
- Cycle 2
- Cycle 3
- Cycle 4



Bottom panel:

- HIM
- (F) WNM
- (G) unstable gas
- (H) CNM

Figure 5: Conversion of energy and phase transitions in the ISM.

# Conclusion

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- ♠ Novel thermal mechanism for turbulence forcing in the neutral atomic phases



# Appendix A: Low density model

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Movies:

- ➔ evolution in the phase plane
- ➔ evolution in the  $\mathcal{M} - \rho$  plane
- ➔ density PDF
- ➔ temperature PDF
- ➔ density power spectrum
- ➔ velocity power spectrum

# Appendix B: High density model

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Movies:

- ➔ evolution in the phase plane
- ➔ evolution in the  $\mathcal{M} - \rho$  plane
- ➔ density PDF
- ➔ temperature PDF
- ➔ density power spectrum
- ➔ velocity power spectrum