Galactic Outflows and Photoheating at z ≧ 6

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1. Questions

1a. Star formation during the reionization epoch was regulated by photoionization heating and galactic outflows. **How did the total feedback strength vary with halo mass?**

1b. Halos with virial temperature T_{vir} below 10^5 K were abundant at $z \geq 6$ but susceptible to photoheating feedback. **Did they dominate the reionization photon budget?**

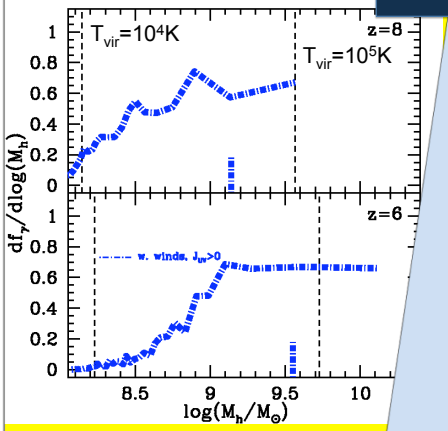
2. Simulations

- GADGET-2[1] including metal enrichment and cooling, star formation, outflows[2]
- radiation transport solver simulates growth of spatially-resolved UV background self-consistently assuming f_{esc} = 50%
- 6 h^{-1} Mpc boxes
- 2×256^3 particles resolves the HI cooling mass for z ≤ 7
- 4 kinds of simulations:
  - with/without outflows
  - with/without radiation transport[3] (z_{reion}=6-7)

6. Results

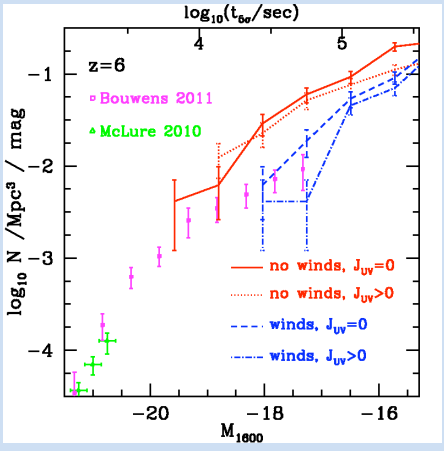
- The observed galaxy luminosity function at $z = 6$ requires outflows at all masses;
- Photoheating suppresses star formation in low-mass halos ($T_{vir} \leq 10^5$ K);
- Despite this photoheating, the abundant low-mass halos still dominated reionization.

5. Ionizing Photon Fraction



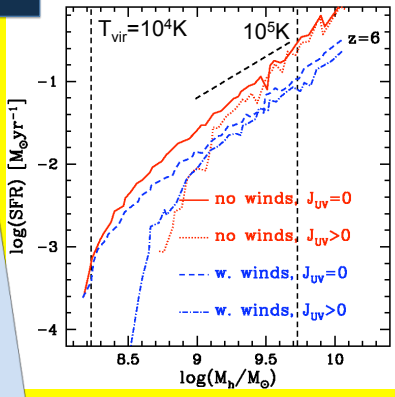
- curves: differential ionizing photon fraction versus halo mass in a simulation with outflows and a UVB (z_{reion}=6)
- vertical tick: 50% mass
- halos with $T_{vir}<10^5$K dominate reionization

4. Luminosity Functions



- without outflows, simulations generically overproduce the observed LF, indicating that outflows are required;
- with outflows, the impact of photoheating on the observable LF is negligible.

3. Star Formation Rate



- SFR ∝ $M_{halo}^{1.3\text{-}1.4}$
- photoheating does suppress star formation for $T_{vir}<10^5$K
- outflows suppress star formation at higher masses owing to higher gas densities

References: [1] Springel, V. 2005, MNRAS, 364, 1105; [2] Murray, Quatert, & Thompson 2005, ApJ, 618, 569; [3] Finlator, Özel, & Davé 2009, MNRAS, 393, 1090;