Journal Club(2013/06/10)

Sunmyon Chon

(1305.1325)Population Ⅲ Stars and Remnants in High Redshift Galaxies

Hao Xu, John H. Wise and Michael L. Norman

（1305.6966）The Destruction of Protogalaxies by Population Ⅲ Supernovae : Prompt Chemical Enrichment and Supermassive Black Hole Growth

Daniel J. Whalen, Jarrett L. Johnson, Joseph Smidt, Avery Meiksin, Alexander Heger, Wesley Even and Chris L. Fryer

(1305.5923)Black hole formation in the early universe

M. A. Latif, D. R. Schleicher, W. Schmidt and J. Niemeyer

1. Population Ⅲ Stars and Remnants in High Redshift Galaxies

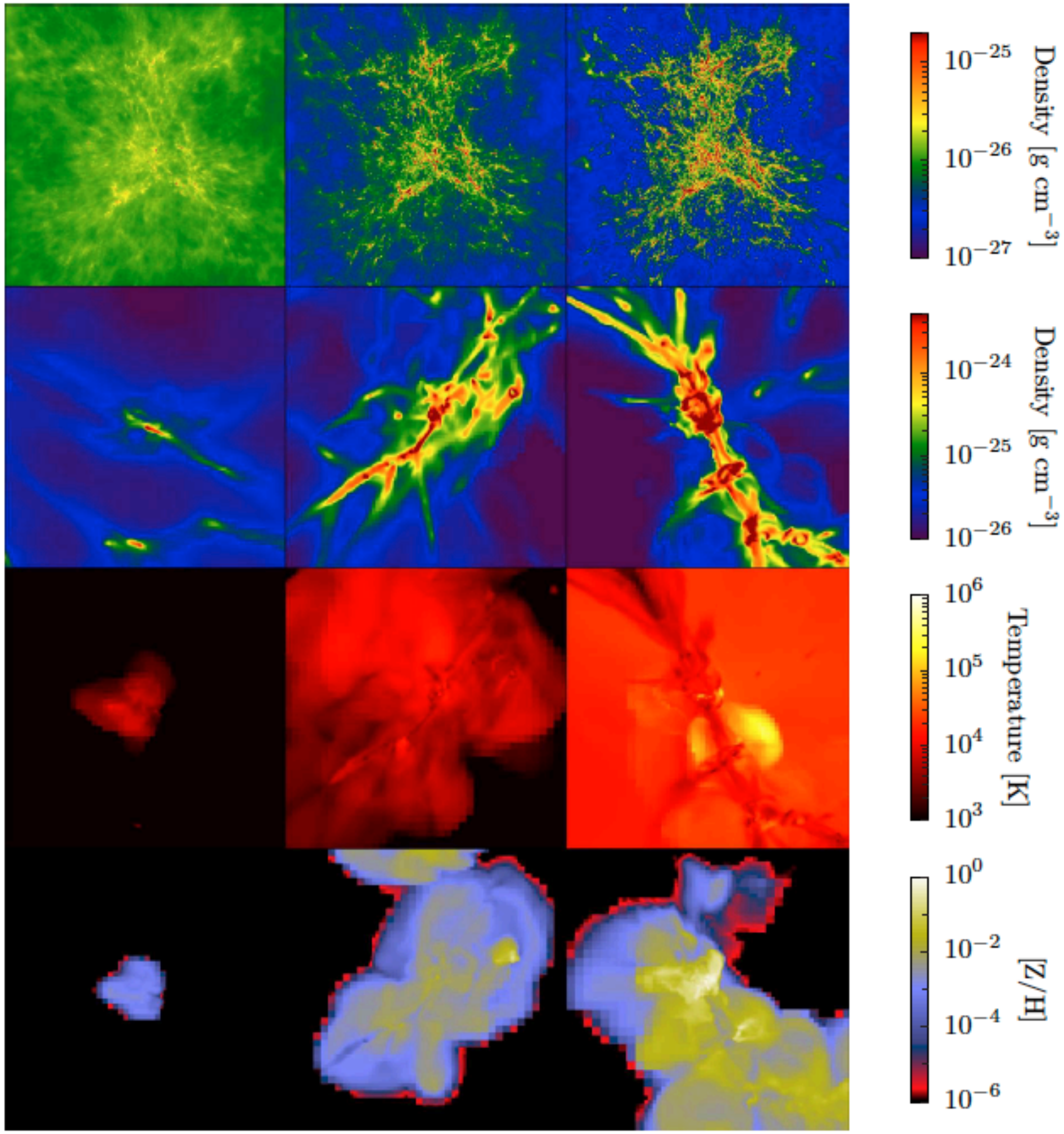

Figure 1. Snapshots of the refined regions and the most massive halos at redshifts 25 (left), 17.91 (middle) and 15 (right). The images are the density-weighted projections of baryon density in cubic volumes 6.6 comoving Mpc on a side (first row), enclosing the refined regions, the density-weighted projections of baryon density (second row), temperature (third row) and metallicity (fourth row) in cubic volumes 10.0 proper kpc on a side, enclosing the most massive halos.

- How did the Universe transition from PopⅢ to PopⅡ?

- What is the property of first galaxy?

⇒The authors investigate the statistical property of the PopⅢ stars by large scale cosmological simulation.

Set Up of the Simulation

- Cosmological hydrodynamic simulation by Enzo, with
  - chemistry and cooling effect
  - stellar feedback
    - Radiation
      - including LW feedback from PopⅢ stars
    - metal contamination by SN explosion
  - difference of PopⅡ and PopⅢ
    - If overdense region has metallicity
      - [Z/H] > -4 → PopⅡ, otherwise → PopⅡ
  - star formation

Result

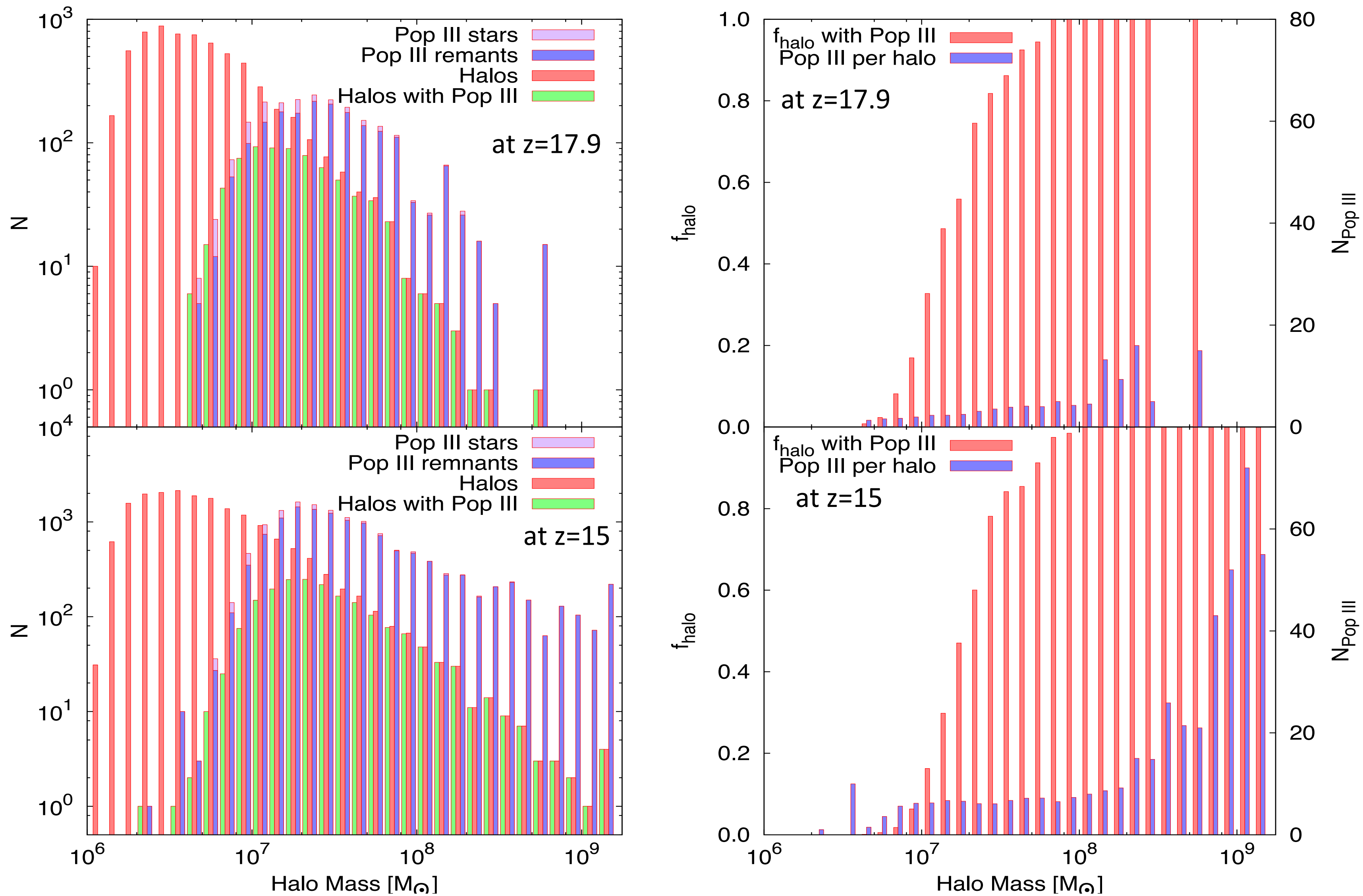

Figure 3. Left panel: Number of Pop III, total halos and halos with Pop III as functions of halo mass at redshifts 17.91 (Top) and 15 (Bottom). The number of living Pop III stars are stacked over the Pop III remnants showing in the same bin. Right panel: Fraction of halos hosting Pop III and average number of Pop III per halo at redshift 17.91 (Top) and 15 (Bottom).

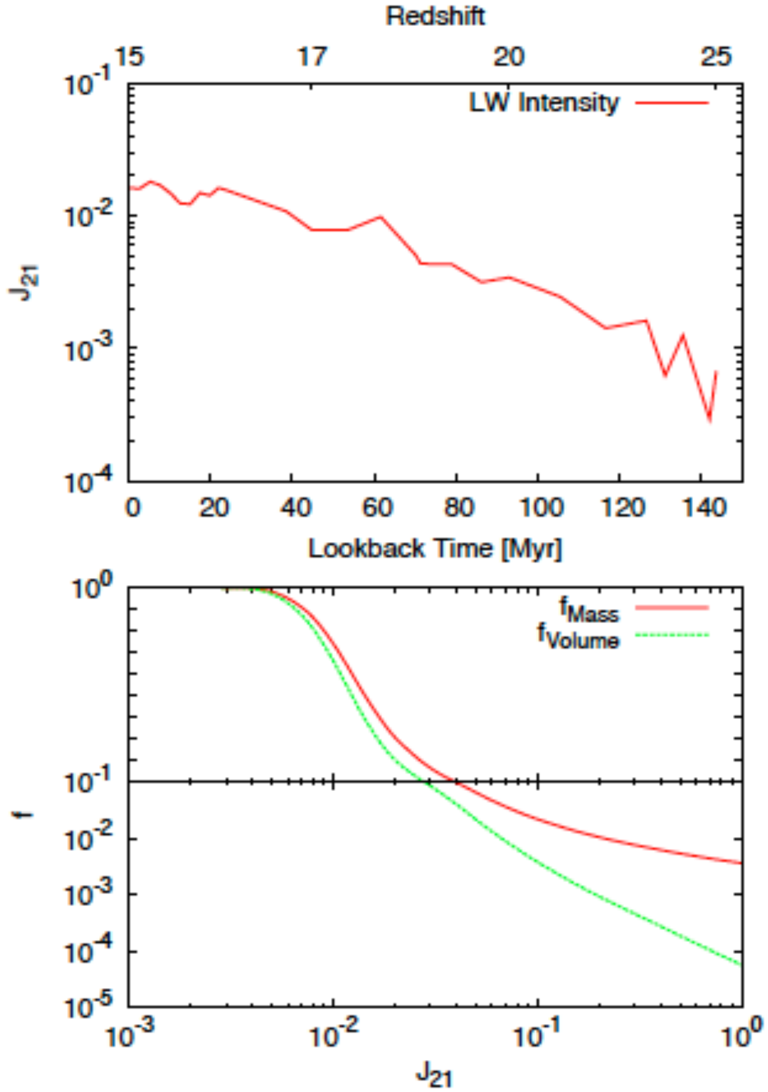

Figure 7. Top panel: Evolution of the volume averaged Lyman-Werner radiation intensity from stars in the simulation. Bottom panel: Complementary cumulative distributions of the LW intensity at $z = 15$. J_{21} is the LW intensity in the unit of 10^{-21} erg s^{-1} cm^{-2} Hz^{-1} sr^{-1}. The averaged LW intensity gradually increases to and maintains above 10^{-23} erg s^{-1} cm^{-2} Hz^{-1} sr^{-1} for the last 40 Myr. This LW radiation is not enough to significantly slow down the Pop III formation.

Summary

- The number of PopⅢ stars per halo increases with time and more massive halo has larger number of PopⅢ satars.
- Even at z ～15, the PopⅢ stars are still formed.
- The LW background is not so important to prevent H_2 cooling. Only due to the nearby PopⅢ stars, the H_2 cooling is suppressed.