Reionization Era: The First Stars

What is the Reionization Era?

A Schematic Outline of the Cosmic History



The Cosmic Reionization Era

(The Cosmic **Renaissance**)

S.G. Djorgovski et al. & Digital Media Center, Caltech

The First Stars

Gas infall into the potential wells of the dark matter fluctuations leads to increased density, formation of H_2 , molecular line cooling, further condensation and cloud fragmentation, leading to the formation of the **first stars**



Primordial Star Formation: a Top-Heavy IMF?

Expected in all modern models of Pop III star formation, characteristic M $\sim 10^2 - 10^4$ M_{\odot} (due to a less efficient cooling of protostellar clouds)



Population III Stars: Hot and Luminous

They can easily reionize the universe by $z \sim 6$



Population III Supernovae

- Early enrichment of the protogalactic gas
- Transition to the "normal" Pop II star formation and IMF when the metallicity reaches a critical value $Z_{crit} \sim 10^{-3.5} Z_{\odot}$

Simulated Pop III SN shell after $\sim 10^6$ yr

Distrib. of metals (red)

(from Bromm et al. 2003)





GRB 050904 at z = 6.295

A preview of the more distant, Pop. II flashes to come!

(Kawai et al. 2006, Haislip et al. 2006, Tagliaferri et al. 2006, etc.)





GRB 090423 at z ~ 8.2 (?)

The current record holder – no details available yet





Population III Stars

- They may have formed in large numbers as early as z ~ 20 - 30, and (partly?) reionized the universe, as WMAP data indicate
- However, their feedback may have extinguished the star formation in their hosts, possibly leading to a (partial?) recombination
- Then the formation of Pop. II stars may have reionized the universe again, ending the process at z ~ 6, as QSO data indicate





Simulations of the Cosmic Reionization

(from P. Madau et al.)





