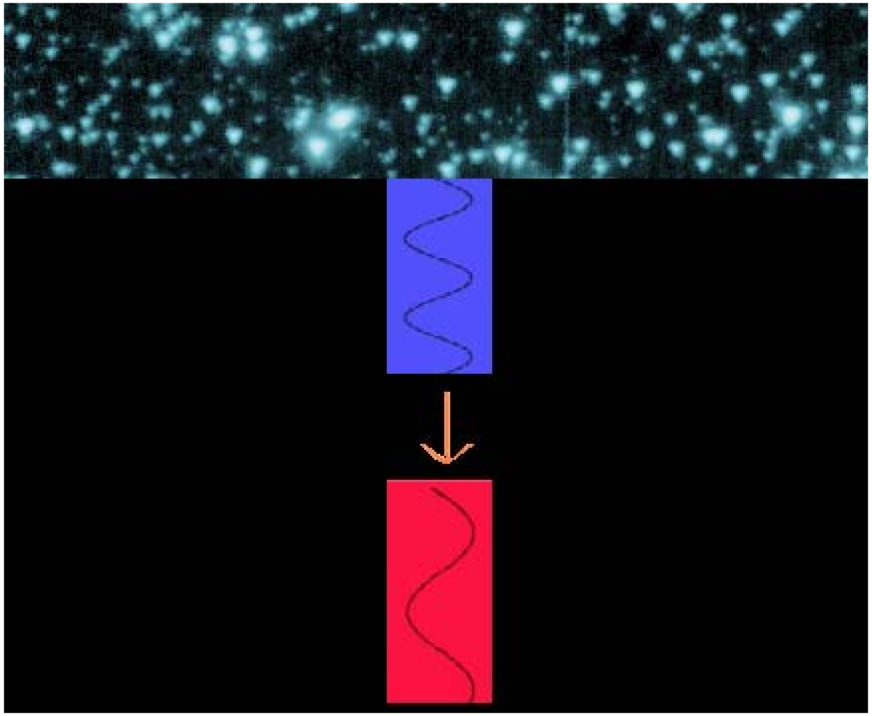
Remnant Light from the First Stars in the Near Infrared Background

Elizabeth Fernandez
Eiichiro Komatsu, Ilian Iliev, Paul Shapiro
University of Texas, Austin

To be submitted

The Near Infrared Background



~ a few microns

Why Study Fluctuations?

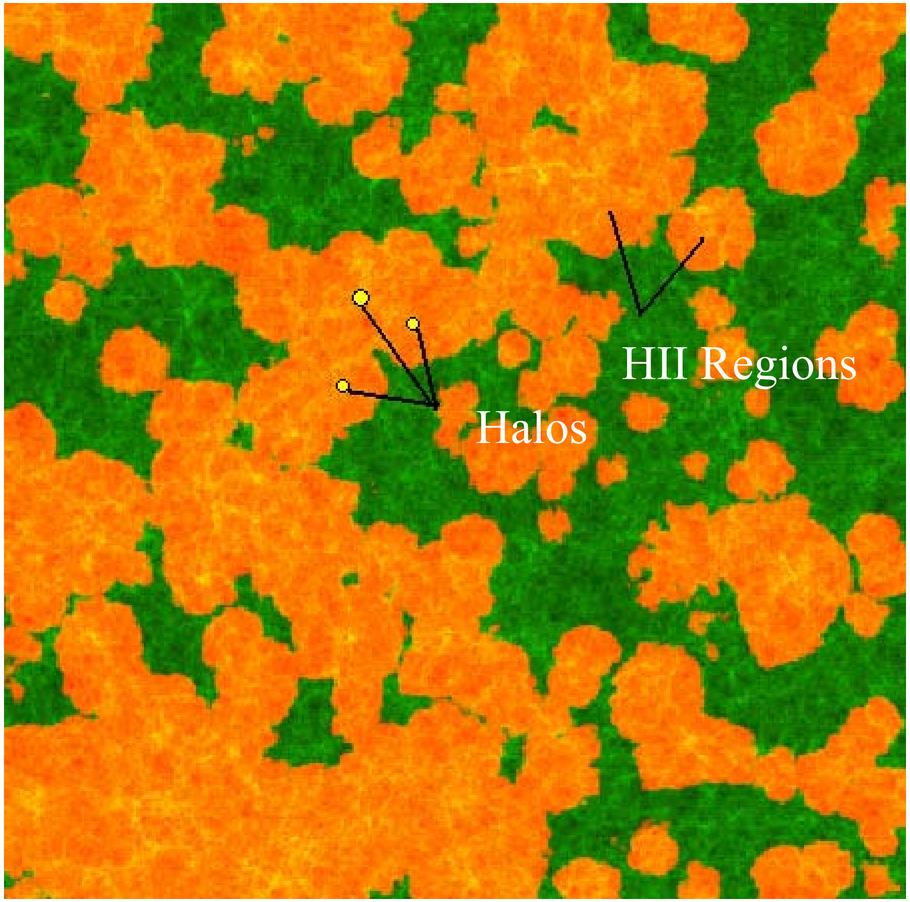
- Fluctuations reveal information about the primordial density field
- Information on reionization of the universe
- First structures in universe
- Easier to study than mean intensity
- Large fluctuations – very luminous & existed for a short period of time

Observing the Fluctuations of the NIRB

- Current and Future Missions
  - AKARI (ASTRO-F)
    - 2-160 micron
  - CIBER
    - 0.8 & 1.6 micron
    - 7”-2°
    - Combined will fluctuations 100 times fainter than IRTS/DIRBE

The Simulation

- Provided by Iliev et al. (2006,2007)
- N-body code
  - 1624^3 particles
  - Minimum resolved mass = 10^9 $M_\odot$
  - Box size = 100/h Mpc
- C^2-Ray tracks ionization front



Modeling Stellar Populations

- Must agree with simulation parameters

$$f_\gamma = f_* f_{esc} N_i$$

- $f_\gamma = 250$
- Two populations were modeled:
  - Salpeter, $f_{esc} = 0.22$, $f_* = 0.2$
  - Larson, $f_{esc} = 0.1$, $f_* = 0.1$

Luminosity from the Halos

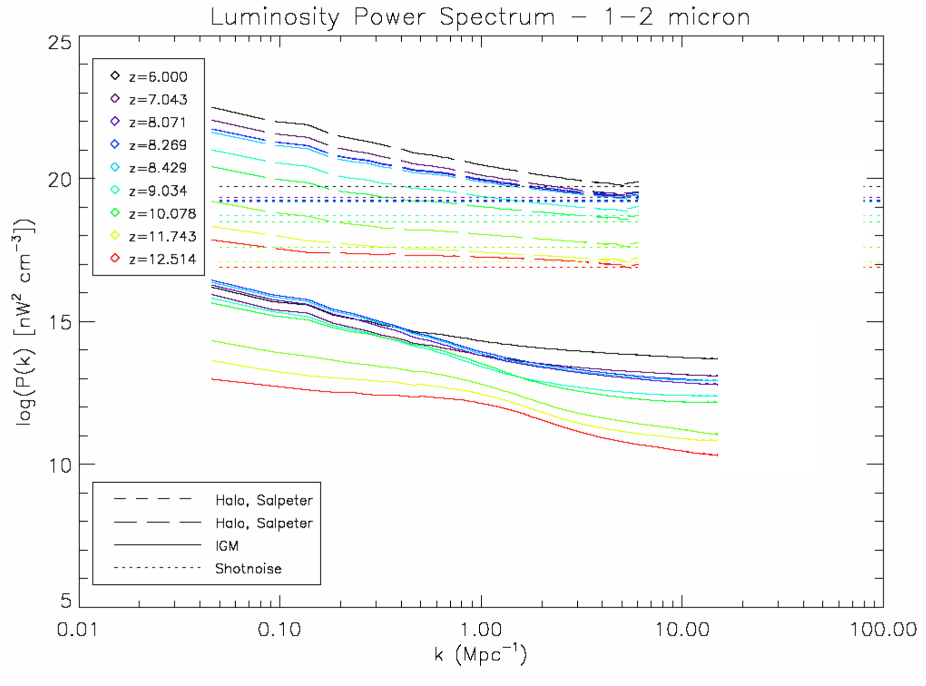
$$L_{halo} = L_{stellar} + L^{p}_{neb}$$

$$L_{stellar} = M_h \bar{l}_* \frac{\Omega_b}{\Omega_m} f_*$$

$$L^{p}_{neb} = M_h \bar{l}^{p}_{neb} \frac{\Omega_b}{\Omega_m} f_* (1 - f_{esc})$$

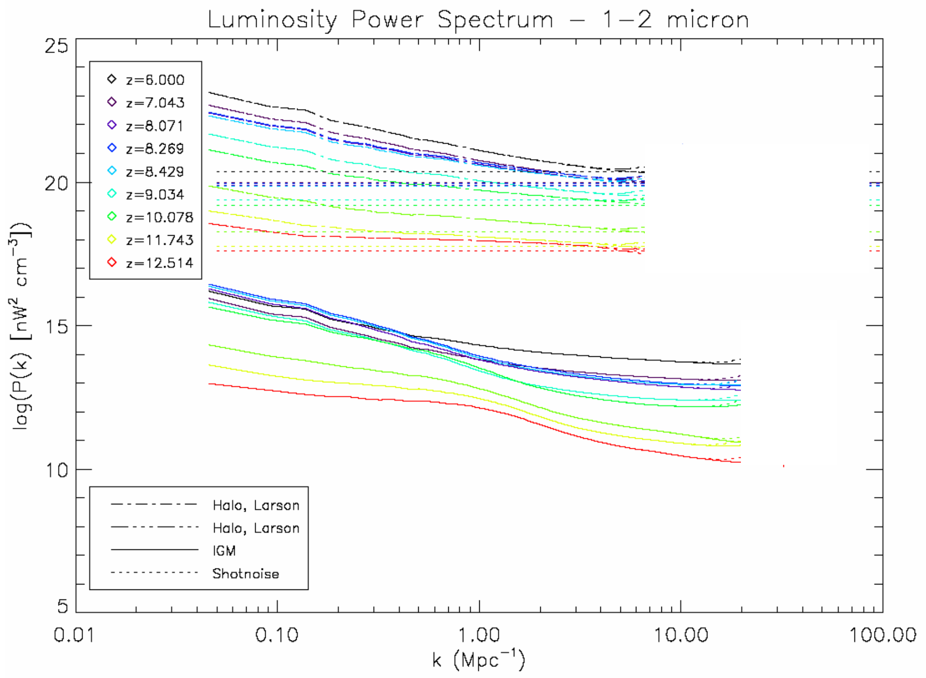
Luminosity Density from the HII Regions in the IGM

- Escaped ionizing photons produce emission in the HII region
- Free-free and free-bound $$\epsilon_\nu = 4\pi n_H^2 X_e^2 \gamma_c \frac{e^{-h\nu/kT_g}}{T_g^{1/2}}$$
- Two photon emission $$\epsilon_\nu = 2h\frac{\nu}{\nu_{Ly\alpha}} P(y)(1 - f_{Ly\alpha)}\alpha_B n_H^2 X_e^2$$
- Lyman-α $$\epsilon_\nu = f_{Ly\alpha} h\nu_{Ly\alpha} n_H^2 X_e^2 \alpha_B \phi(\nu - \nu_{Ly\alpha})$$



The Luminosity Power Spectrum

- Halo power greater than HII regions
- Higher power from heavier stars
- Power increases as $X_e = 0.5$

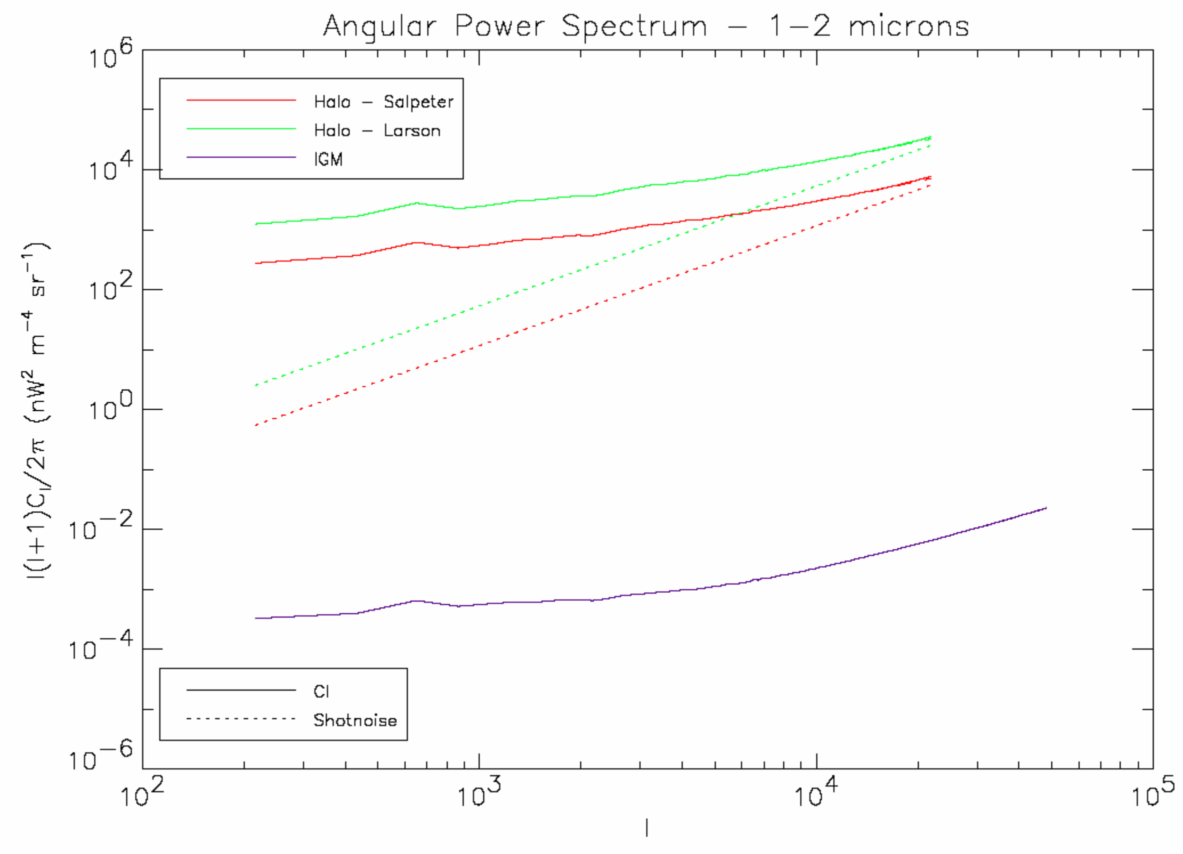


The Angular Power Spectrum

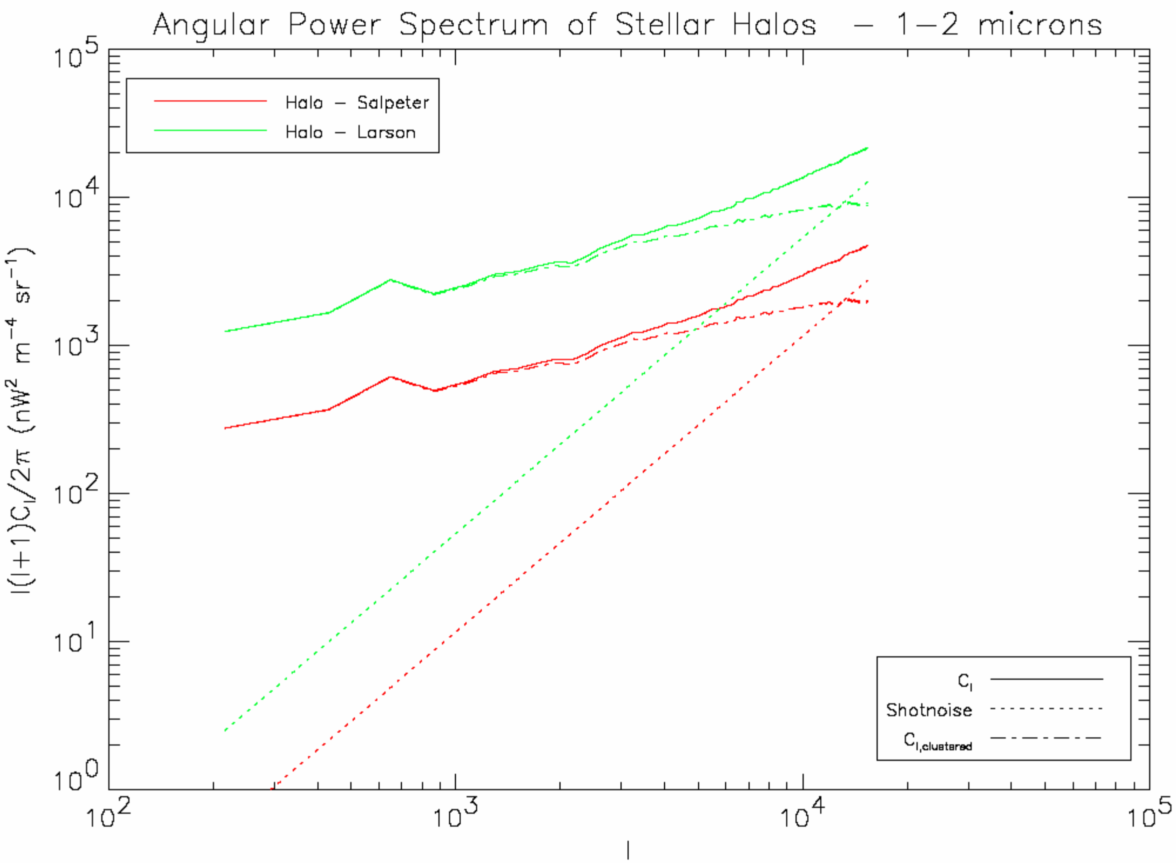
- What we actually observe – integrated over a range of redshifts

$$C_l = \int dz \frac{dr}{dz} \frac{a(z)^2}{r(z)^2} P_L(k = \frac{l}{r(z)}; z)$$

The Angular Power Spectrum



The Angular Power Spectrum



Conclusions

- Fluctuations are easier to observe than mean intensity!
- Fluctuations from halos greatly outweigh that of HII regions
- Large scale observations (~1 degree) will minimize shotnoise component