Luminosity Density of Star-Forming Galaxies

Giavalisco et al. 2004

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Outline

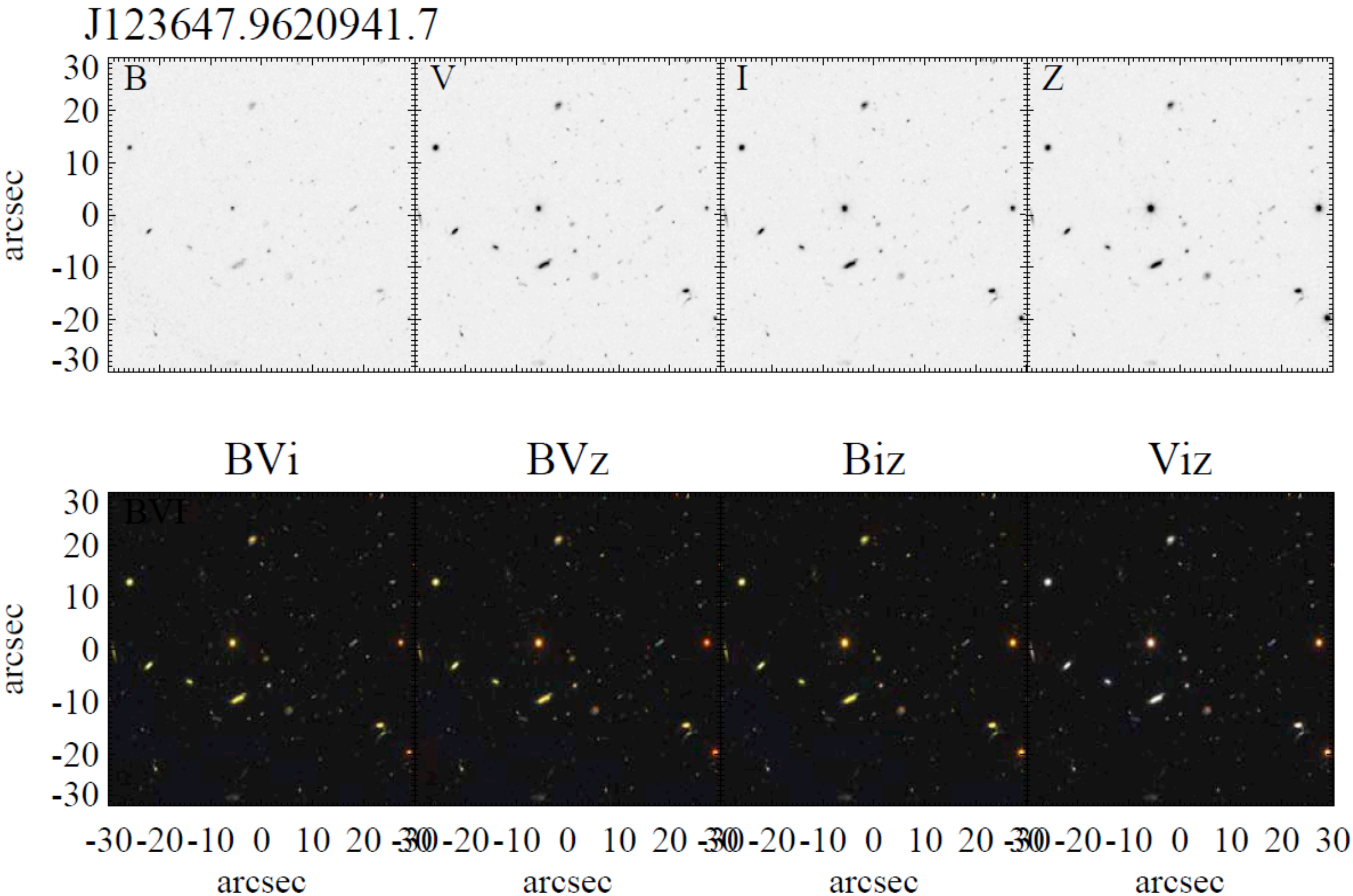
- Review of Lyman Break Galaxies
- HST data used for the survey
  - Data spans redshift: z~3 to z~6
- The methods used for selecting LBGs
- Calculation of the Specific Luminosity Density
- Conclusions of this paper

LBGs

- Galaxies at very high red shift
- They are normal galaxies, not quasars
  - They are not extremely luminous
- Characterized by non-detection in certain bands, depending on red shift
- Good indicators for star formation

The Data

- Deep, multiband HST observations
  - Using the Advanced Camera for Surveys (ACS)
  - B,V,i,z filters were used
- Can detect galaxies up to z ~ 6.5
  - Up to z(850 nm) ~ 26.
  - Up to $(0.2)L^*_3$
- Large area of coverage
  - 316 arcmin^2


J123647.9620941.7
B
V
I
Z
BVi
BVz
Biz
Viz
BVI
arcsec
30
20
10
0
-10
-20
-30

Selecting LBGs from Data

- At z ~4 (B band drops) color for LBGs is:

$$(B_{450} - V_{606}) \geq 1.2 + 1.4 \times (V_{606} - z_{850}) \;\wedge$$

$$(B_{450} - V_{606}) \geq 1.2 \;\wedge\; (V_{606} - z_{850}) \leq 1.2,$$

- At z~5 (V band drops) color for LBGs is:

$$[(V_{606} - i_{775}) > 1.5 + 0.9 \times (i_{775} - z_{850})] \;\vee$$

$$[(V_{606} - i_{775}) > 2.0] \;\wedge\; (V_{606} - i_{775}) \geq 1.2 \;\wedge$$

$$(i_{775} - z_{850}) \leq 1.3,$$

- At z~6 (i band drops out): (i-z) $\geq$ 1.3

Selecting LBGs from Data Cont.

- They also require non-detections for shorter bands in z~5 and z~6
- They visually inspected data, removing artifacts
- Required that all galaxies have S/N >5 in z

Specific Luminosity Density

- Used Monte Carlo sim. to find redshift distribution function for the first two samples

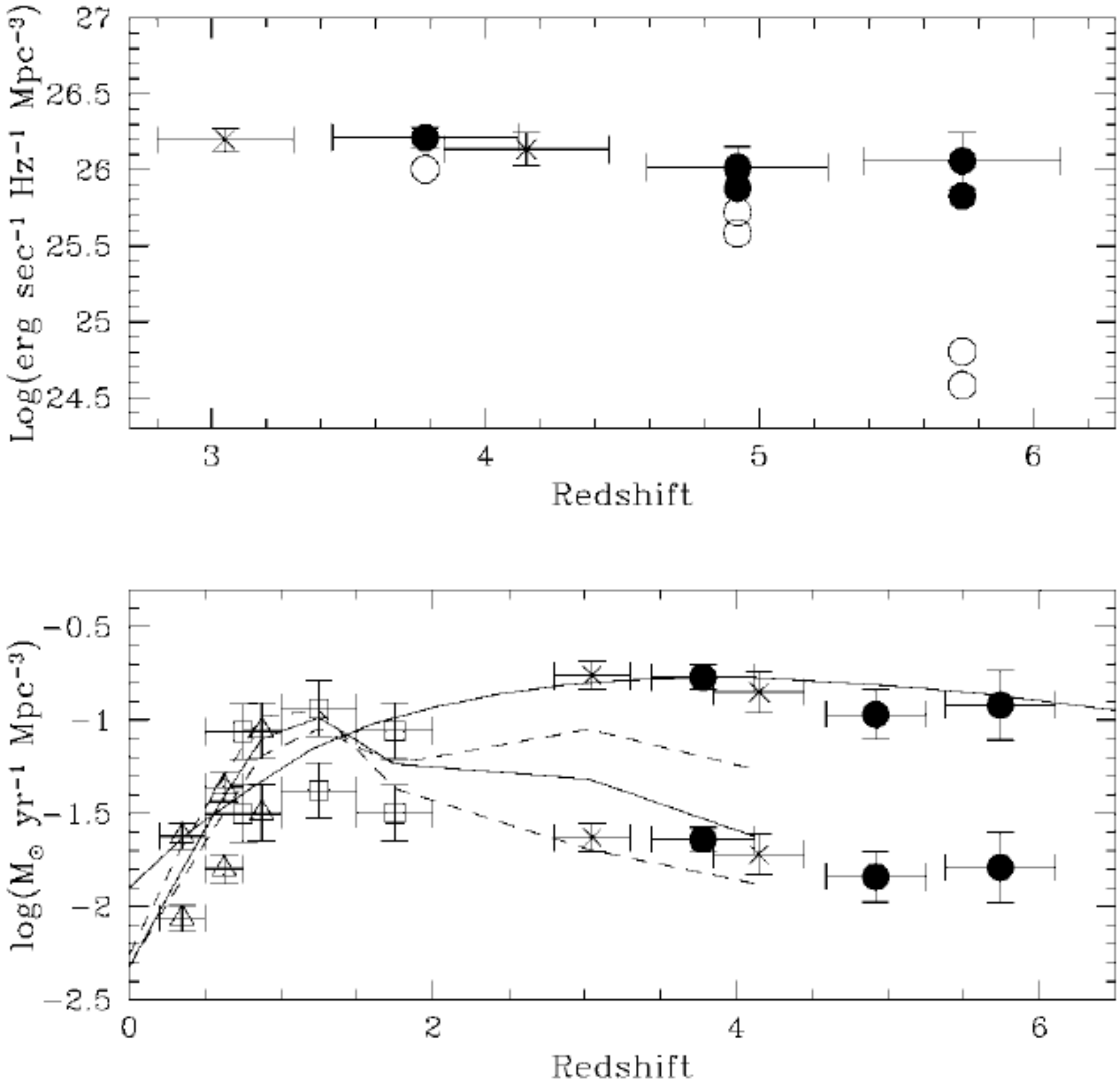
$$d\mathcal{L}(m) = n(m)L(m,\ \bar{z})V_{\text{eff}}^{-1}\ (m)\ \ dm,$$

$$V_{\text{eff}}(m) = \int \int p(M,\ z,\ m)\ dM \frac{dV(z)}{dz}\ \ dz.$$

  - P is prob. that LBG with M at z has m
  - zbar is average redshift of simulated Gal
  - n(m) # of LBGs observed with m
  - L(m,zbar) is specific luminosity density of a LBG

Specific Luminosity Density for z~6

- Veff method underestimates for i dropout
  - m corresponds to a wide range of M
- For z~6: $\mathcal{L} = \int L\phi(M)\,dM$
  - $\phi(M)$ is the intrinsic luminosity function of the simulated galaxies
- They found:
  - z_B = 3.78 (stdev = 0.34) so z ~4
  - z_v = 4.92 (stdev = 0.33) so z~5
  - z_i = 5.74 (stdev = 0.36) so z~6



Log(erg sec⁻¹ Hz⁻¹ Mpc⁻³)
27
26.5
26
25.5
25
24.5
3
4
5
6
Redshift
log(M☉ yr⁻¹ Mpc⁻³)
−0.5
−1
−1.5
−2
−2.5
0
2
4
6
Redshift

Conclusions from Paper

- They summed it up best:

  "If the dust obscuration properties of LBGs are similar to local starburst galaxies … and do not significantly change $3<z<6.5$, then star formation activity decreases very mildly with increasing redshift…"

- Major cosmic star formation started before $z=6$