THE SIZES OF Z ~ 6-8 LENSED GALAXIES FROM THE HUBBLE FRONTIER FIELDS DATA OF ABELL 2744

Kawamata+15, ApJ, in press (astro-ph/1410.1535)





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OUTLINE

Measurements of sizes and magnitudes

Results

Properties of z~6-8 galaxies

The redshift evolution of sizes and its implication for disk formation and evolution

PREVIOUS SAMPLES OF Z~7 & 8^{1/13} BY ACCURATE 2D FIT ARE SMALL

from HUDF12



Ono+13

PREVIOUS SAMPLES OF Z~7 & 8¹⁷¹³ BY ACCURATE 2D FIT ARE SMALL

from HUDF12+HFF



Kawamata+15

HUBBLE FRONTIER FIELDS PI: J. Lotz

Deep and high-resolution observations by HST + Strong gravitational lensing by clusters



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ABELL 2744 DATA

Brighter galaxies from the samples in Ishigaki, RK+2015 31 galaxies at Z~6-7 (i-drop) 8 galaxies at Z~8 (Y-drop)



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MASS MODEL CONSTRUCTION^{4/13}

glafic (Oguri 2010)

- Parametric modeling method
- Mass components
 - Cluster dark halos:
 NFW profiles
 - Member galaxies:
 elliptical pseudo-Jaffe models
 External shear
- 24 sets of multiple images



SIZE MEASUREMENT

Fit galaxy light profiles with lensed and distorted Sérsic profiles.

Observed Image







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SIZE-LUMINOSITY RELATION 6/13



Positive but weak correlation

 Large scatter as expected from the simulated halo spin parameters

DEPENDENCE ON COLOR & MULTIPLICITY



Largest galaxies are mostly red and smallest galaxies are mostly blue.
Galaxies with multiple cores (□, ◊) are bright.

COMPARISON WITH NEARBY GALAXIES



They show similar SFs to the center regions of circumnuclear galaxies where gases are fed along bars

They show similar SFRSDs to clumps in $z\sim2$ SFGs, but are smaller in size

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PREVIOUS INTERPRETATION ⁹⁷



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Assumption:

the half-light radius scales with the virial radius

One can get information on what halos are traced



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PREVIOUS INTERPRETATION 9/13

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Based on the unconfirmed assumption.
 No absolute value for M_{vir} discussed.

ESTIMATING HALO RADII FROM MUV



ESTIMATING HALO RADII FROM MUV



The size ratio of disk to halo is constant at 3.3% over $z\sim2.5-9.5$.

DISK FORMATION MODEL

$$M_{o} + 1998$$

$$\frac{r_{e}}{r_{vir}} = \frac{1.678}{\sqrt{2}} \left(\frac{j_{d}}{m_{d}}\lambda\right) f_{c}(c)^{-1/2} f_{R}(j_{d}/m_{d}, m_{d}, \lambda, c)$$

j_d: angular momentum ratio of disk to halo m_d: mass ratio of disk to halo

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- λ : spin parameter of halo
- c: concentration parameter of halo

 λ and c are well determined by N-body simulations. (e.g. Bullock+01)

■ jd and md depend on baryonic physics and are not reliably predicted.





The observed size ratio is consistent with $j_d/m_d = 1$

SUMMARY

- Measured sizes of 31 z~6-7 and 8 z~8 lensed galaxies using our own mass map
- The ratio of half-light radius to virial radius is constant at 3.3%, which is consistent with $j_d/m_d = 1$
- Positive but weak correlation between r_{e} and L_{UV}
- Largest galaxies are red, and smallest galaxies are blue
- Galaxies with multiple cores are bright
- Their SFs are similar to those of circumnuclear galaxies

FUTURE WORK

Measure sizes of ~200 z~6-7 and ~50 z~8 galaxies with the complete 6-cluster data

Measure sizes of low-z galaxies with the HFF data