The sizes of $z \sim 6-8$ lensed galaxies from the Hubble Frontier Fields Abell 2744 data

Ryota Kawamata[1], Masafumi Ishigaki[2,3], Kazuhiro Shimasaku[1,4], Masamune Oguri[2,4,5], Masami Ouchi[3,5]

[1] *Department of Astronomy, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*
[2] *Department of Physics, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*
[3] *Institute for Cosmic Ray Research, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8582, Japan*
[4] *Research Center for the Early Universe, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*
[5] *Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU, WPI), The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8583, Japan*

Abstract

We investigate sizes of $z \sim 6-8$ dropout galaxies using the complete data of the Abell 2744 cluster and parallel fields in the Hubble Frontier Fields program (HFF; PI: J. Lotz). HFF is a project to conduct deep imaging observations of 6 high-magnification clusters aiming at probing faint high-redshift galaxies behind these clusters. Thanks to strong magnification by cluster lensing combined with very deep exposures, the data enable us to detect $z \sim 6-8$ galaxies as faint (in intrinsic luminosity) as those from the HUDF12 data. By directly fitting light profiles of observed galaxies with lensing-distorted Sérsic profiles on the image plane with the `glafic` software, we accurately measure intrinsic sizes of 31 $z \sim 6-7$ and eight $z \sim 8$ galaxies, including those as faint as $M_{\rm UV} \simeq -17$. We find that half-light radii $r_{\rm e}$ positively correlates with UV luminosity at each redshift, although the correlation is not very tight. Largest ($r_{\rm e} > 0.8$ kpc) galaxies are mostly red in UV color while smallest ($r_{\rm e} < 0.05$ kpc) ones tend to be blue. We also find that galaxies with multiple cores tend to be brighter. Combined with previous results at $2.5 \leq z \leq 12$, our result confirms that the average $r_{\rm e}$ of bright ($(0.3-1)L^{\star}_{z=3}$) galaxies scales as $r_{\rm e} \propto (1+z)^{-m}$ with $m = 1.31 \pm 0.1$. We find that the ratio of $r_{\rm e}$ to virial radius is virtually constant at $3.5 \pm 0.1\%$ over a wide redshift range, where the virial radii of hosting dark matter halos are derived based on the abundance matching. This constant ratio is consistent with the disk formation model by Mo et al. (1998) with $j_{\rm d} \sim m_{\rm d}$, where $j_{\rm d}$ and $m_{\rm d}$ are the fractions of the angular momentum and mass within halos confined in the disks.