THE SIZES OF MASSIVE QUIESCENT AND STAR FORMING GALAXIES AT Z ∼ 4 WITH ZFOURGE[11] AND CANDELS

Caroline M. S. Straatman[1,2], Ivo Labbé[2], Lee R. Spitler[3,4], Karl Glazebrook[5], Adam Tomczak[6], Rebecca Allen[5], Gabriel B. Brammer[7], Michael Cowley[3,4], Pieter van Dokkum[8], Glenn G. Kacprzak[5], Lalit Kawinwanichakij[6], Nicola Mehrtens[6], Themiya Nanayakkara[5], Casey Papovich[6], S. Eric Persson[9], Ryan F. Quadri[6], Glen Rees[4], Vithal Tilvi[6], Kim-Vy H. Tran[6], Katherine E. Whitaker[10]

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ABSTRACT

We study the rest-frame ultra-violet sizes of massive ($\sim 0.8 \times 10^{11} M_{\odot}$) galaxies at $3.4 \leq z < 4.2$, selected from the FourStar Galaxy Evolution Survey (ZFOURGE), by fitting single Sérsic profiles to HST/WFC3/F160W images from the Cosmic Assembly Near-Infrared Deep Extragalactic Legacy Survey (CANDELS). Massive quiescent galaxies are very compact, with a median circularized half-light radius $r_e = 0.63 \pm 0.18$kpc. Removing 5/16 (31%) sources with signs of AGN activity does not change the result. Star-forming galaxies have $r_e = 2.0 \pm 0.60$kpc, $3.2 \pm 1.3\times$ larger than quiescent galaxies. Quiescent galaxies at $z \sim 4$ are on average $6.0 \pm 1.7\times$ smaller than at $z \sim 0$ and $1.9 \pm 0.7\times$ smaller than at $z \sim 2$. Star-forming galaxies of the same stellar mass are $2.4 \pm 0.7\times$ smaller than at $z \sim 0$. Overall, the size evolution at $0 < z < 4$ is well described by a powerlaw, with $r_e = 5.08 \pm 0.28(1+z)^{-1.44\pm0.08}$kpc for quiescent and $r_e = 6.02 \pm 0.28(1+z)^{-0.72\pm0.05}$kpc for star-forming galaxies. Compact star-forming galaxies are rare in our sample: we find only $1/14 \Rightarrow 7\%$ with $r_e/(M/10^{11}M_{\odot})^{0.75} < 1.5$, whereas $13/16 \Rightarrow 81\%$ of the quiescent galaxies is compact. The number density of compact quiescent galaxies at $z \sim 4$ is $1.8 \pm 0.8 \times 10^{-5}$Mpc^{-3} and increases rapidly, by $> 5\times$, between $2 < z < 4$. The paucity of compact star-forming galaxies at $z \sim 4$ and their large rest-frame ultra-violet median sizes suggest that the formation phase of compact cores is very short and/or highly dust obscured.

イントロダクション

- z~4のquiescent、star-formingのrest-frame UVでのr_eを調査
- quiescentは非常にcompact、star-formingはextended
- z~4からz~2にかけてquiescentの数密度は5倍以上に

サンプル

- ZFOURGEサーベイで見つかった銀河のうち、HST/WFC3/F160W from CANDELSでカバーされているもの
- $3.4 \leq z \leq 4.2$、$\log(M/M_{sun}) \geq 10.55$、$K_s$バンドでのSNR>7
- 16個のquiescent、14個のstar-forming
- Sersic profileでのfittingとGALFIT(Peng et al. 2010)によりr_eを決定

Fig. 2 有効半径の比較

Star-formingはquiescentの3倍程度

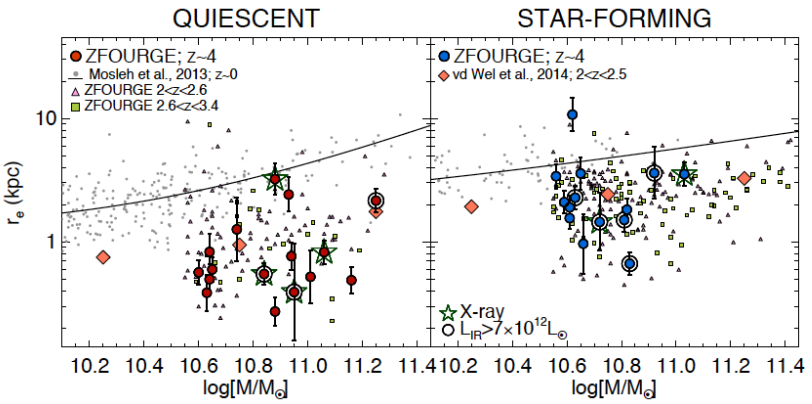


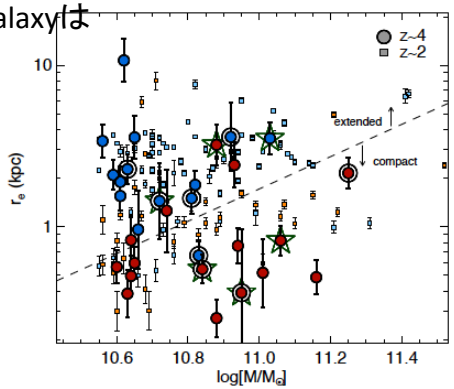
FIG. 2.— Circularized effective radius for galaxies at $z \sim 4$. In purple and green we show our control sample at $2 \leq z < 2.6$ and $2.6 \leq z < 3$ and in orange the median of van der Wel et al. (2014) at $2 < z < 2.5$. The black solid line is the $z \sim 0$ relation of Mosleh et al. (2013). X-ray detections and bright 24μm sources are indicated with stars and open circles. The median sizes are $r_e = 0.63 \pm 0.18$kpc (quiescent galaxies) and $r_e = 2.0 \pm 0.60$kpc (star-forming galaxies).

Fig. 3.1 有効半径と質量の関係

点線はcompactnessの指標：$r_e/(M/10^{11}M_{sun})^{0.75}=1.5$ (van der Wel et al. 2014)

z~4においてcompactなstar-forming galaxyはほとんどない

→単純にこれらの星形成shutdownによってquiescentができるという考え方では、2<z<4での数密度変化を説明できない



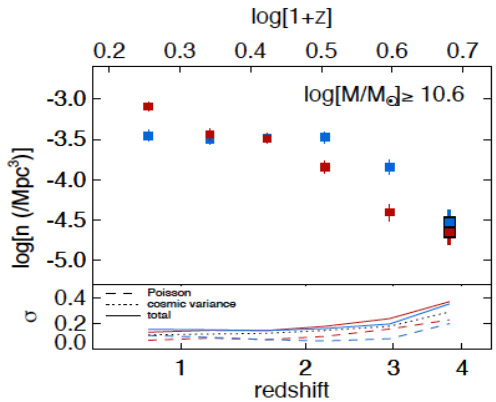


Fig. 4.2 redshiftと数密度

2<z<4あたりで数密度が急激に変化

→quiescent形成を理解するために重要な時代？

結論

- 同質量のtypicalなstar-forming galaxyが星形成を止めてquiescentになるとは考えづらい
- Quiescent galaxyのdense coreは中心部でのstarburstにより形成された可能性
- Dustのobscuringによって有効半径を過大評価している可能性もある