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Insights on the Formation, Evolution, and Activity of Massive Galaxies From Ultra-Compact and Disky Galaxies at z=2-3

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We present our results on the structure and activity of massive galaxies at z=1-3 using one of the largest (166 with M_star>=5e10 M_sun) and most diverse samples of massive galaxies derived from the GOODS-NICMOS survey: (1) Sersic fits to deep NIC3/F160W images indicate that the rest-frame optical structures of massive galaxies are very different at z=2-3 compared to z~0. Approximately 40% of massive galaxies are ultra-compact (r_e<=2 kpc), compared to less than 1% at z~0. Furthermore, most (~65%) systems at z=2-3 have a low Sersic index n<=2, compared to ~13% at z~0. We present evidence that the n<=2 systems at z=2-3 likely contain prominent disks, unlike most massive z~0 systems. (2) There is a correlation between structure and star formation rates (SFR). The majority (~85%) of non-AGN massive galaxies at z=2-3, with SFR high enough to yield a 5 sigma (30 micro Jy) 24 micron Spitzer detection have low n<=2. Such n<=2 systems host the highest SFR. (3) The frequency of AGN is ~40% at z=2-3. Most (~65%) AGN hosts have disky (n<=2) morphologies. Ultra-compact galaxies appear quiescent in terms of both AGN activity and star formation. (4) Large stellar surface densities imply massive galaxies at z=2-3 formed via rapid, highly dissipative events at z>2. The large fraction of n<=2 disky systems suggests cold mode accretion complements gas-rich major mergers at z>2. In order for massive galaxies at z=2-3 to evolve into present-day massive E/S0s, they need to significantly increase (n, r_e). Dry minor and major mergers may play an important role in this process.

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