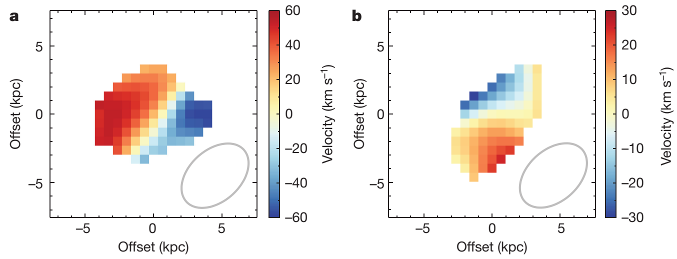

Figure 3 | Velocity structure of the detected [C II] emission in COS-3018555981 and COS-2987030247. a, b, Velocity fields measured in COS-3018555981 (**a**) and COS-2987030247 (**b**). The observations are spatially resolved, as shown by the beam size of the observations (grey ellipses), and reveal a projected velocity difference over the galaxies of $111 \pm 28\,\mathrm{km\,s^{-1}}$ and $54 \pm 20\,\mathrm{km\,s^{-1}}$, respectively. Given the low angular resolution of the observations, we could interpret the velocity gradients as disk rotation or alternatively perhaps as a merging system with two or more velocity components.

our galaxies with that measured through Hα emission for galaxies at redshifts of around 1 to 3 (ref. 25). Although our sources are an order of magnitude smaller in terms of stellar mass, and at an epoch 2.5 billion years earlier in cosmic time, we find $\Delta v_{\mathrm{obs}}/2\sigma_{\mathrm{tot}}$ values of 0.57 ± 0.16 and 0.52 ± 0.21 for COS-3018555981 and COS-2987030247—similar to the values for the turbulent yet rotationally supported galaxy disks at redshifts of about 2 (ref. 25). Assuming a circularly symmetric galaxy disk model, we estimate dynamic masses, M_{dyn}, of $1.0^{+0.3}_{-0.2} \times 10^{10} M_{\odot}$ and $0.4^{+0.9}_{-0.3} \times 10^{10} M_{\odot}$ for COS-3018555981 and COS-2987030247, respectively. (Note, however, that the influence of turbulence in these sources could increase the dynamic mass estimates, although by at most a factor of two.) Therefore, these sources have around four to ten times less mass than the bright, UV-selected sources observed recently at redshifts of around 5 to 6 (corresponding to just 200–300 million years later in cosmic time[16]), which otherwise appear similar in their [C II] and infrared properties (Fig. 2). Furthermore, the stellar mass in our sources makes up about 14% and 43% of the total dynamic mass that we measure (Fig. 4), in good

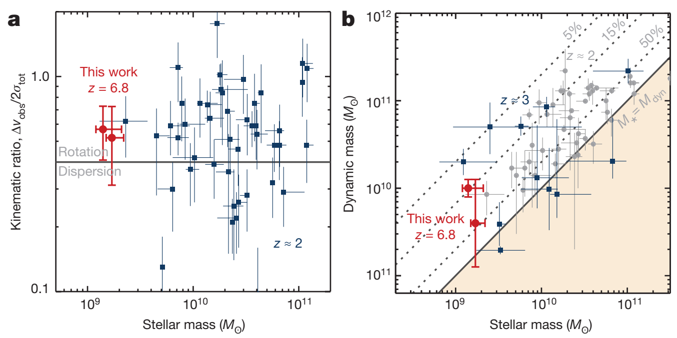

Figure 4 | Dynamic classification and masses of galaxies with redshifts of around 2 or more. a, The observed kinematic ratio of the projected velocity range of a galaxy over the velocity dispersion of the system ($\Delta v_{\mathrm{obs}}/2\sigma_{\mathrm{tot}}$) as a function of stellar mass, for COS-3018555981 and COS-2987030247 (red points), and for Hα-emitting galaxies from the SINS[25] spectroscopy survey at redshifts of about 2 (blue squares). Galaxies with $\Delta v_{\mathrm{obs}}/2\sigma_{\mathrm{tot}}$ ratios of more than 0.4 are classified as probable rotation-dominated systems, while sources with $\Delta v_{\mathrm{obs}}/2\sigma_{\mathrm{tot}}$ ratios of less than 0.4 are probably dispersion-dominated (demarcated by the grey line)[25]. **b**, Dynamic (total) mass within a roughly 2-kpc half-light radius (assuming a circularly symmetric thin-disk model) is plotted against stellar mass for our sources (red points). Grey dotted lines indicate stellar mass as a fraction of total dynamic mass; the stellar-mass fractions of 14% and 43% for COS-3018555981 and COS-2987030247 are in good agreement with the range of values found for galaxies in the AMAZE survey[26] at redshifts of about 3 (blue squares) and in the SINS survey[25] for redshifts of about 2 (grey points). Error bars represent 1σ.

agreement with the 33% stellar mass estimated for the UV-selected sources at redshifts of about 5–6 (ref. 16), and consistent with the wide range of values observed for star-forming galaxies at redshifts of around 1–3 (refs 25, 26). These results indicate a substantial gas fraction in the inner few kiloparsecs of our galaxies, consistent with hydrodynamic simulations of star-forming galaxies at this epoch[27].

Online Content Methods, along with any additional Extended Data display items and Source Data, are available in the online version of the paper; references unique to these sections appear only in the online paper.

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