X37a Rotating Disk at z=10.6 Revealed by JWST Integral Field Spectroscopy

Yi Xu (UTokyo), Masami Ouchi (UTokyo/NAOJ), Hidenobu Yajima, Hajime Fukushima (Tsukuba University), Yuichi Harikane, Yoshiaki Ono, Hiroya Umeda, Hiroto Yanagisawa, Minami Nakane (UTokyo), Kimihiko Nakajima, Yechi Zhang (NAOJ), Yuki Isobe (Waseda)

We investigate the dynamics of GN-z11, a luminous galaxy at $z = 10.60$, by analyzing the public deep integral field spectroscopy (IFS) data taken with JWST NIRSpec IFU. While the observations of the IFS data originally targeted a He II clump near GN-z11, we find that C III]$\lambda\lambda$1907,1909 emission from ionized gas at GN-z11 is bright and spatially extended significantly beyond the point-spread function (PSF) in contrast with the GN-z11's compact UV-continuum morphology. The spatially extended C III] emission of GN-z11 shows a velocity gradient, red- and blue-shifted components in the NE and SW directions, respectively, which cannot be explained by the variation of [C III]λ1907/C III]λ1909 line ratios. We perform forward modeling with GalPak^{3D} and find that the best-fit model is a nearly edge-on disk with a rotation velocity of $v_{\rm rot} = 376$ km s^{-1}, a velocity dispersion of $\sigma_v = 113$ km s^{-1}, and a ratio of $v_{\rm rot}/\sigma_v = 3.3$, indicative of a rotation-dominated disk at $z = 10.6$. Interestingly, the disk rotation velocity is faster than the circular velocity at the virial radius, suggesting a compact disk produced under weak feedback such predicted in numerical simulations. While higher S/N data are necessary for a conclusion, these observational results would suggest that GN-z11 has a fast-rotating gaseous disk whose center possesses luminous stellar components or AGN providing weak feedback.