

Challenging the AGN scenario for JWST/NIRSpec broad H α emitters/Little Red Dots in light of non-detection of NIRCам photometric variability and X-ray

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JWST has uncovered a substantial population of high- z ($z > 4$) galaxies exhibiting broad H α emission line with a Full Width at Half Maximum exceeding 1,000 km/s. This population includes a subset known as ‘Little Red Dots’, characterized by their compact morphology and extremely red rest-frame optical colors. If all of these broad H α emitters were attributed to type 1–1.9 Active Galactic Nuclei (AGNs), it would imply a significantly higher number density of low-luminosity AGNs than extrapolated from that of more luminous AGNs. Here, we have examined the rest-frame ultraviolet (UV)–optical flux variability of five JWST broad H α emitters using multi-epoch, multi-band JWST/NIRCам imaging data. The rest-frame temporal sampling interval of the NIRCам data ($\sim 400\text{--}500$ days/($1+z$)) is comparable to typical variability timescales of AGNs with black hole (BH) masses of $M_{\text{BH}} \sim 10^7 M_{\odot}$; thus, the flux variations should be detectable if AGNs were present. However, no measurable flux variation over the rest-frame wavelength range of $\lambda_{\text{rest}} \sim 1,500\text{--}9,000\text{\AA}$ has been detected, placing stringent upper limits on the variability amplitudes. This result, combined with the X-ray faintness confirmed by the ultra-deep Chandra data, indicates that, under the AGN scenario, we need to postulate peculiar Compton-thick broad-line AGNs with either (a) an intrinsically non-variable AGN disk continuum, (b) a host galaxy-dominated continuum, or (c) scattering-dominated AGN emission. Alternatively, (d) they could be non-AGNs where the broad-line emission originates from unusually fast and dense/low-metallicity star-formation-driven outflows or inelastic Raman scattering of stellar UV continua by neutral hydrogen atoms.

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