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

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JWST has uncovered a substantial population of high-z (z>4) galaxies exhibiting broad Hα 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 Hα 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 Hα emitters using multi-epoch, multi-band JWST/NIRCam imaging data. The rest-frame temporal sampling interval of the NIRCam data (~400–500 days/(1+z)) is comparable to typical variability timescales of AGNs with black hole (BH) masses of M_BH~10^7 M⊠; thus, the flux variations should be detectable if AGNs were present. However, no measurable flux variation over the rest-frame wavelength range of λ_rest ~ 1,500–9,000Å 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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