X02a The Age of Discovery with the James Webb Space Telescope: Excavating the Spectral Signatures of the First Massive Black Holes

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The James Webb Space Telescope (JWST) will open a new window into the most distant universe and unveil the early growth of supermassive black holes (BHs) in the first galaxies. We model the spectral energy distribution (SED) of rapidly accreting BHs in metal-poor galaxies at $z > 8$, applying postprocess line transfer calculations to radiation hydrodynamical simulation results. Here, we focus on the phase where a nuclear seed BH with initial mass of $10^5\ M_\odot$ is fed with a dense gaseous disk embedded in bulge stars with a total mass of $M_\star \gtrsim 100\ M_\bullet$ and grows in mass nearly tenfold within ~ 2 Myr. We find that exposures of 10ks with the NIRCam and MIRI broad-band filters are sufficient to detect the radiation flux from the seed BHs with bolometric luminosities of $L_{\rm bol} \simeq 10^{45}$ erg s^{-1}. While the continuum colors are similar to those of typical low-z quasars, strong Hα line emission with a rest-frame equivalent width $\mathrm{EW_{rest}} \simeq 1300$ Å is so prominent that the line flux affects the broad-band colors significantly. The unique colors, for instance F356W$-$F560W $\gtrsim 1$ at $7 < z < 8$ and F444W$-$F770W $\gtrsim 1$ at $9 < z < 12$, provide robust criteria for photometric selection of the rapidly growing seed BHs. Moreover, NIRSpec observations of low-ionization emission lines can test whether the BH is fed via a dense accretion disk at super-Eddington rates. Finally, we discuss a candidate of a super-Eddington accreting BH with $\sim 10^6\ M_\odot$, which was selected from the first near-infrared images of the JWST CEERS project based on the SED fitting analysis.