X55b A Nitrogen-enriched, dust-reddened quasar at z=6 revealed by JWST/NIRSpec and Keck/MOSFIRE

Yuki Kaneko, Masafusa Onoue (Waseda.U), Kohei Ichikawa (Tohoku.U), Yoshiki Matsuoka (Ehime.U)

The unprecedented sensitivity of the James Webb Space Telescope (JWST) has revealed a significant population of mildly dust-obscured ($0 < A_{\rm V} < 3$ mag), low-luminosity ($M_{\rm UV} > -21$ mag) AGNs. However, the connection between these objects and classical unobscured quasars remains unclear. Moreover, JWST observations challenge the long-standing paradigm of chemical evolution. The number of nitrogen-enriched high-redshift objects has increased thanks to JWST discoveries, yet its origin remains uncertain. We present the dust-reddened quasar J020719.59+023826.0 at $z = 6.14$, initially identified by a wide-field survey of Subaru Hyper Suprime-Cam. JWST/NIRSpec spectroscopy of it revealed broad Balmer emission lines with single-epoch black hole mass of $M_{\rm BH} = 9.55 \times 10^7\,M_\odot$. From the Balmer decrements we derive a mild dust obscuration of $A_{\rm V} = 0.28 \pm 0.10$ mag, confirming that J0207+0238 is a dust-reddened quasar. Furthermore, Keck/MOSFIRE spectroscopy detected a narrow N IV] $\lambda 1483, 1486$ doublet emission with equivalent width of $\mathrm{EW}_{\mathrm{N\,IV]}\lambda 1486} = 796$ Å, indicating a pronounced overabundance with $\log(\mathrm{N}^{3+}/\mathrm{O}^{2+}) = 0.44 > \log(\mathrm{N/O})_\odot = -0.86$. It also shows sub-solar metallicity of $12 + \log(\mathrm{O}^{2+}/\mathrm{H}^{+}) = 7.49$. This suggests that, despite its high redshift, the narrow-line region (NLR) or the surrounding gas of this object is significantly nitrogen-enriched, and further point to a scenario that energetic quasar activity contributes to the N IV] excess observed in many JWST galaxies.