Z133a Deep Near-Infrared Spectroscopy of a $z = 7.54$ Quasar, ULAS J1342+0928

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Previous studies of high-redshift quasars showed that the mass assembly and the chemical enrichment of the broad line region (BLR) gas are rapid processes, as there exist $M_{\rm BH} > 10^9 M_\odot$ super massive black holes (SMBHs) and there is no redshift evolution in the BLR metallicity down to $z \sim 7$ (e.g., De Rosa et al. 2014, ApJ, 790, 145; Wu et al. 2015, Nature, 518, 512). We present our recent near-infrared spectroscopic observations of ULAS J1342+0928 at $z = 7.54$ (Bañados et al. 2018, Nature, 553, 473). From a 9-hour Gemini/GNIRS spectrum covering $\lambda_{\rm rest} = 970$–2930Å, various broad emission lines were detected such as CIV λ1549, MgII λ2798, and iron pseudo continuum. Our MgII-based mass measurement confirmed that this quasar is powered by a $9 \times 10^8 M_\odot$ SMBH accreting at the Eddington limit. We also found that the BLR lines of ULAS J1342+0928 are characterized by extreme blueshifts up to 6000 km s^{-1} with respect to [CII] 158μm redshift, indicating exotic nuclear-scale outflows. There is no significant difference in the line flux ratios such as SiIV/CIV and CIII]/CIV when compared to lower-redshift quasars. This is also the case for FeII/MgII, albeit systematic uncertainties are large, while supernovae nucleosynthesis models predict delayed iron enrichment in the early universe. We also took a deep VLT/XSHOOTER spectrum of ULAS J1342+0928, from which seven MgII and one CIV metal absorption systems were identified down to $z = 6.84$ in the line of sight. The $z \gtrsim 6$ systems significantly lack high ionization ions based on their column densities of CII and CIV. Therefore, our result suggests a clear redshift evolution of the metallicity and ionization hardness of the absorption systems.