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Metallicity and black hole masses of $z \simeq 6$ quasars

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Abstract. We present NIR spectroscopy of emission lines of a sample of five $z \simeq 6$ quasars, including fainter objects than observed before. The measured Fe II / Mg II ratios are around solar and consistent with a lack of evolution of the metallicity of quasar BLRs up to $z \simeq 6$, suggesting that stars in their hosts formed at $z \gg 6$. The BH masses, measured from both Mg II and C IV line widths are within the range $2\text{-}16 \times 10^8$ $M_\odot$, the smallest found in such distant objects.

Keywords. galaxies: high-redshift, galaxies: fundamental parameters, galaxies: abundances

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Quasars at $z \simeq 6$ provide direct probes of galaxy hosts and the IGM close to the epoch of reionization. In the last few years, more than twenty such objects at $z > 5.7$ have been discovered. We have selected five of these for follow-up NIR spectroscopy. The sample (J0836+0054, J1030+0524, J1306+0356, J0005−0006, and J1411+1217, see Fan *et al.* 2001, 2004) contains all published quasars observable by the VLT with $z > 5.8$ and includes quasars with magnitudes in the range $18.7 < i^* < 20.5$ at $5.8 < z < 6.3$, extending this kind of research by about a factor two down the luminosity function (e.g., Maiolino *et al.* 2004). Observations were carried out with VLT-ISAAC in low resolution mode in the SZ-, J- and K-bands with exposure times of one to three hours per spectrum. The emission lines were fitted by a Gaussian curve (Mg II), Lorentzian curve (C IV) or iron template (Fe II, from Vestergaard & Wilkes 2001), while the underlying continuum was fitted by a power law. In the region around 3000 Å, the Balmer pseudo-continuum was modeled. The measured Fe II / Mg II ratios are in the range 2.2 - 4.7, consistent with those found in lower redshift quasars. Applying the relations found by McLure & Jarvis (2002) and Vestergaard (2002) to the width of the Mg II and C IV lines and the continuum fluxes at $\lambda_0 = 3000$ Å and 1350 Å, respectively, we find black hole (BH) masses of 2, 3, 12, 13 and 16×10^8 $M_\odot$. These results imply that the metallicity of BLRs in quasars does not evolve up to $z \simeq 6$, suggesting a period of intense star formation at $z > 10$ in the host galaxy. We also find that quasars at $z \simeq 6$ do no only contain BHs more massive than 10^9 $M_\odot$.

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