

X40a **Spectroscopic Identification of 3  $z$ -Dropout Galaxies at  $z = 6.84 - 7.21$ :  
Spectroscopic Demography of  $z \sim 7$  Galaxies**

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We present results from our ultra-deep Keck/DEIMOS spectroscopy of  $z$ -dropout galaxies in the SDF and GOODS-N fields. For 3 out of 11  $z$ -dropout candidates, we detect an emission line at  $\sim 1\mu\text{m}$  with a signal-to-noise ratio of  $\sim 10$ . The emission lines show asymmetric profiles with high weighted skewness values, consistent with being Ly $\alpha$  lines. As a result, we conclude these candidates to be at  $z = 7.213$ , 6.965, and 6.844, with Ly $\alpha$  fluxes of  $\sim 3 \times 10^{-17} \text{ erg s}^{-1} \text{ cm}^{-2}$ . Specifically, the  $z$ -dropout at  $z = 7.213$  is confirmed by three independent DEIMOS exposures with different configurations in two runs. The  $z = 6.965$  object is a known Ly $\alpha$  emitter, IOK-1, for which our improved spectrum with a higher resolution yields skewness measurement. The result here doubles the number of  $z$ -dropouts with spectroscopic confirmation. Combined with the spectroscopic data for  $z$ -dropout candidates from other studies, we find a Ly $\alpha$ -emitting galaxy fraction of  $X_{\text{Ly}\alpha} = 31 \pm 16\%$  ( $5 \pm 5\%$ ) at  $\text{EW}^{\text{Ly}\alpha} > 25\text{\AA}$  ( $55\text{\AA}$ ) for galaxies with  $-21.75 < M_{\text{UV}} < -20.25$ . These values are comparable to the extrapolations from  $z \sim 4 - 6$  within statistical errors and field-to-field variations, and rule out both a strong rise and drop of the fraction of Ly $\alpha$ -emitting galaxies toward  $z \sim 7$ . This would imply that the ionizing state of the IGM and star-formation properties do not drastically change from  $z \sim 6$  to 7.