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Galaxies in the first billion years: implications for re-ionization and the star formation history at $z > 6$

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Abstract. We discuss the selection of star-forming galaxies at $z \simeq 6$ through the Lyman-break technique. *Spitzer* imaging implies many of these contain older stellar populations (> 200 Myr) which produce detectable Balmer breaks. The ages and stellar masses ($\sim 10^{10}\,M_{\odot}$) imply that the star formation rate density at earlier epochs may have been significantly higher than at $z \simeq 6$, and might have played a key role in re-ionizing the universe.

Keywords. galaxies: high-redshift; evolution; formation; stellar content

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We have discovered a population of star-forming galaxies at $z \simeq 6$ and beyond (within the first billion years) through the i'-drop technique. The first application of this to *HST*-ACS imaging was presented in Stanway *et al.* (2003), using the public GOODS survey. We were able to prove this technique through Keck-DEIMOS spectroscopy (Bunker *et al.* 2003). Using the same i'-drop selection, our first analysis of the Hubble Deep Field revealed 50 star forming galaxies at redshifts around six with magnitudes $z_{AB} > 28.5$ (Bunker *et al.* 2004). *Spitzer* observations with IRAC enable us to estimate the stellar masses and luminosity-weighted ages for this population; we find in some cases that there are Balmer breaks, indicating ages of > 200 Myr and formation redshifts of $z \simeq 10$ (Eyles *et al.* 2005). From the whole sample of v-drops and i'-drops we estimate the stellar mass density at $z \approx 5$ (Stark *et al.* 2007) and at $z \approx 6$ (Eyles *et al.* 2007). The implications of this work are that the previous star formation history was higher prior to $z \simeq 6$, and might have played a key role in generating the UV photons necessary to re-ionize the universe at $z \simeq 8 - 10$. Our work is the strongest constraint to date on the star formation history at $z > 6$.

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