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The first galaxies at cm and mm wavelengths

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Abstract. Observations of the most distant ($z \simeq 6$) QSOs in the centimetre and millimetre regime currently serve as the only direct probe of the host galaxies of these extreme systems in the Epoch of Re-ionization. Such observations reveal that about 1/3 of the hosts contain massive reservoirs of dust ($> 10^8$ M$_\odot$) and molecular gas ($> 10^{10}$ M$_\odot$) – the fuel for galaxy formation, and also indicate coeval starbursts at a rate $> 10^3$ M$_\odot$ yr^{-1}, adequate to form a large elliptical galaxy in a dynamical timescale. These data imply that a highly metal enriched, molecular ISM, can be generated in galaxies within 870 Myr of the Big Bang. High-resolution imaging of the gas also provide an estimate of the host galaxy dynamical mass. However, current observations are restricted to rare, hyper-luminous IR galaxies. I will close by considering the prospects of observing the gas, dust, and star formation in the first 'normal' galaxies (e.g., the Ly-α galaxies) into cosmic reionization ($z > 6$), using ALMA and the EVLA.

Keywords. radio lines: ISM,radio lines: galaxies, quasars: general

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We present new results of our ongoing efforts to study the properties of the molecular gas and dust in high-redshift quasars. Our ongoing survey using MAMBO at the IRAM 30 m to detect dust emission in $z \simeq 6$ QSOs has resulted in a number of new detections (Wang *et al.* 2007). As the detected objects are dust-rich, they represent good targets to perform follow-up observations of the molecular gas phase. We also report on observations of the (rest-frame) FIR continuum of the GRB 050904 at $z = 6.29$ with MAMBO, which have resulted in a non-detection of the GRB host galaxy (Walter *et al.* 2006).

Sensitive radio continuum observations of the quasars using the VLA have resulted in a number of new detections which reveal that at least some of the objects appear to be radio loud (Wang *et al.* 2007). These observations provide a glimpse of what will be possible with the expanded (E)VLA, which will improve the continuum sensitivity of similar observations by an order of magnitude. Observations of the molecular gas phase in $z \simeq 6$ objects are still limited by (*i*) redshift uncertainties, and (*ii*) the sensitivity of current instruments. This is the main reason why to date there is only one $z > 6$ CO detection (the $z = 6.42$ QSO J1148+5251, Walter *et al.* 2003, 2004).

This situation will improve dramtically with the advent of new telescopes with larger bandwidths and collecting area (most notably ALMA), which will also enable us to map the CO emission in the host galaxies at these extreme redshifts. Of additional interest are detection and mapping experinents of the emission from ionized carbon which appears to be bright in the $z = 6.42$ QSO (Maiolino *et al.* 2005).

References

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