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High-z radio starbursts host X-ray AGN

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Abstract. We use Virtual Observatory methods to investigate the association between radio and X-ray emission at high redshifts. Fifty-five of the 92 HDF(N) sources resolved by combining MERLIN+VLA data were detected by *Chandra*, of which 18 are hard enough and bright enough to be obscured AGN. The high-z population of μJy radio sources is dominated by starbursts an order of magnitude more active and more extended than any found at $z < 1$ and at least a quarter of these simultaneously host highly X-ray-luminous obscured AGN.

Keywords. galaxies: starburst, galaxies: active, radio continuum: galaxies, X-rays: galaxies, techniques: high angular resolution, surveys

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A region of 100 arcmin^2 around the Hubble Deep Field North was observed by the MERLIN and the VLA (Muxlow *et al.* 2005). 92 sources brighter than 40 μJy were detected at 1.4 GHz and all showed structure at $0.''2 - 2''$ resolution. These are the only observations apart from the HST images which provide morphological information. We were thus able to classify the specific origins of the radio emission in each galaxy, which may be different from the sources of optical and other radiation from the same object. We used the presence of rest-frame FIR emission (e.g. Garrett 2002) and the HST images (Giavalisco *et al.* 2004) to provide supporting information only. Compact bright peaks with a flat radio spectrum are probably AGN whilst extended emission with a steep non-thermal spectrum is likely to be of starburst origin. The latter are often associated with *ISO*, *Spitzer* or SCUBA sources (e.g. Chapman *et al.* 2005) and with interacting or distorted galaxies in the *HST* images. 55 of the radio sources are among the 100 X-ray sources detected by *Chandra* in the same field (Alexander *et al.* 2003), including 18 obscured AGN identified by Padovani *et al.* 2004 (with X-ray luminosities $> 10^{35}$ W and photon indices $\geqslant 1$) but the radio emission is starburst dominated in at least 11 of these. The mean angular size of the radio sources in the HDFN is $1''.3$, corresponding to a typical extent of 8–10 kpc for starbursts and the inferred star-formation rates are 1–2000 $M_\odot$ yr^{-1} for the higher-redshift sources. This is an order of magnitude more exended and more vigourous than for local ULIRGS.

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