RADIO EMISSION FROM HIGH REDSHIFT GALAXIES: VLA OBSERVATIONS OF THE HUBBLE DEEP FIELD

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1. Introduction

To study galaxy populations and their evolution at the highest possible redshifts, a small area of the sky, the Hubble Deep Field (HDF) was imaged to an unprecedented sensitivity of R = 29.5 (Williams *et al.* 1996). As a complement to the HST observations, we have used the VLA at 8 GHz to image an area 5.′4 in diameter (FWHM) centered on the HDF to an *rms* sensitivity of 2 μJy. With a radio resolution of about 3″, we have 33 sources above 9.5 μJy, seven in the 4 arcmin^2 HDF field of which six have clear optical IDs. There are an additional 12 IDs in the HST flanking fields. The optical counterparts of the radio sources are a mixture of ellipticals, spirals, and irregulars, consistent with earlier surveys of comparable depth (Windhorst *et al.* 1995). With a median redshift <z> $\sim$ 1, the radio galaxies we are sampling are somewhat more distant than the classical starbursting galaxies which dominate less sensitive radio surveys. Our HDF identifications are predominately with post-starburst galaxies, moderate power AGN, and blue irregulars (Fomalont *et al.* 1996).

2. Primeval Galaxies or Nascent AGN?

Six faint radio sources in our survey are identified with high redshift galaxy candidates ($z \geq 3$) as evidenced by their optical spectral energy distributions (SED) (Steidel *et al.* 1996). Two of these radio emitters have confirmed redshifts of $z = 2.845$ and $z = 3.158$ (Steidel *et al.*). (One of the former has a measured J,H, and K flux (Cowie *et al.* 1996), and a seven band photometric $z = 2.358 \pm 0.007$.) Thus we may be uncovering a new population of high redshift radio sources. At redshifts $z = 2.3$–3.5, and

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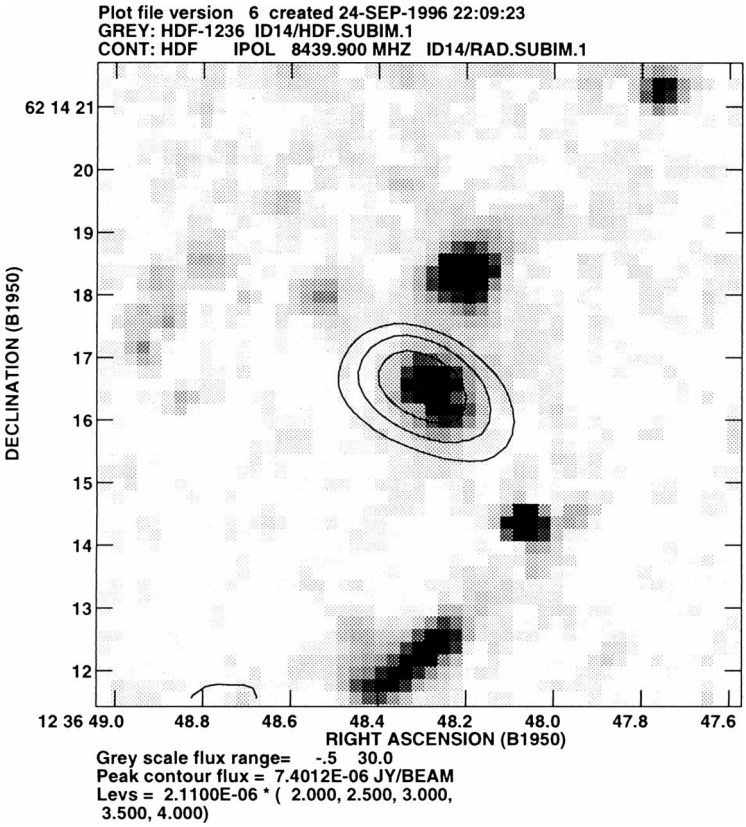

Figure 1. A J = 21.6 galaxy (Cowie *et al.*): the radio contours show the unresolved ($\theta < 3''$) radio source at 8 GHz. With a $z = 2.845$, the radio power is log P = 24.3 implying either a very high star formation rate or a powerful AGN. The radio/optical coincidence is better than $0.2''$and the identification confidence is > 99%.

assuming a typical radio spectral index of -0.8, the power of these sources at 1 GHz is $10^{25.5}$ W/Hz, typical of strong FRI radio sources. Two different mechanisms may be responsible for this intense radio emission. The sources may be massive, star-forming galaxies, perhaps akin to the local ultraluminous IRAS galaxies. On the other hand, these galaxies may be relatively normal galaxies with an embedded AGN "monster."

References

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