The sharpest view of the earliest radio quasars

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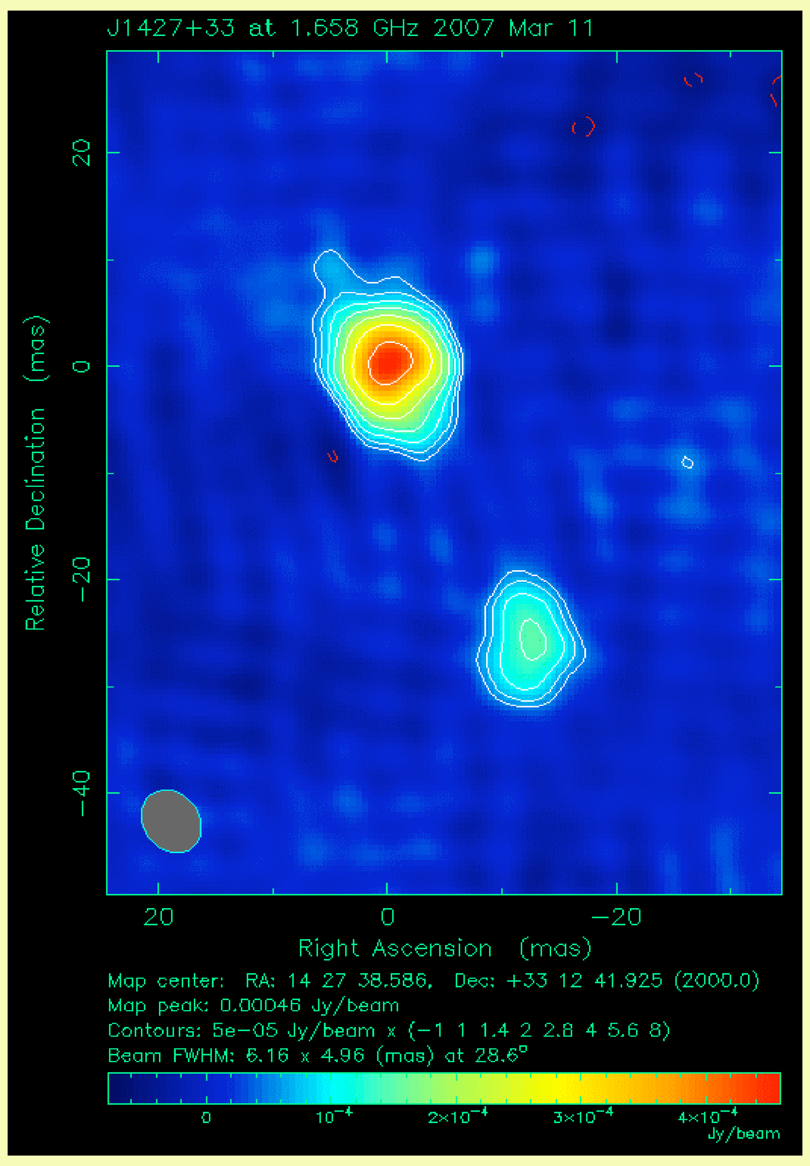
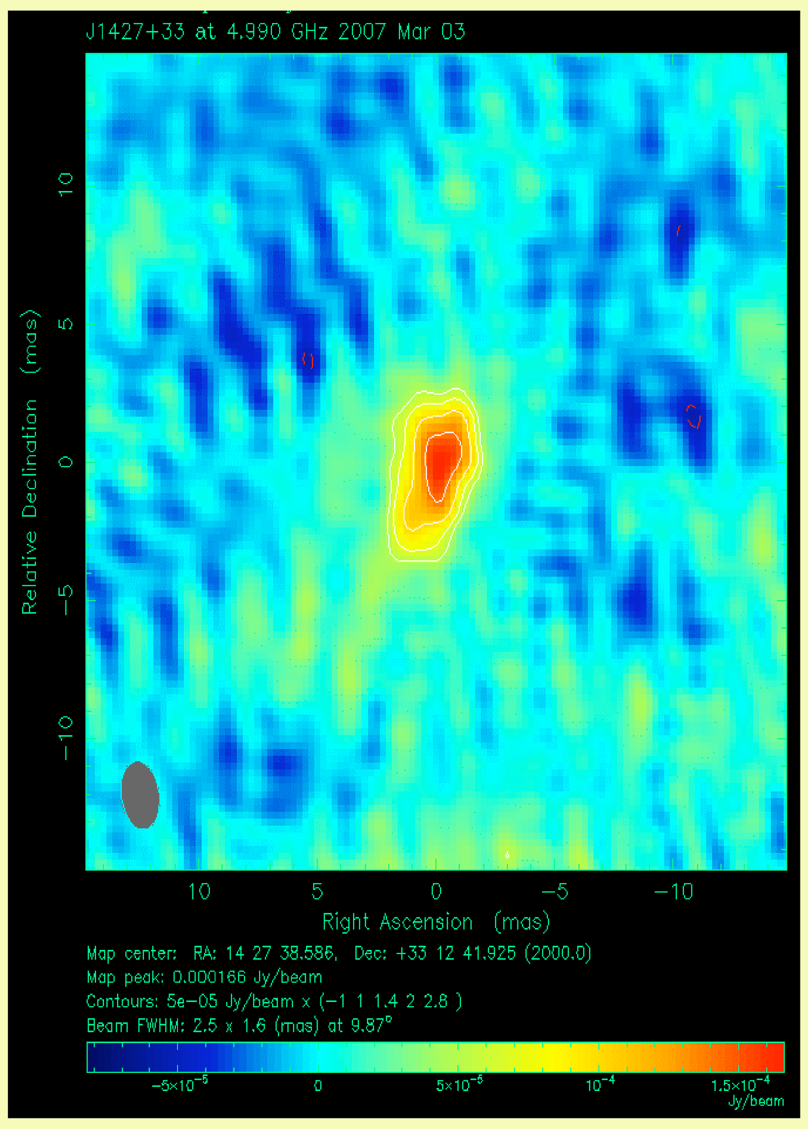
Quasars at the highest redshift (z~5 or more) place strong constraints on the early cosmological evolution of active galactic nuclei (AGNs) and the growth of the supermassive (~10^9 $M_\odot$) black holes. The AGN activity observed at high z indicates that AGN feedback processes may have played an important role in the early galaxy and cluster evolution. The ultimate evidence for AGN jet activity has to come from **Very Long Baseline Interferometry** (VLBI) observations. Recent observations of compact radio sources at z~6 (J0836+0054, *Frey et al.* 2003, 2005; J1427+3312, *Frey et al.* 2008, *Momjian et al.* 2008) indicate that there is a steep-spectrum population of distant radio AGNs

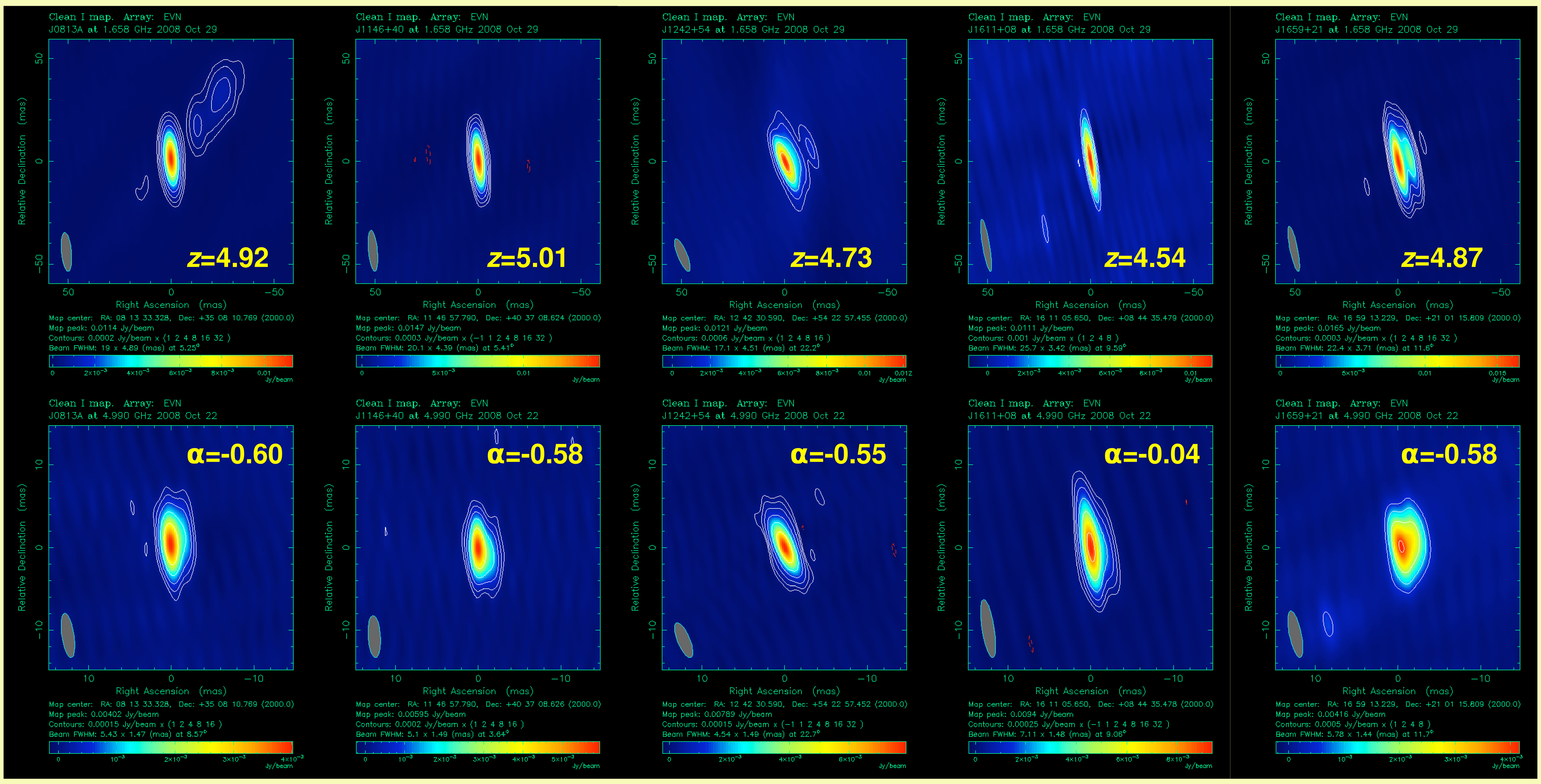
The quasar **J1427+3312** (z=6.12) is the first and so far the only radio-loud quasar known at a redshift z>6 (*McGreer et al.* 2006, *Stern et al.* 2007). The source is found in the NOAO Deep Wide-Field Survey (NDWFS) region. Earlier radio measurements by the Very Large Array (VLA) and the Westerbork Synthesis Radio Telescope (WSRT) give 1.4-GHz flux densities of 1.7-2.1 mJy. The source has been detected in several infrared bands. The optical and near-infrared colours, the broad absorption lines, and the possible intrinsic X-ray absorption implied by the Chandra non-detection all suggest that dust extinction plays an important role in determining the appearance of this distant quasar. Assuming a cosmological model with H_0=70 km s^{-1} Mpc^{-1}, Ω_m=0.3 and Ω_Λ =0.7, the redshift z=6.12 corresponds to 0.9 Gyr after the Big Bang (<7% of the present age of the Universe).



We observed J1427+3312 in phase-reference mode with the **European VLBI Network** (EVN) at 1.6 and 5 GHz (*Frey et al.* 2008). These frequencies correspond to ~11 GHz and ~36 GHz in the rest frame of the quasar. The source was clearly detected with the EVN at 1.6 GHz, showing a prominent double structure. The two components are separated by 28.3 mas, corresponding to a projected linear distance of ~160 pc. Circular Gaussian model fitting indicates that both components are resolved. In the position of the brightest component at 1.6 GHz, we detected mas-scale radio emission at 5 GHz as well. The comparison of the VLBI and WSRT flux densities indicates that practically the entire radio emission of J1427+3312 originates from the components seen in the VLBI images. The radio spectral index of the feature detected at both frequencies is α=-0.6 (S~ν^α). The quasar with the second highest redshift known (z=5.77, SDSS J0836+0054) has also been studied with the EVN (*Frey et al.* 2003, 2005), showing a single compact component. Its radio spectrum is similarly steep (α=-0.8).



The radio structure of J1427+3312 is typical of the Compact Symmetric Objects (CSO) which are in the earliest stage of their evolution. The appearance of this AGN is certainly determined by the dense environment in which it resides. CSOs at such extremely high redshifts - close to the epoch of reionisation - might be suitable background sources for the detection of HI absorption in their host galaxy.

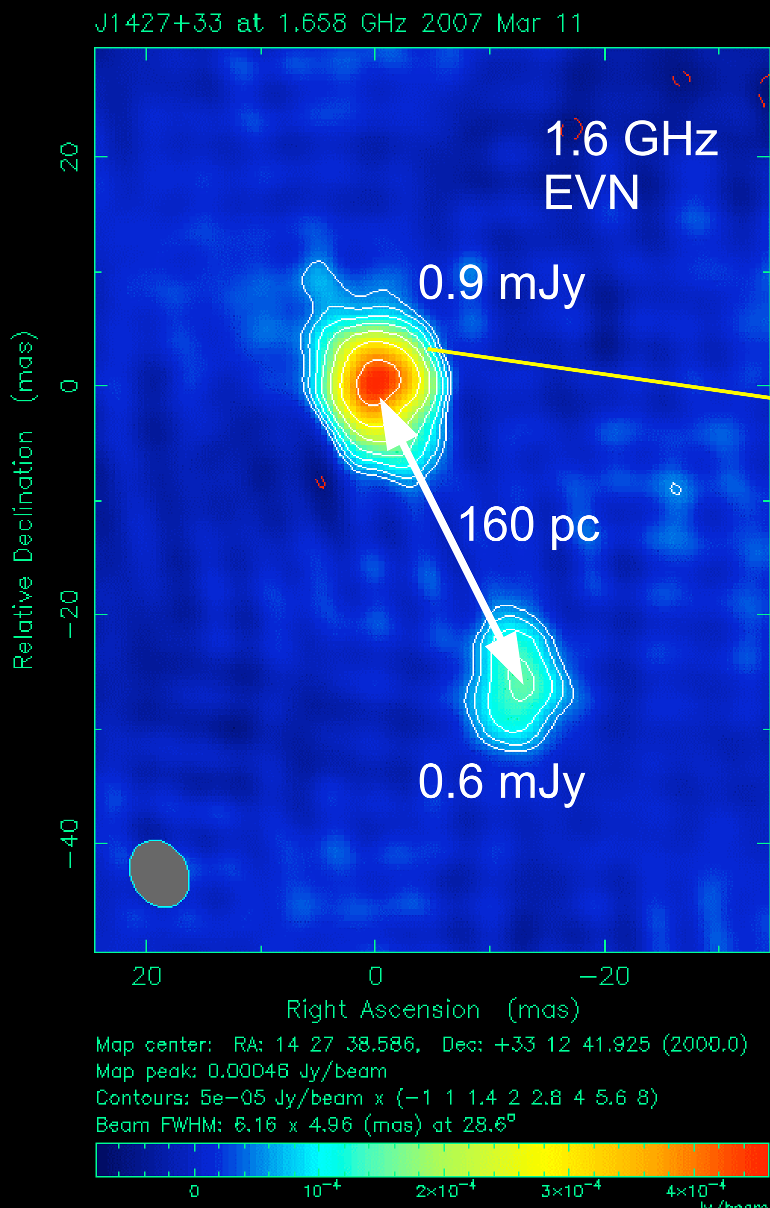


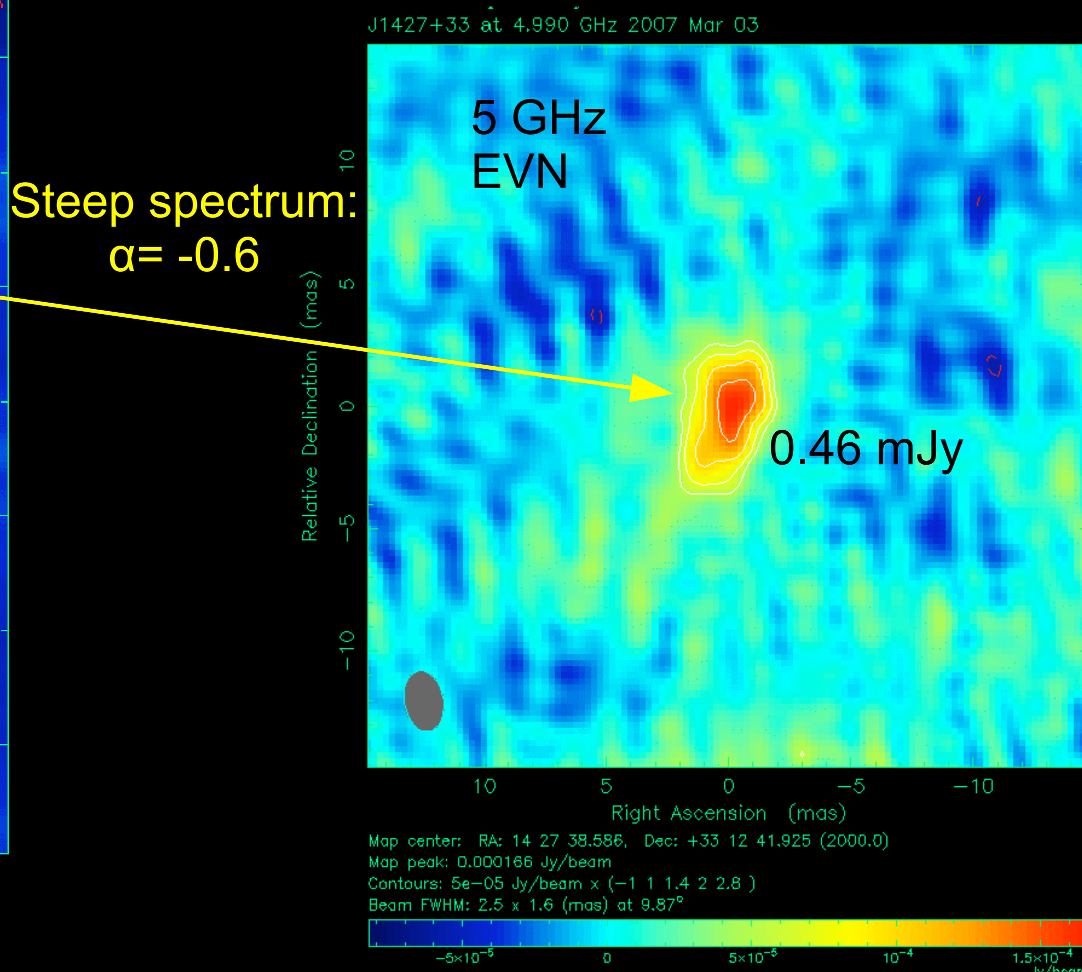
Until recently, there were only eight radio-loud AGNs at z>4.5 imaged with VLBI. The majority of them are flat-spectrum radio sources. In October 2008 we observed five additional quasars with the EVN, at both 1.6 GHz (*top row*) and 5 GHz (*bottom row*). These have been selected from the Sloan Digital Sky Survey (SDSS) spectroscopic catalogue and the VLA Faint Images of the Radio Sky at Twenty-centimeters (FIRST) survey at 1.4 GHz.

References:

» Frey S. et al. 2003, *MNRAS* **343**, L20
» Frey S. et al. 2005, *A&A* **436**, L13
» Frey S. et al. 2008, *A&A* **484**, L39
» McGreer I.D. et al. 2006, *ApJ* **652**, 157
» Momjian E. et al. 2008, *AJ* **136**, 344

Most distant radio loud quasar: z=6.12 *(McGreer et al., 2006; Stern et al, 2007)*: J1427+3312 (<7% of the present age of the Universe)





Frey et al., A&A 484, L39-L42, 2008
Momjian et al., AJ 136, 344-349, 2008