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VLBA Scientific Memorandum 21: A Strategy for Surveying Thousands of Continuum Sources with the VLBA

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Abstract: *I suggest a strategy for surveying thousands of radio continuum sources with the VLBA. The Sloan Digital Sky Survey will provide ancillary optical data for all these radio sources, whether or not they are detected by the VLBA.*

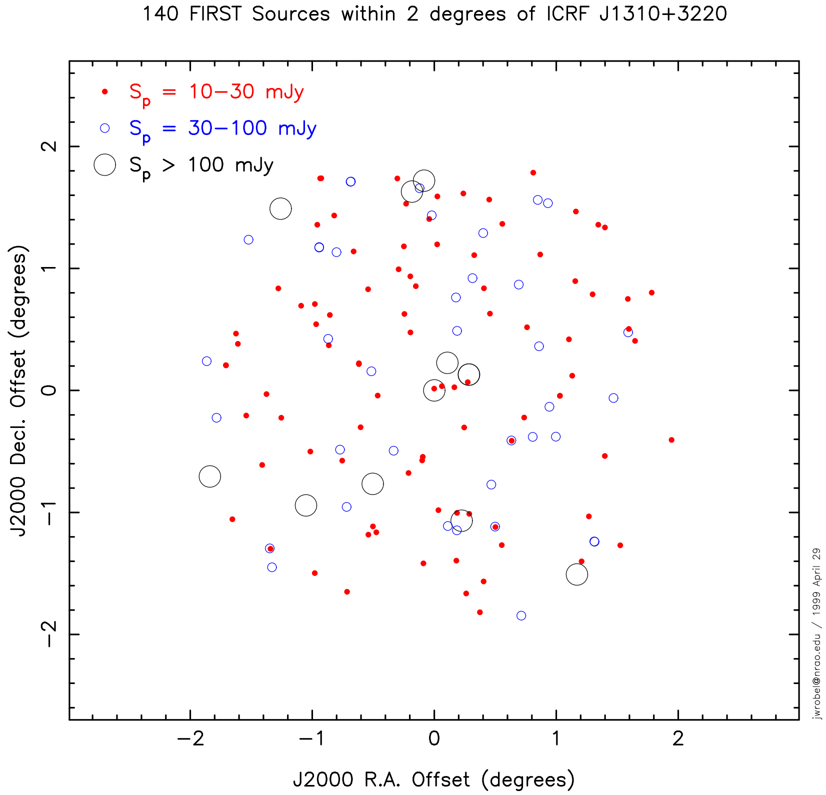
The astrophysical impact of existing VLBI surveys is limited by the small numbers of continuum sources involved and by the paucity of optical redshifts. To date, only one VLBI survey has targeted more than 1000 sources (Peck & Beasley 1998, ASP Conf. Series, 144, 155) and redshifts are available for only a few hundred of those sources (Pearson 1998, ASP Conf. Series, 144, 17). How might these number and redshift barriers be overcome?

Garrett & Garrington (1998, ASP Conf. Series, 144, 145) selected $\sim$100 sources from the VLA FIRST survey (Becker, White & Helfand 1995, ApJ, 450, 559), with each source being less than 5 arcsec in size, stronger than 10 mJy at 1.4 GHz, and located within a patch of radius $\sim$2 degrees around a random ICRF calibrator (Ma et al. 1998, AJ, 116, 516). The sources were not filtered by spectral index. This ICRF calibrator was used to phase-reference the $\sim$100 sources at 5 GHz with the EVN+VLBA recording at 128 Mbps and accumulating 9 minutes per source. Their VLBI detection rate was compromised by poor positions for the EVN antennas, but Garrett (priv. comm.) contends that the VLBA alone would achieve a detection rate of 30 percent.

Suppose one expands the Garrett-Garrington technique to the patches around the $\sim$150 ICRF calibrators in the quarter of the sky to be covered, eventually, by FIRST and by the Sloan Digital Sky Survey (SDSS; Gunn & Knapp 1993, ASP Conf. Series, 43, 267; Gunn et al. 1998, AJ, 116, 3040). The VLBA could then survey 150 patches times $\sim$100 sources per patch, or 15000 sources. Figure 1 shows an example patch centered on ICRF J1310+3220 close to the North Galactic Pole. For comparison, the largest directed VLA survey to date has involved 12000 sources (Browne et al. 1998, in Observational Cosmology with the New Radio Surveys, 323).

The positional accuracy at 90-percent confidence of an unresolved 10-mJy FIRST source is $\sim$350 mas (White et al. 1997, ApJ, 475, 479), adequate for a single pass with the VLBA correlator. Each FIRST source should be observed three times with the VLBA, with the observations spread to enhance coverage in the (u, v) plane. VLBA recordings at 512 Mbps for 3 minutes per source would provide an r.m.s. thermal sensitivity of 0.3 mJy beam^{-1} in an image at either 5 GHz or 8.4 GHz, comparable with the Garrett-Garrington images.

Fig. 1.— An example patch close to the North Galactic Pole. The symbol size increases with source strength.



Adding a factor of two for (mainly phase) calibration overhead means that surveying 50 sources would fill a pair of tapes at each VLBA station. Reaching 100 sources per patch would require two 5-hour segments, or two "nights" if one thought nighttime would be beneficial for phase-referencing. Thus the VLBA would require 300 segments, or a total of 1500 hours, to survey 15000 FIRST sources in 150 patches. Such a VLBA survey would yield about 4500 detections.

The SDSS will provide photometric data through multiple optical filters toward all 15000 FIRST sources, whether or not they are detected by the VLBA. The SDSS will also deliver spectroscopic redshifts for 10^6 galaxies and 10^5 QSOs, and some of those redshifts will correspond to some of the 15000 FIRST sources. Redshifts for sources in the VLBA patches, but not in the SDSS spectroscopic survey, could still be efficiently obtained with multi-fiber optical spectroscopy (Garrett & Garrington 1998).

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