

Highly Polarized Radio Sources – an On-going Project

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ABSTRACT The NRAO VLA Sky Survey detected about 1.8 million radio sources, for the first time, with linear polarization information. The global polarization percentage of any type of objects, except for pulsars, can rarely be more than 20% to 25%. We construct a sample of highly polarized radio sources from the NVSS catalog, with polarization percentage $> 30\%$. We have conducted the pulsar searching on these targets. However, except the a dozen known pulsars, no new pulsars have been found. Superposition of the sources over optical pictures revealed several sources being 2MASS infrared-strong objects. It is intriguing to understand why these sources are so highly polarized.

Detailed studies of radio sources have been one of the most important approaches for the major discoveries. For example, in 1960s, deliberate measurements of fluctuations of radio sources in scintillation studies directly resulted in the discovery of pulsars (Hewish et al. 1968). Optical identifications of radio sources led to the discovery of radio galaxies (e.g. Baade & Minkowski 1954) and quasars (e.g. 3C273 by Schmidt 1963), which are powered by a black hole with an accretion disk. In 1980s, the first millisecond pulsar was discovered during the very detailed investigation of a compact low-latitude radio source with very steep spectrum and interplanetary scintillations (Backer et al. 1982).

The NRAO VLA Sky Survey (NVSS; Condon et al. 1998) is a great project, which mapped 82% of the celestial sphere at 1.4 GHz and detected 1.8 million radio sources with flux density greater than 2.5 mJy. Most grandly, it is the first time to have linear polarization information for such a large complete sample of radio sources.

The polarization of synchrotron emission in a perfectly regular field can reach a maximum of 70% (assuming an electron spectral distribution index of -2). An intrinsic polarization percentage of 30% implies that $> 40\%$ of magnetic energy is stored in a relatively large-scale regular field.

Previously very few studies on highly polarized sources have been published. The anomalously high-linearly polarized radio source near the spiral galaxy NGC 891 was ever found to be a very luminous binary millisecond pulsar by Navarro et al. (1995). PSR B1951+32 was first identified as a polarized steep-spectrum point source in CTB 80 (Strom 1987). The exotically polarized object, J06587-5558, discovered by Liang et al. (2001) near a cluster of galaxies, is an extended non-pulsar extragalactic object with the highest polarization (54%) up to now and a very steep spectrum ($\alpha \sim -1$). It is not clear yet what it is.

We are going to work on a sample of radio sources with highest polarization detected by the NVSS. All sources in the NVSS catalog with polarization percentage, p_p , greater than 30% have been checked. Some of them have been observed as pulsar candidates with Parkes and Jodrell bank telescopes, two dozen of them have been imaged with VLA and ATCA for higher resolution polarization map; a number of sources have been observed for optical spectra.

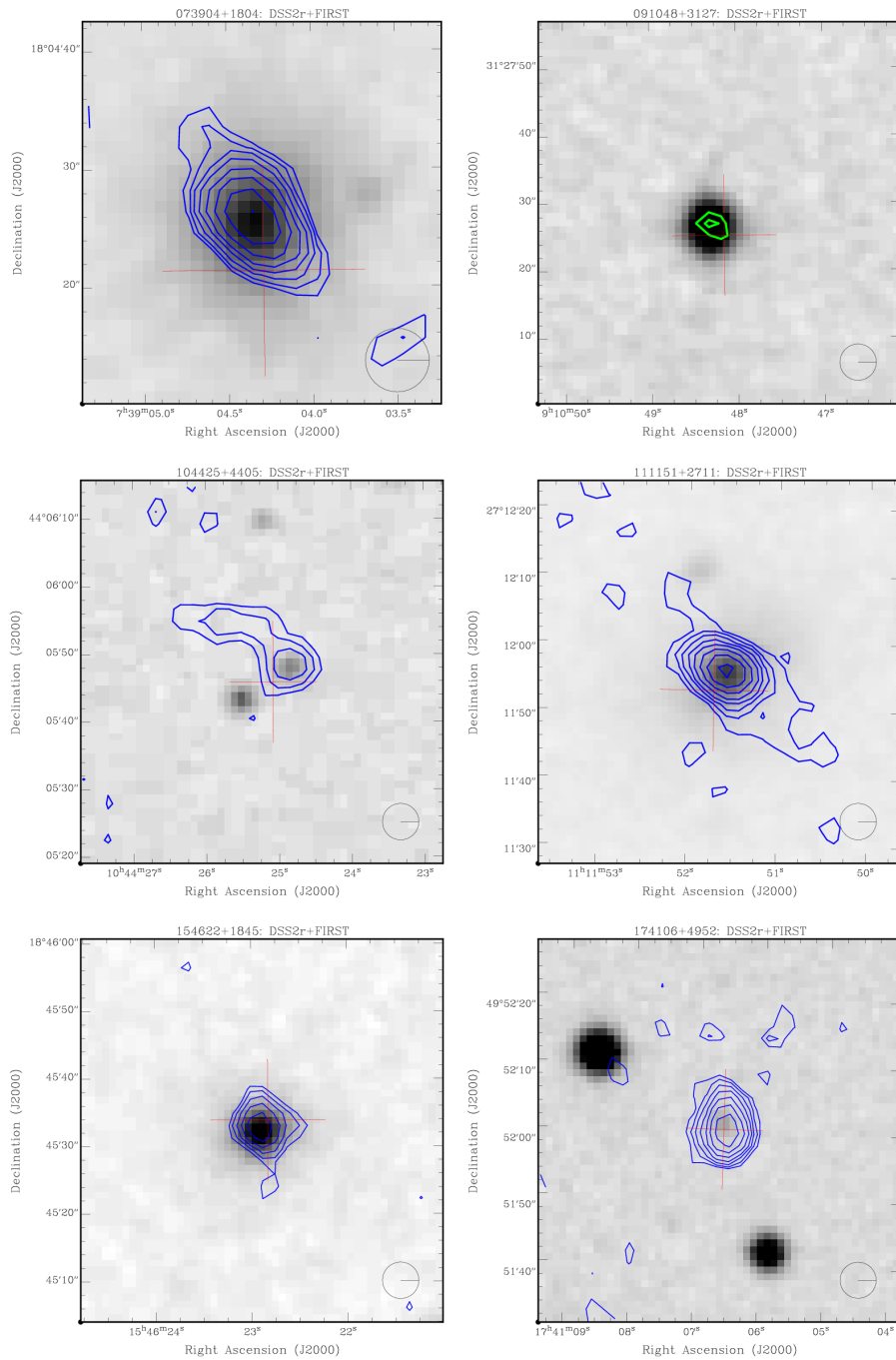


Fig. 1 Some highly polarized NVSS sources have optical identifications, most likely associated with galactic nuclei, as clearly shown by the higher resolution FIRST map superimposed onto the DSS images.

We cross-check all known pulsars in pulsar catalog (the updated version of Taylor, Manchester & Lyne 1993) with our sample by position coincidence. 10 sources are found to be known pulsars.

Among 52 sources with good FIRST survey images (Becker, White & Helfand 1995), 19 sources have optical identifications. According to the profiles of optical images obtained from DSS-FITS file, almost all of them are galactic nuclei (maybe active!). The high resolution FIRST maps of most of them show good extended emission. It is not clear why they generate radio emission with high polarization. It is somewhat astonishing that 5 of 6 known objects are very red objects, either detected in 2MASS or IRAS surveys.

Table 1 Some highly polarized sources are very red objects

Source name	$p_p \pm \sigma_{p_p}$ (%)	USNO results (in mag)			NED results
		B2	R2	I2	
073904+1804	60.5±16.7	10.93	10.32	10.57	2MASXi J0739043+18042 5: IrS
111151+2711	30.7± 6.3	11.64	10.57	10.49	2MASXi J1111515+27115 5: IrS
131015+1056	31.6± 6.4			11.71	MAPS-NGP O-498-116998 8: G
142945-0009	61.4±14.8	20.38	19.84		IRAS 14 272+0003; z=0.03; IrS
162558+5651	52.6±13.9	17.15	15.54	15.07	2MASXi J1625591+56512 3: IrS
163221+1551	36.5± 8.0	17.24	16.23	16.53	IRAS F16300+1558; LINER; z=0.241; IrS

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