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FIRST ‘Winged’ and ‘X’-shaped Radio Source Candidates

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Abstract. A small number of double-lobed radio galaxies are found with an additional pair of extended low surface brightness ‘wings’ of emission giving them a distinctive ‘X’-shaped appearance. One popular explanation for the unusual morphologies posits that the central supermassive black hole (SMBH)/accretion disk system underwent a recent realignment; in a merger scenario, the active lobes mark the post-merger axis of the resultant system (e.g., Merritt & Ekers 2002). However, this and other interpretations are not well tested on the few (about one dozen) known examples. In part to remedy this deficiency, a large sample of winged and X-shaped radio sources is being compiled for a systematic study. An initial sample of 100 new candidates is described as well as some of the follow-up work being pursued to test the different scenarios.

1. FIRST Identifications and Work in Progress

To compile the sample, image fields from the VLA-FIRST survey (Becker et al. 1995) containing components bright and extended enough to judge the source morphologies were inspected by-eye. This gave an initial 100 candidates with extended winged emission (Fig. 1; Cheung 2006). Compared to previously known examples (e.g., Lal & Rao 2006), the new candidates are systematically fainter ($\sim 10\times$) and more distant ($z \gtrsim 0.3$). New optical spectroscopic observations are identifying many of the fainter, more distant optical hosts.

Most candidates have clear winged emission and higher resolution VLA observations of initially ~ 40 sources have been obtained to confirm the morphological identifications. Of the candidates, enough are legitimate X-shaped sources (conventionally, those with wing to lobe extents of $>0.8:1$) to more than double the number known. Lower frequency GMRT observations of selected objects are being pursued to map any spectral structure to estimate the particle ages in the wings to test formation scenarios (e.g., Dennett-Thorpe et al. 2002).

We examined the host galaxies of about a dozen new and previously known examples with available SDSS images (54 sec exposures) to quantify any asymmetry in the surrounding medium as required by hydrodynamic wing formation models (e.g., Capetti et al. 2002). Most of the galaxies are highly elliptical with the minor axes roughly aligned with the wings, consistent with the findings of

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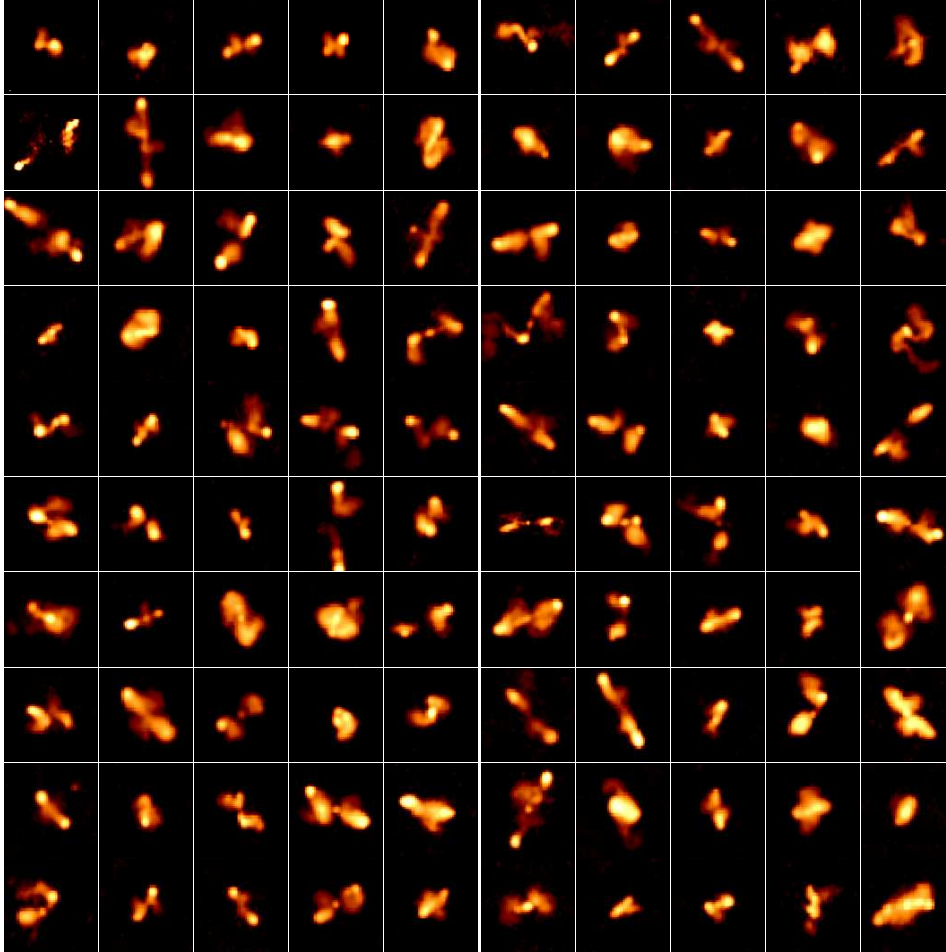


Figure 1. VLA-FIRST $\lambda 20\text{cm}$ images ($\sim 100'' \times 100''$) of the 100 new winged and X-shaped radio source candidates at $5.4''$ resolution from Cheung (2006).

Capetti et al. for a similarly sized sample. However, we found smaller ellipticities ($\epsilon < 0.1$) in at least two examples, 3C192 and B2 0828+32, confirming previous studies of these hosts (Smith & Heckman 1989; Ulrich & Rönnback 1996). “Round” hosts are not necessarily incompatible with the hydrodynamic picture as observed ϵ values can be lowered by projection. This should be investigated more thoroughly with a dedicated host galaxy imaging program.

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