



A nexus of surveys: studying compact radio sources across multiple datasets from wide-field instruments

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There are now dozens of wide-area surveys being conducted with SKA precursors and pathfinders, each producing gigabytes, if not terabytes, of their own data to satisfy their individual science goals. But in order to truly maximise the scientific output of this new generation of observations, we need to think beyond the original survey design and consider ways in which these wide-field datasets can both supplement and complement each other in new scientific endeavors. It is through this lens that we shall discuss our work on compact, extragalactic radio sources, bridging surveys and instruments to better understand a crucial phase of AGN jet evolution.

Identifying the youngest radio AGN, in which the jets have yet to break out through the ISM of their host, is key to understanding their formation, duty cycle and feedback processes. These sources appear compact in all but the highest resolution VLBI images, so they are typically identified by a peak in their broadband radio spectrum. However, this peak may be anywhere from ~ 100 MHz to tens of gigahertz due to a convolution of source size and redshift, and evidently no single survey is designed with such broadband coverage in mind. Indeed, the first statistical sample of these sources was created by combining low-frequency, widefield data from the MWA with archival VLA and ATCA data [1], so it naturally favoured sources peaking below 500 MHz due to the reliance on the MWA band. Following this work, we developed a pipeline for incorporating flux densities from all large-area surveys to-date, effectively extending our coverage of spectral peaks into the gigahertz regime simply through efficient use of archival data [2]. Applying our method to pilot results from a widefield spectral line survey (the First Large Absorption Survey in HI; FLASH) revealed a surprising over-density of these compact radio AGN amongst HI detections [3]. To better understand this result, the survey team has been collaborating closely with observers conducting a widefield search for Interplanetary Scintillation (IPS). Although typically used in space weather diagnostics, IPS is also powerful tool for studying sub-arcsecond radio structures without the overheads of VLBI [4]. It is this second, serendipitous usage of IPS data which has proved extremely valuable for our science.

In this talk, we present new results for 44 sources within the ASKAP-IPS and FLASH fields. Chosen for their unusual broadband characteristics and strong IPS signatures, these sources have been searched for evidence of neutral gas between redshifts of $0.4 < z < 1$. We discuss our strategy for follow-up continuum observations to improve broadband spectral coverage, and we confirm the presence of compact radio jets within a large fraction of the sample. We show that by combining several datasets with different primary science cases – from spectral line searches for neutral gas, to time-domain space-weather monitoring – we can fully exploit the power of widefield surveys to answer new and interesting questions, even while the surveys themselves are still in progress.

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2. E. F. Kerrison, J. R. Allison, V. A. Moss, E. M. Sadler and G. R. Rees, “RADIOSED - I. Bayesian inference of radio SEDs from inhomogeneous surveys”, *Monthly Notices of the Royal Astronomical Society*, **533**, 4, pp. 4248-4267, doi: 10.1093/mnras/stae1796.

3. E. F. Kerrison, E. M. Sadler, V. A. Moss, E. K. Mahony, “Why so young? A curious connection between the broadband flux and neutral gas content of AGN,” *Proceedings of the International Astronomical Union*, (in press) doi: 10.48550/arXiv.2412.08002.

4. R. Chhetri, J. Morgan, R. D. Ekers, J. P. Macquart, E. M. Sadler, M. Giroletti, J. R. Callingham, S. J. Tingay, “Interplanetary scintillation studies with the Murchison Widefield Array - II. Properties of sub-arcsecond compact sources at low radio frequencies,” *Monthly Notices of the Royal Astronomical Society*, **474**, 4, pp. 4937-4955, doi: 10.1093/mnras/stx2864.