3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Cross-matching Low Frequency Array (LOFAR) Sources

Lukas Böhme
Faculty of Physics, Bielefeld, Germany

Multi-frequency studies of the radio sky provide insight into the nature of the observed objects. To do so, I cross-match resolved and unresolved radio sources at different frequencies and angular resolutions. Special focus lies on low-frequency observations with the LOFAR LBA Sky Survey (LoLSS) at 54 MHz, which had a first preliminary data release of 25,247 radio sources in a region of 740 square degrees in 2021 [1].

The combination of several radio bands from LOFAR and other radio telescopes with multi-frequency optical and infrared data allows for photometric redshift estimates, not only for LoTSS [2] sources, but also for lower resolution LoLSS, NVSS [3], TGSS [4] and WENSS [5] sources.

I present a new cross-matching algorithm [6] incorporating the radio source extensions and apply it to the catalogues LoLSS-PR, LoTSS-DR1, LoTSS-DR2 [7] (all LOFAR), NVSS (VLA), TGSS-ADR1 (GMRT) and WENSS (WSRT).

I study the number of components and counterparts of LoLSS radio sources and their spectral properties. The spectral index and flux density relation is interpreted by using the Peak-to-Total-Flux ratio, which allows the distinguishing into young and core dominated AGNs, evolved and lobe dominated AGNs and old, fading AGNs. The spectral curvature between sets of three catalogues is observed. Here I find that the LoTSS-DR1 and LoTSS-DR2 flux density scales differ by around 8%, affecting the inferred mean spectral curvature. A flux density dependence of the spectral index can not be ruled out, as sensitivity limits and error bars impact the analysis.

Along with the whole cross-matching catalogue, three smaller catalogues are made available. These include hundreds of very steep spectrum sources, tens of high-redshift, steep spectrum sources and tens of compact, single component, steep spectrum sources, which are potential candidates for high-redshift radio galaxies (HzRGs) for follow-up studies [8].

References

[1] F. de Gasperin et al., "The LOFAR LBA Sky Survey. I. Survey description and preliminary data release," *A&A*, **648**, April 2021, A104.

[2] T. W. Shimwell et al., "The LOFAR Two-metre Sky Survey - II. First data release," *A&A*, **622**, February 2019, A1.

[3] J. J. Condon et al., "The NRAO VLA Sky Survey," *AJ*, **115**, 5, May 1998, pp. 1693-1716 .

[4] H. T. Intema, P. Jagannathan, K. P. Mooley, and D. A. Frail, "The GMRT 150 MHz All-sky Radio Survey: First Alternative Data Release TGSS ADR1," *A&A*, **598**, February 2017, A78.

[5] R. B. Rengelink et al., "The Westerbork Northern Sky Survey (WENSS) - I. A 570 Square Degree Mini-Survey around the North Ecliptic Pole," *A&AS*, **124**, 2, August 1997, pp. 259-280.

[6] L. Böhme, "Cross-matching radio sources from different surveys," M.S. thesis, Bielefeld University, Bielefeld, Germany, 2021.

[7] T. W. Shimwell et al., "The LOFAR Two-metre Sky Survey - V. Second data release," *A&A*, accepted December 2021, unpublished.

[8] G. Miley and C. De Breuck, "Distant radio galaxies and their environments," *A&AR*, **15**, February 2008, pp. 67-144.