Cross-matching Low Frequency Array (LOFAR) Sources

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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