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The Problem of Identifying Decametric Sources

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Abstract. We describe a method to cross-identify and construct continuum spectra for radio sources from decametric surveys with comparatively large positional errors. The 1822 sources from the UTR-2 catalogue (10–25 MHz, antenna beam of $\sim$40′) were cross-identified with entries from other radio catalogues at higher frequencies. Using the CATS database we found accurate positions for 2314 counterparts to UTR sources, as well as a best-fit radio spectrum for most of these. About 350 (or 19%) of the UTR sources appear to be blends of two or more sources.

The catalogue of 1822 radio sources obtained with the UTR telescope near Kharkov (Braude et al. 1978, 1979, 1981, 1985, 1994) covers about 30% of the sky at six frequencies from 10 to 25 MHz, and is currently the lowest-frequency catalogue of its size. As the optical identification rate in the original version of UTR-2 (UTR in what follows) is only 19%, it provides an ideal basis to study the little known optical identification content of sources selected at decametric frequencies. We worked with both existing versions of the UTR catalogue, the printed version (Braude et al. 1978–94) and the more recent electronic one (*http://www.ira.kharkov.ua/UTR2/*). We note that there are differences between these versions, both in source content and source names. In our analysis we included UTR sources of all reliability levels (A,B,C in the catalogue).

The very large uncertainties of the UTR source positions ($\sim$0.7°) forced us to use an interactive process to derive radio source spectra. We also made use of a graphical interface within CATS (program *spg*) which displays a "radio spectrum" for all sources found in the search window at various frequencies. By human interaction the most deviant flux measurements in the spectrum are recognized as an inappropriate counterpart, and are discarded from the spectrum.

The various steps involved in the UTR source identification are the following: (1) We used the CATS database (Verkhodanov et al. 1997) to extract all likely candidate radio counterparts: all sources from catalogues of low or intermediate frequency and of low angular resolution (6C, 7C, MY, TXS, B3, WB92, GB6, PMN) in a window of 40′×40′ centred on the UTR position. To avoid being flooded with weak unrelated sources we used sensitive surveys like NVSS, being flooded with weak unrelated sources we used sensitive surveys like NVSS, FIRST and WENSS only at a later stage of the process (see below). (2) Within the area of $40' \times 40'$ all source entries from step (1) were separated into groups of entries that fall within a circle of $1'$ diameter and have a flux measurement at two or more frequencies. Each group is considered as belonging to one of perhaps several candidate counterparts to the UTR source. (3) The spectrum of each candidate counterpart was fitted with one of several curves and extrapolated to the UTR frequency range. (4) We only retained the best counterparts obeying the following rules: (4a) the extrapolated decametric fluxes should be close to the UTR fluxes, and (4b) the counterpart coordinates should be close to the mean UTR position. Using these criteria we kept between 1 and 4 counterparts per UTR source. In the case of two or more counterparts, all of these will contribute to the UTR flux, i.e. the UTR detection is a result of blending. We found this to be the case for 350 of 1822 UTR sources (19%). (5) For further (e.g. optical) identification we defined "best radio coordinates" from the following catalogues (in order of decreasing priority): TXS (365 MHz), GB6, 87GB, PMN (all 4850 MHz). (6) If the identification area was poor of objects (e.g. at low declinations), and there were no sources detected simultaneously at several frequencies (i.e. no spectral fit was possible), then all objects within the box were retained for further study. (7) The areas around the best radio coordinates were searched for identifications from NVSS or FIRST. Fluxes from NVSS or FIRST usually improved the smoothness of the radio spectra. (8) Only if an NVSS identification was found, the "best radio positions" of item 5 were overwritten with the NVSS position. (9) The "best radio positions" were searched for optical objects from the APM or COSMOS catalogues derived from scans of the POSS or ESO/SERC surveys, and for objects detected in other wavelength ranges.

To check the reliability of the derived spectra we used the low frequency catalogues 6C, 7C (151 MHz), 3C, 4C (178 MHz), and others included in Dixon's Master List, like CL (26 MHz), WKB (38 MHz), or MSH (85 MHz). Although these do not cover the entire UTR survey area, they confirm the high efficiency of our methods in regions where these surveys overlap.

As a result we obtained a list of 2314 counterparts to UTR sources with accurate positions and available radio spectrum. Different subsamples of sources identified with the above methods are under study by the authors.

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References

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Verkhodanov O.V. et al. 1997, ASP Conf. Ser. 125, 322, eds. G. Hunt & H.E. Payne; cf. also *http://cats.sao.ru*