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Radio properties of radio-loud high-redshift quasars at z>3

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We present a study of the radio properties of distant quasars at z>3. The complete sample consists of 101 objects with a flux density level greater than 100 mJy at 1.4 GHz selected in a declination range from -35° to +49°. The study based on simultaneous RATAN-600 observations at frequencies of 1.2, 2.3, 4.7, 8.2, 11.2, and 22.3 GHz in 2017-2020. The flux density measurements uncertainties are about 9-31% and the detection rate is 100, 89, and 46% at 4.7, 11.2, and 22 GHz, respectively. For more detailed analysis we included available radio data from the literature.

We have analysed the averaged radio spectra of the quasars and classify 46% of radio spectra as peaked-spectrum, 24% as flat, and none as ultra-steep spectra ($\alpha <$ -1.1). The multifrequency data reveal that a peaked spectral shape (PS) is a common feature for bright high-redshift quasars. This indicates the dominance of bright compact core emission and the insignificant contribution of extended optically thin kpc-scale components in observed radio spectra.

The variability index V_S, which quantifies the normalized difference between the maximum and minimum flux density while accounting for measurement uncertainties, ranges from 0.02 to 0.96 for the quasars. Approximately half of the objects in the sample exhibit a variability index within the range of 0.25 to 0.50, comparable to that observed in blazars at lower redshifts. The distribution of V_S at 22.3 GHz is significantly different from that at 2.3-11.2 GHz, which may be attributed to the fact that a compact AGN core dominates at the source's rest frame frequencies greater than 45 GHz, leading to higher variability indices obtained at 22.3 GHz (the V_S distribution peaks around 0.4) compared to the lower frequencies (the V_S distribution at 2.3 and 4.7 GHz peaks around 0.1–0.2).

We propose 7 new candidates for gigahertz peaked-spectrum (GPS) sources and 5 new megahertz peaked-spectrum (MPS) sources based on their spectrum shape and variability features. Only 6 out of 23 sources previously reported as GPS demonstrate a low variability level typical of classical GPS sources ($V_S < 0.25$) at 4.7-22.3 GHz. When excluding the highly variable peaked-spectrum blazars, we expect no more than 20% of the sources in the sample to be GPS candidates and no more than 10% to be MPS candidates.

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