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Astro Space Center
RadioAstron Newsletter
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Record breaking results of AGN studies with RadioAstron

RadioAstron AGN survey continues to bring new exciting results. Already many active galactic nuclei are detected at 18 and 6 cm up to the projected baselines of 20 Earth diameters. As expected, results at longest projections are mostly delivered on baselines with the most sensitive ground radio telescopes – Effelsberg (Germany), Arecibo and GBT (USA). In the same time, all of the ground radio telescopes participating in the AGN survey routinely result in positive Space VLBI detections with Spektr-R.

Observations of 3C273 in January 2013 have broken the record of angular resolution announced last year by ground based 1.3 mm VLBI observations of 3C279 with APEX, SMA, and SMT. The quasar was detected at 8.1 Earth diameters (7.6 Gλ, fringe spacing 27 μarcsec, see Figure 1) by the RadioAstron-GBT interferometer at 1.3 cm.

In the beginning of February 2013 RadioAstron has successfully observed the radio galaxy M87. These 1.3 cm observations were, for the first time, supported from the ground by the phased VLA. Angular resolution was comparable to the size of a shadow of the super-massive black in the center of M87, as predicted by the theory. The AGN working group is currently reducing the data.

Pulsars at long interferometer baselines and interstellar medium

Several effects accompany propagation of radio waves through an inhomogeneous interstellar plasma: angular broadening, temporal smearing, distortions in radio spectrum, and intensity modulation (scintillations). These effects are due to interference of separate radio rays scattered or focused by random plasma inhomogeneities ("rough lenses"). Modern theoretical treatment of mentioned above scattering effects predicts very low level of visibility amplitude for distant pulsars at long space-ground baselines of the RadioAstron mission. In contrast to these theoretical predictions strong visibilities were detected in observations of the distant pulsar B0329+54. The observations were conducted with the GBT 100-m radio telescope of NRAO in Green Bank and RadioAstron space telescope at a frequency of 316 MHz. Distance to the spacecraft was about 275 000 km, and RadioAstron-GBT baseline projection was equal to 150 000 km. Fringe visibility amplitude as a function of fringe rate and delay is shown in Figure 2. For a source without scattering one should expect the presence of an isolated peak in the center of the picture. Instead, there is the presence of the whole ensemble of such peaks, each corresponding to certain combination of scattered rays. The observed structure is slowly varying with time at a scale of about 100 seconds. Thus, obtained results require a revision of our understanding of the structure of the interstellar plasma irregularities, and call for a new interpretation of the scattering of radio waves.

Galactic water masers

Successful detection of interference fringes for the water maser in the high-mass star formation region W3 IRS5 located in the Perseus arm at a distance of 1.83 kpc is reported. Correlated signal was obtained with space radio interferometer baselines between the orbiting 10-meter antenna Spektr-R and the 40-m radio telescope in Yebes (Spain) and 32-m ground radio telescope in Torun (Poland). Observing session was held on 2 February 2013. The long projected baseline length (5.4 Earth diameters, about 69 000 km) at the frequency of the water maser transition (22 GHz) corresponds to an angular resolution of about 40 μarcsec. This is equivalent to a linear resolution of 0.074 AU (11 million km) for W3 IRS5. This result represents the highest angular resolution ever obtained in observations of water masers. The observations are part of a RadioAstron campaign to explore the existence of very compact maser structures.

With best regards!
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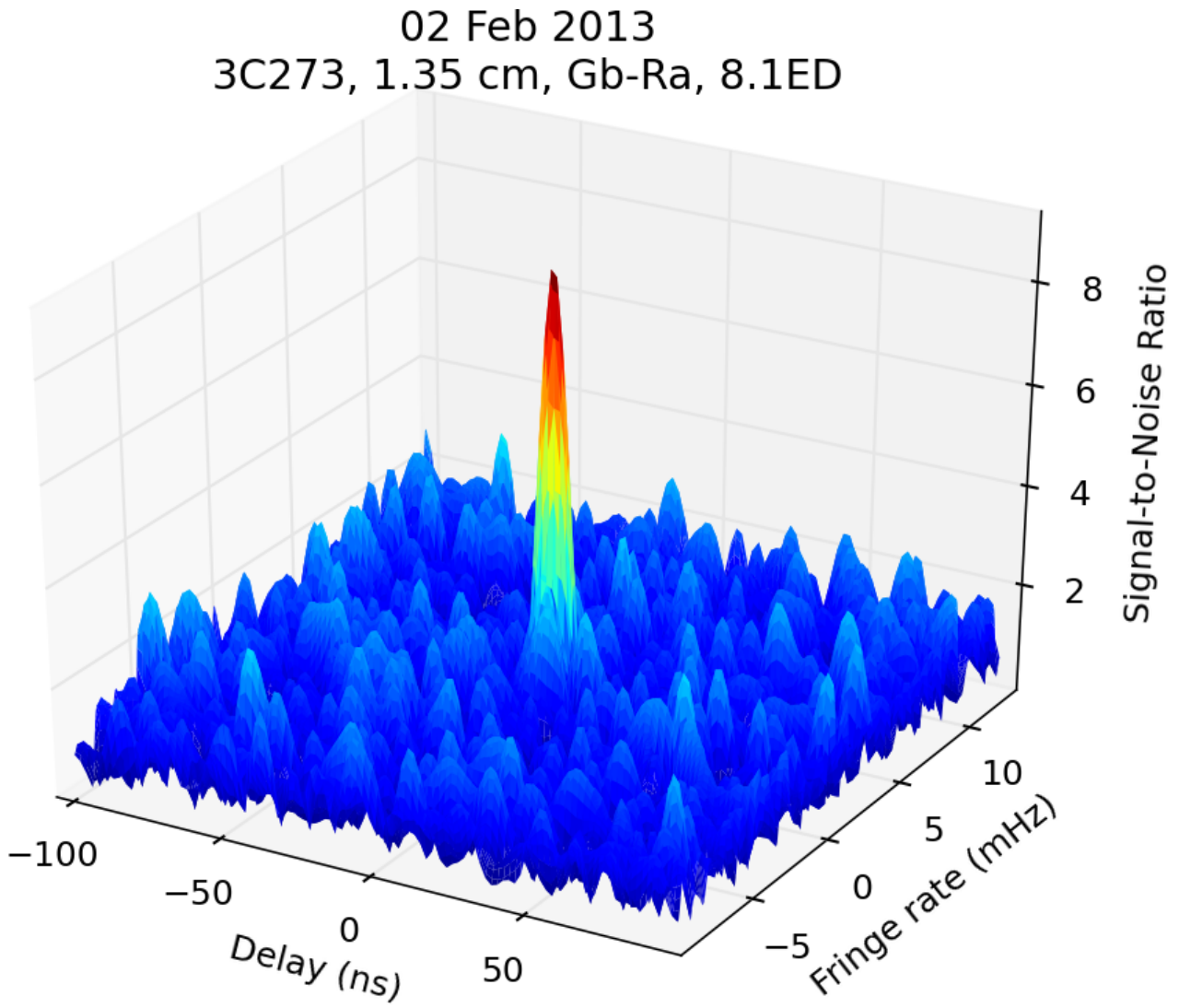

Figure 1: A record breaking fringe detection from the compact core of the quasar 3C273 by the Space VLB interferometer RadioAstron-GBT. The plot shows signal-to-noise ratio versus interferometric delay and fringe rate. Observing band: 1.3 cm, baseline projection 8.1 Earth diameters (7.6 Gλ), observing date 2 February 2013.

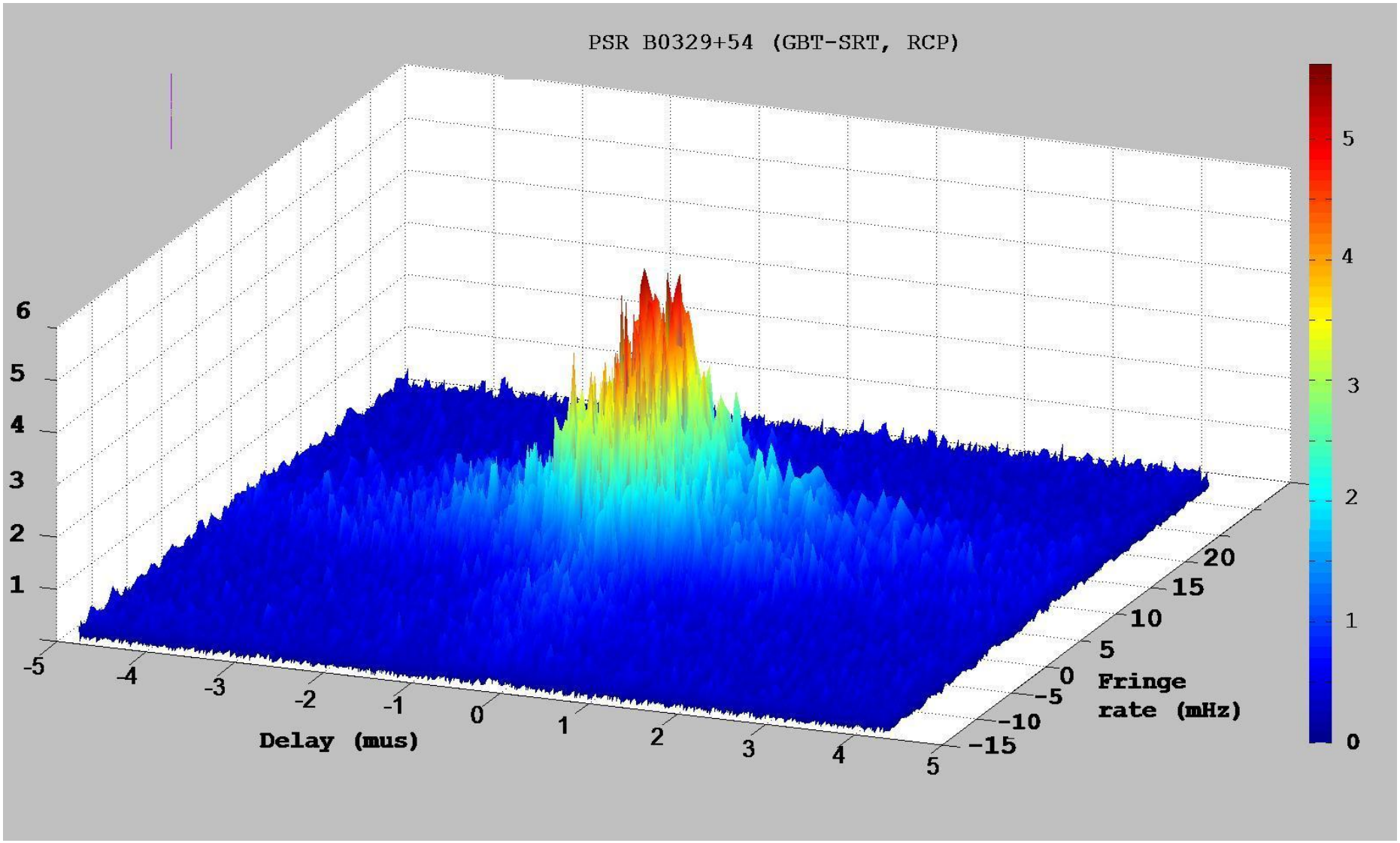

Figure 2: Fringe visibility as a function of fringe rate and delay for the scattered pulsar B0329+54, located at a distance of 6000 light years from the Sun. For a source without scattering one should expect the presence of an isolated peak in the center of the picture. The presence of many peaks reveals multipath propagation of radio waves through the interstellar plasma. The observations were conducted at 92 cm at the RadioAstron-GBT baseline projection of 150 000 km.

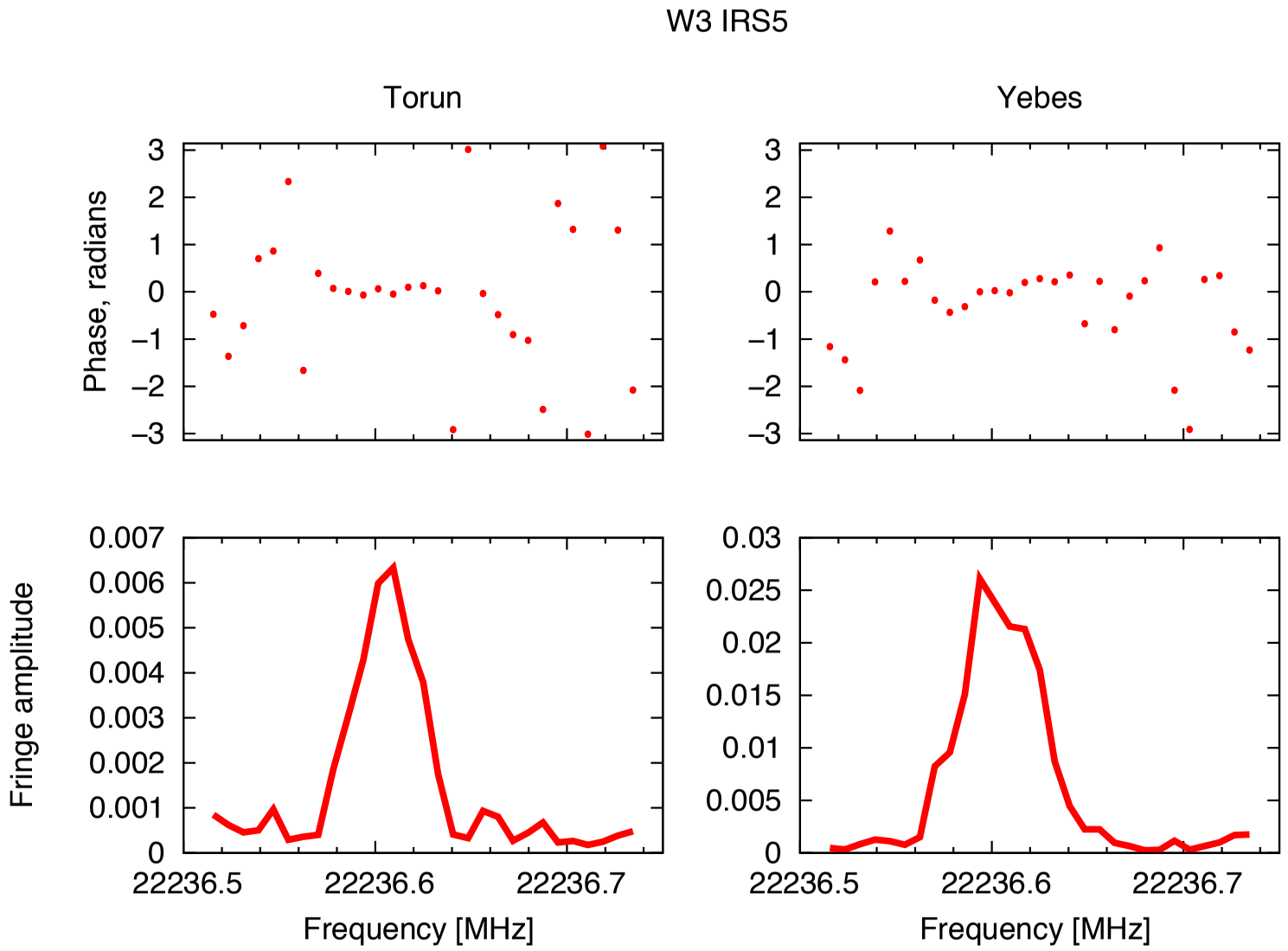

Figure 3: W3 IRS5: cross-correlation spectra of the compact feature in water maser transition at 22 GHz (1.35 cm), obtained in combination of the 10-m space radio telescope with the 40-m radio telescope in Yebes and 32-m radio telescope in Torun. Integration time was 570 sec. Projected baseline of the interferometer was 5.42 Earth diameters for Yebes and 5.28 Earth diameters for Torun. The plots show the normalized fringe amplitude and phase in radians versus frequency in MHz recalculated to the geocentric rest frame.

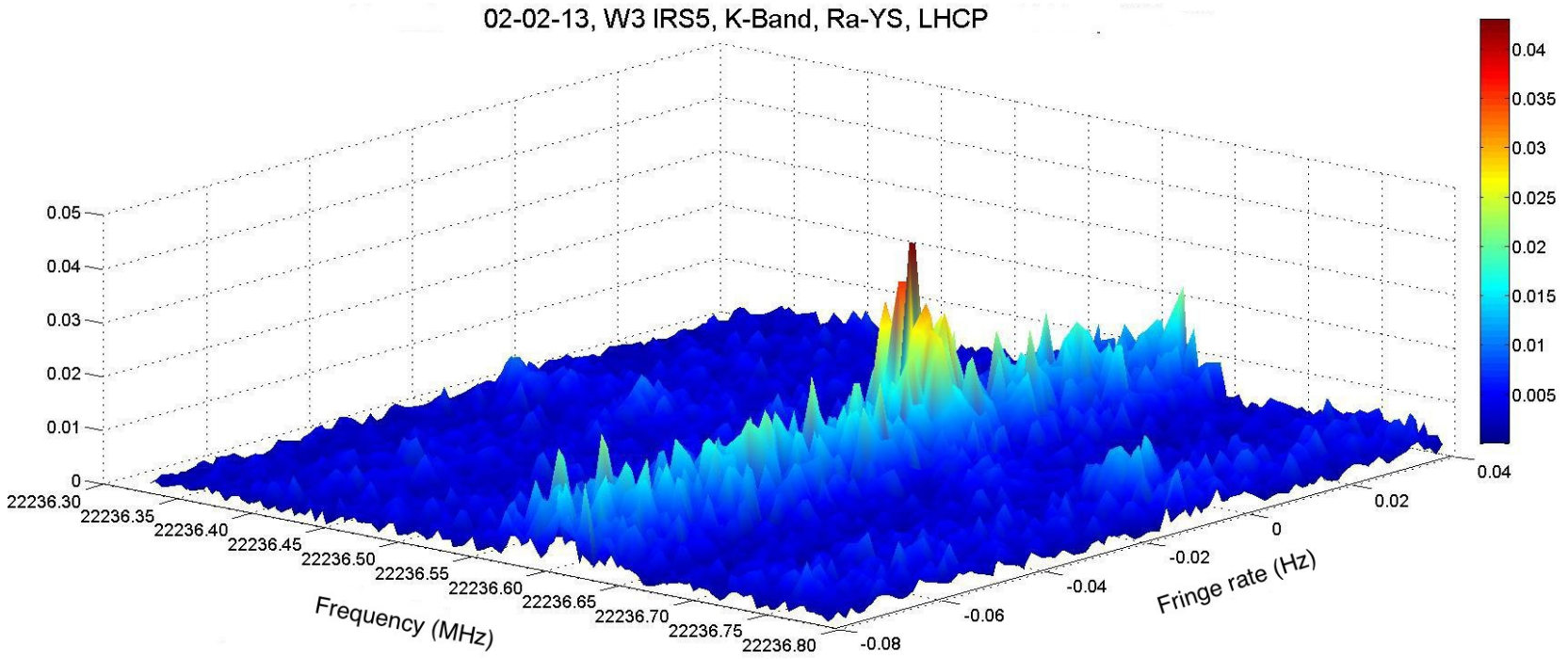

Figure 4: Interference signal from the water maser (wavelength 1.35 cm) in the star forming region W3 IRS5 detected by SRT-Yebes on 2 February 2013 at a projected baseline of 5.42 Earth diameters. Correlated signal is shown versus spectral frequency and fringe rate. Color shows the fringe amplitude.

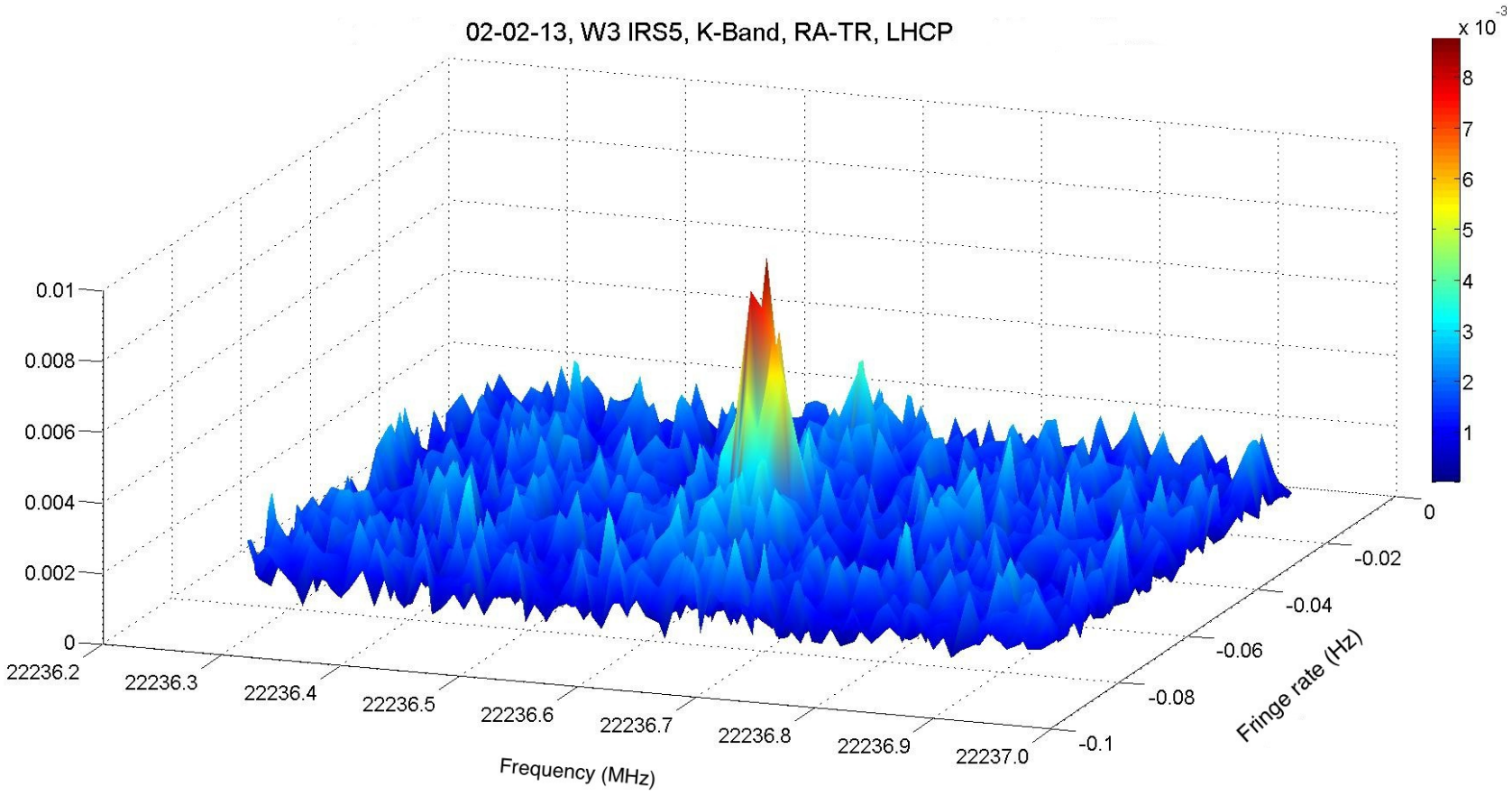

Figure 5: Interference signal from the water maser (wavelength 1.35 cm) in the star forming region W3 IRS5 detected by RadioAstron-Torun on 2 February 2013 at a projected baseline of 5.28 Earth diameters. Correlated signal is shown versus spectral frequency and fringe rate. Color shows the fringe amplitude.