32nd URSI GASS, Montreal, 19–26 August 2017

Water MegaMasers at extreme Resolution

W. A. Baan[(1)], A. Alakoz[(2)], T. An[(3)], S. Ellingsen[(4)], C. Henkel[(5)], H. Imai[(6)], V. Kostenko[(2)], J. McCallum[(4)], J. Moran[(7)], A. Sobolev[(8)], M. Voronkov[(9)]
(1) Netherlands Institute for Radio Astronomy ASTRON, Dwingeloo, Netherlands
(2) AstroSpace Center, Lebedev Institute, Moscow, Russia
(3) Shanghai Astronomical Observatory, Shanghai, China
(4) University of Tasmania, Hobart, Australia
(5) Max Planck Institut für Radioastronomie, Bonn, Germany
(6) University of Kagoshima, Kagoshima, Japan
(7) Center for Astrophysics, Harvard University, Cambridge, United States
(8) Ural Federal University, Ekaterinburg, Russia
(9) CSIRO Commonwealth Scientific Research Organisation, Sydney, Australia

1 Extended Abstract

As part of the ongoing survey of nearby extragalactic H_2O maser sources with the RadioAstron Observatory (RAO), two powerful MegaMasers, NGC 3079 and NGC 4258, have been detected on ground to RAO baselines. The objectives of the K-band survey are fringe detections at increasing baselines for all strong sources that are observable with RadioAstron, which also includes the Circinus galaxy, the MM NGC 4945, and the star-formation regions LMC−N 113 and M 33−IC 133.

The H_2O MM emission in NGC 3079 has been detected on two occasions in 2014 at 1.9 Earth diameters (ED), while NGC 4258 has been detected eight times between at 1ED and 26.9ED in 2014-2016. The recent detections in these older data resulted from re-correlation with updated orbital parameters for RadioAstron and careful scrutiny of the delay-fringe rate data. Other observations of NGC 3079 beyond 2ED did not result in detections.

The current results already emphasise strong differences in the masering environments of the two sources. While the spectra at increasing terrestrial baselines show a decrease in line flux, the multi-ED baselines show that most of the line emission disappears at higher resolution. The features of NGC 4258 are reduced by up to 90% at baselines of 19.5 ED and higher and the features of NGC 3079 appear to totally disappear beyond 2ED although it is twice as far as NGC 4258. At longer baselines the emission features in NGC 4258 appear as unresolved isolated features having a higher apparent gain, while a more diffuse emission component has been resolved. Because saturated features would remain unresolved up to much higher resolution, the bulk of the observed emissions appears to be unsaturated. A (currently) plausible scenario for these sources is that pumped molecular clouds provide amplification of a background radio continuum, where both the amplifying gain distribution and the background have a spatial structure. The nature of the masering environment is important for understanding the MegaMaser phenomenon and is particularly relevant for distant and unresolved sources.

These results also raise questions about the common practise of always interpreting maser components (on terrestrial baselines) as (saturated) point sources, which has important implications with regard to systematic errors affecting trigonometric distance measurements. High signal-to-noise spectral line data obtained for extragalactic sources will potentially show polarisation. At longer baselines the high brightness spectral features appear to be isolated, which makes it possible to detect the presence of ordered magnetic fields for these components rather than having tangled fields suppressing the polarisation signature.