

Hydroxyl (OH) Spectral Lines at 53.2 and 55.1 MHz: A Search for Galactic Maser Emission Using LOFAR

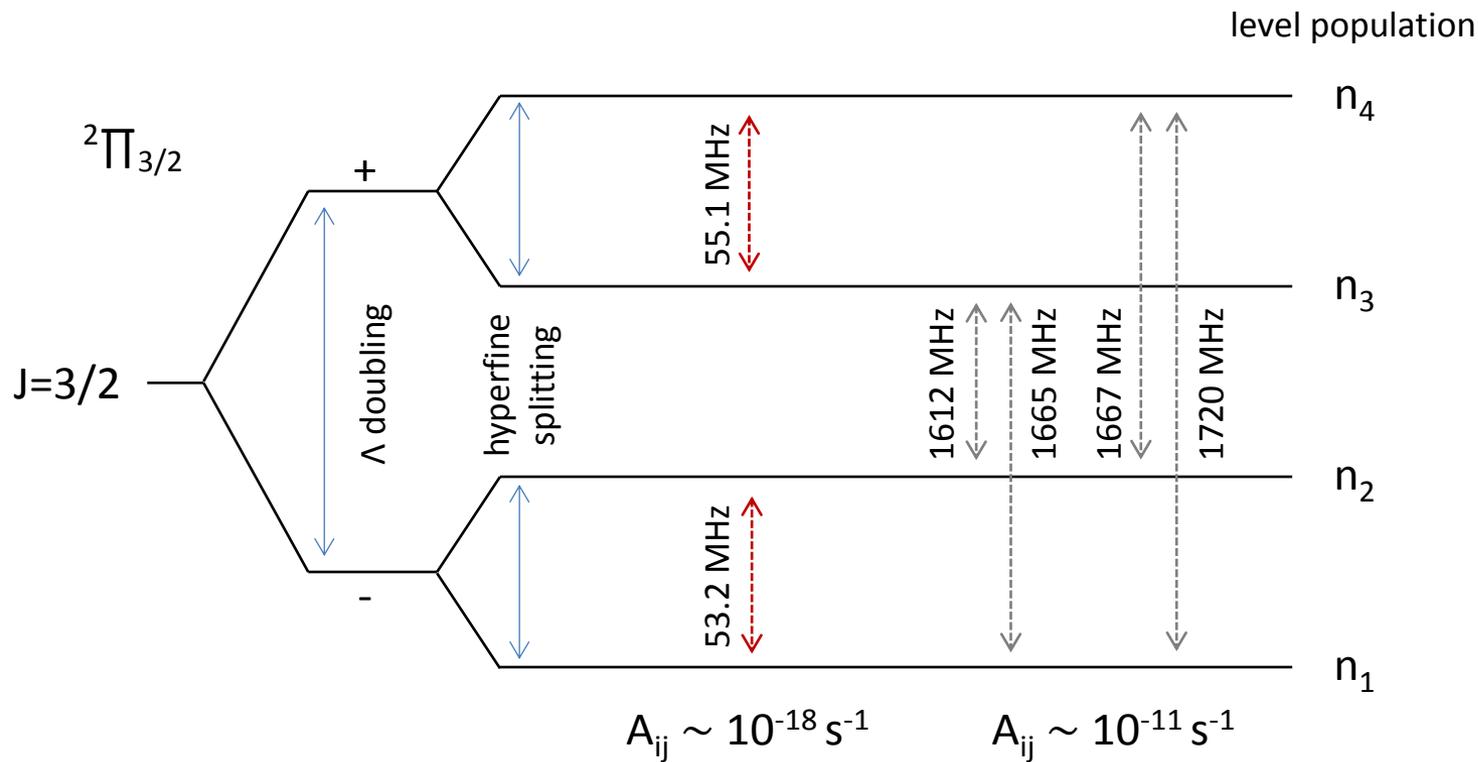
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LOFAR Status Meeting

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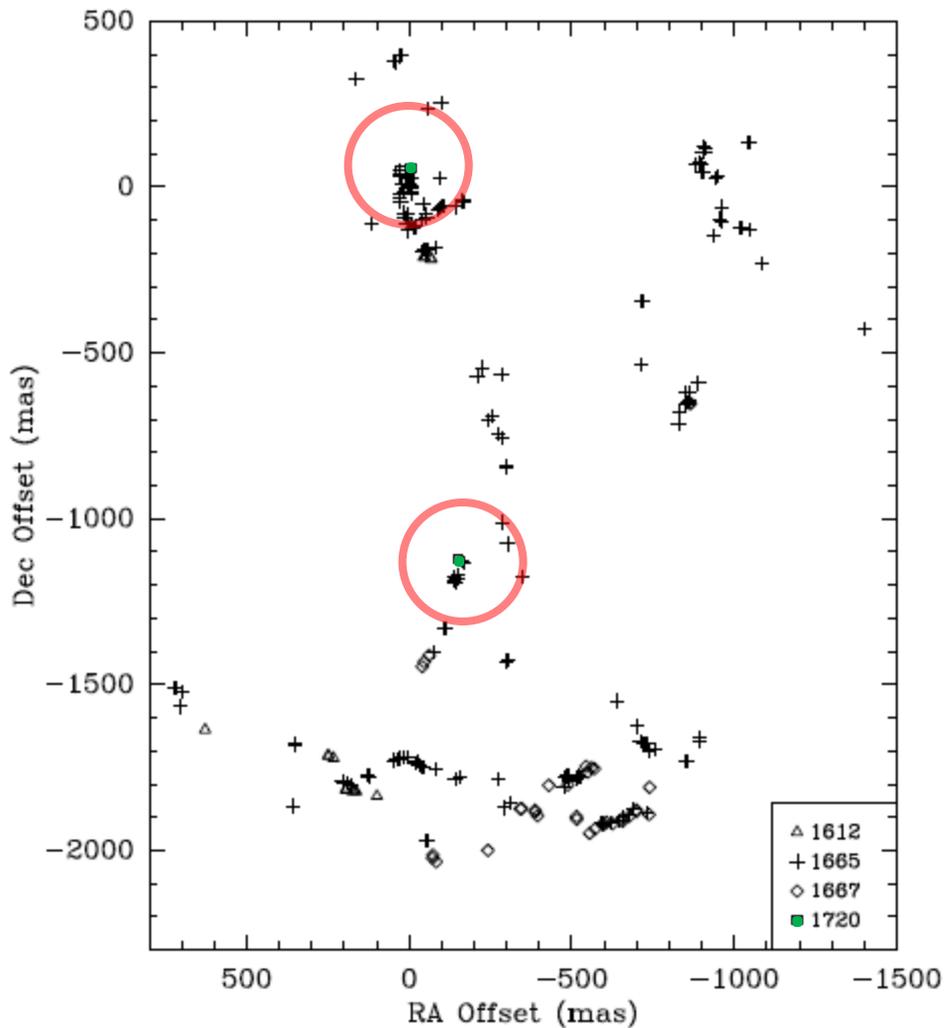




a naïve assumption: the lack of a maser detection means lack of a population inversion

example: maser in 1720 MHz ($n_4 > n_1$), maser in 1665 MHz ($n_3 > n_1$), *no* maser in 1667 MHz ($n_2 > n_4$), and *no* maser in 1612 MHz ($n_2 > n_3$) – then $n_2 > n_3 > n_1$ and $n_2 > n_4 > n_1$ which is a population inversion of the 53-MHz transition ($n_2 > n_1$)

the truth: population inversion is necessary but not sufficient for masering – detecting a 53-MHz maser would mean that 1667 MHz is truly underpopulated, not just suppressed



An example, W3(OH): The circled green dots in this VLBI map are sites of 1720 and 1665 masers without 1667 nor 1612 MHz

Do the sites lack a 1667 maser because

- 1667 is not inverted?
- or
- 1667 is inverted but suppressed?

detecting a 53-MHz maser at either of these sites would indicate that 1667 is *not* inverted.

W3(OH) is typical of the variety of permutations of coincidences seen in other sources; the 53- and 55-MHz lines are valuable diagnostics in every case

Two previous searches for 54-MHz OH maser emission, no detections

- Menon, Roshi, & Prasad, 2005 MNRAS 356, 958
 - 53-MHz line toward W51 SNR and W51 SFR
 - non-detection: 39-Jy 3- σ upper limit in a 4.6-km/s channel
 - National MST Radar Facility, Gadanki, India
- Marthi & Chengalur, 2010 MNRAS 407, 258
 - 55-MHz line toward W44 SNR
 - non-detection: 17-Jy 3- σ upper limit in a 1.0-km/s channel
 - GMRT

Our Commissioning experiments, no detections

- employed 21 48-element stations for 6.0 hours of observations
- 3-Jy 3- σ upper limit (these sources contain L-band masers >100 Jy)
- 0.5-km/s velocity resolution (essential for discerning gradients)
- observed both lines simultaneously: 55 MHz and 53 MHz
- two Galactic sources: W3(OH) and W75N

Future work

- deeper searches (< 1 Jy)
- more targets, including SNR targets, perhaps extragalactic megamaser targets
- survey for 54-MHz emission *without* accompanying L-band emission (!)

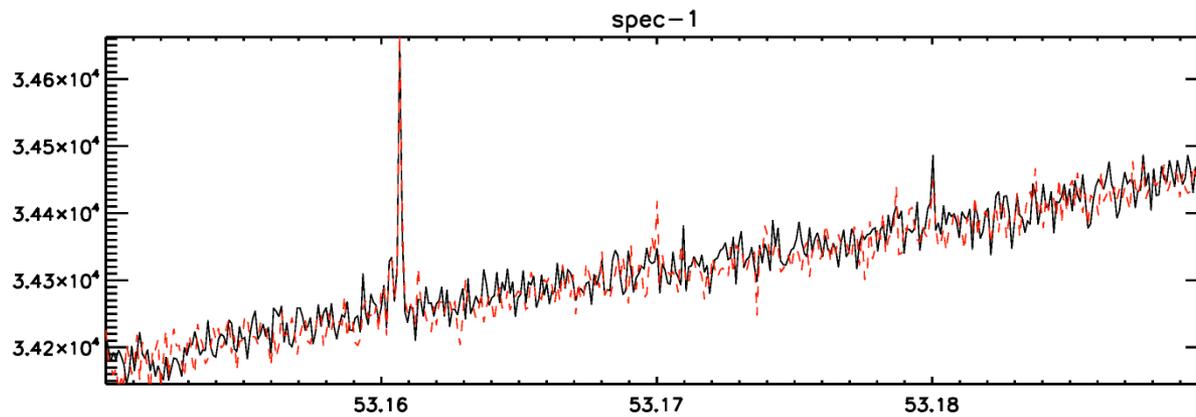
data and technical slides follow this slide

Beamformed Correlation Tests

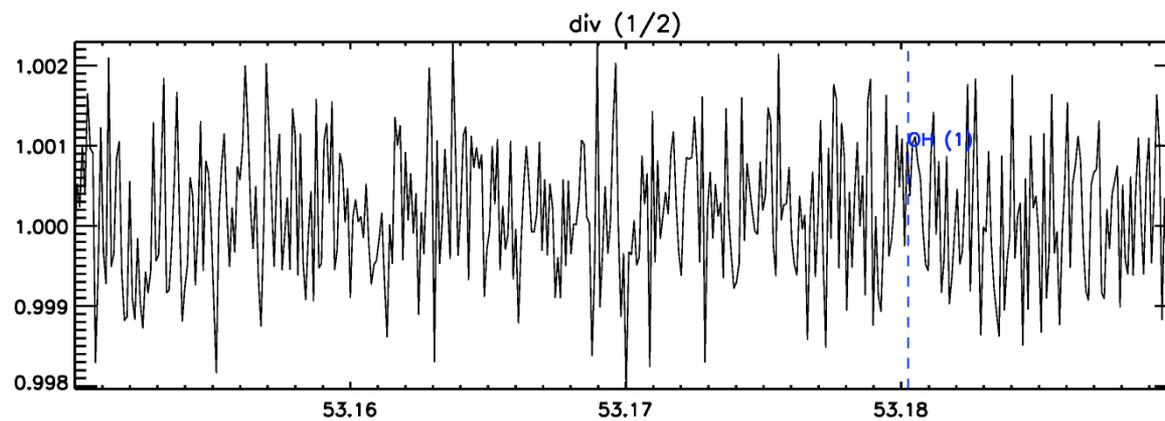
- 512-, 1024-, 2048-channel setups all successful
 - used 2048 70-Hz channels for final observations
- 4096 channels
 - Crashed because total integration time for block exceeded 0.33 s
- 4000 channels
 - Crashed even though $0.3278 \text{ s} < 0.33 \text{ s}$, indicating that 0.33 s is not the actual upper limit
- 3072 channels
 - Crashed due to flag conversion failure

W3(OH)

on, off

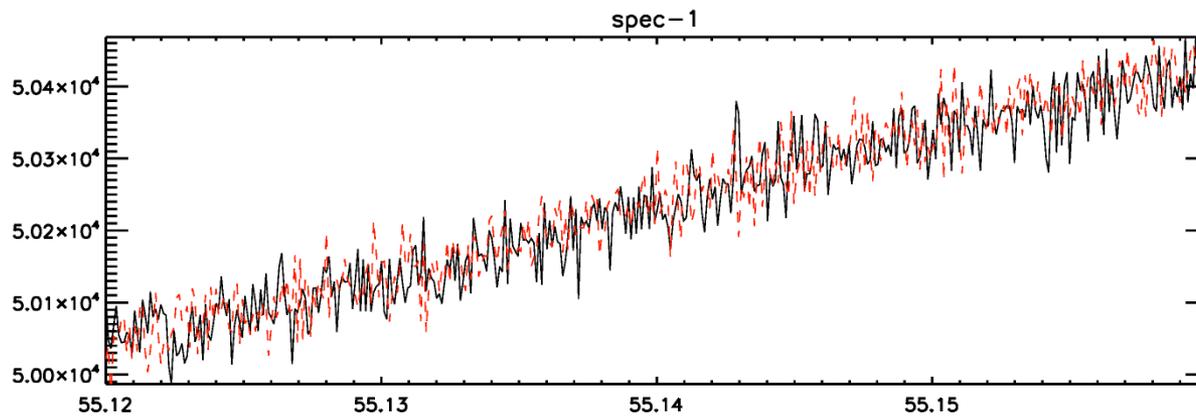


on/off

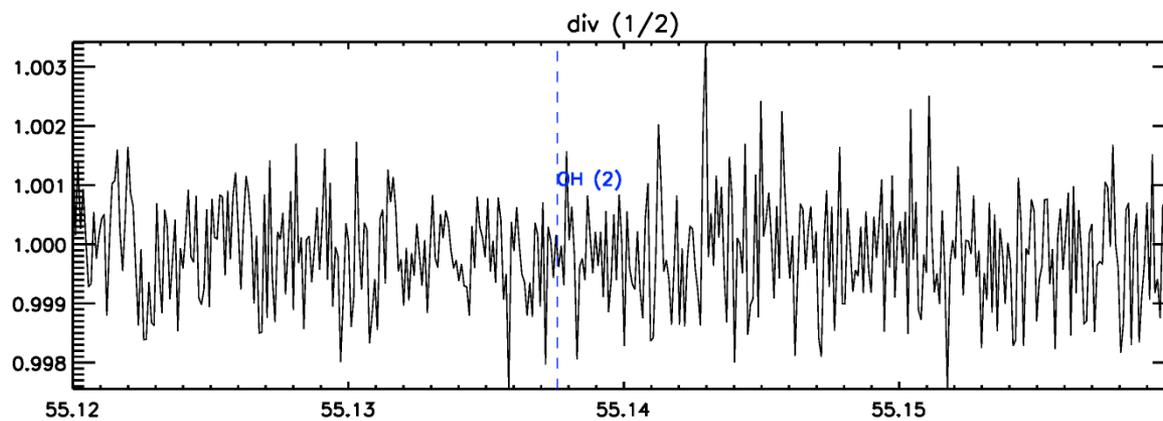


W3(OH)

on, off

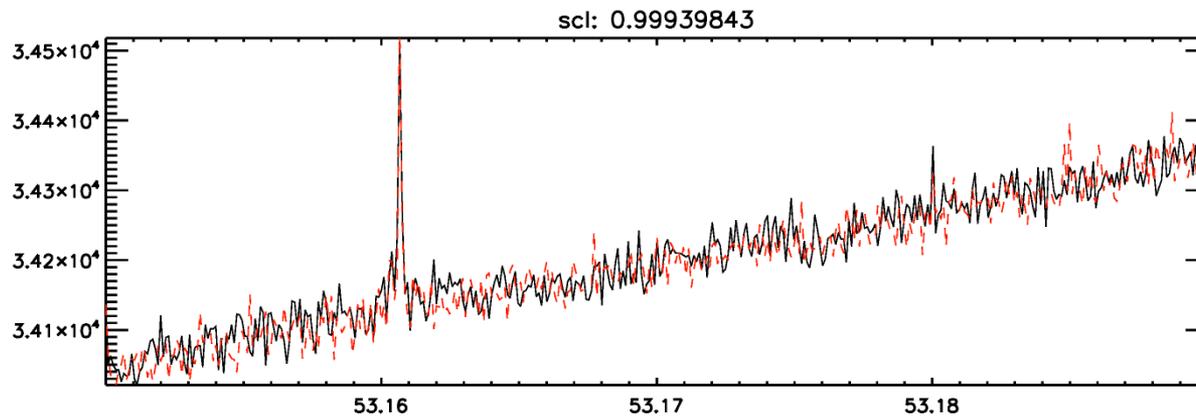


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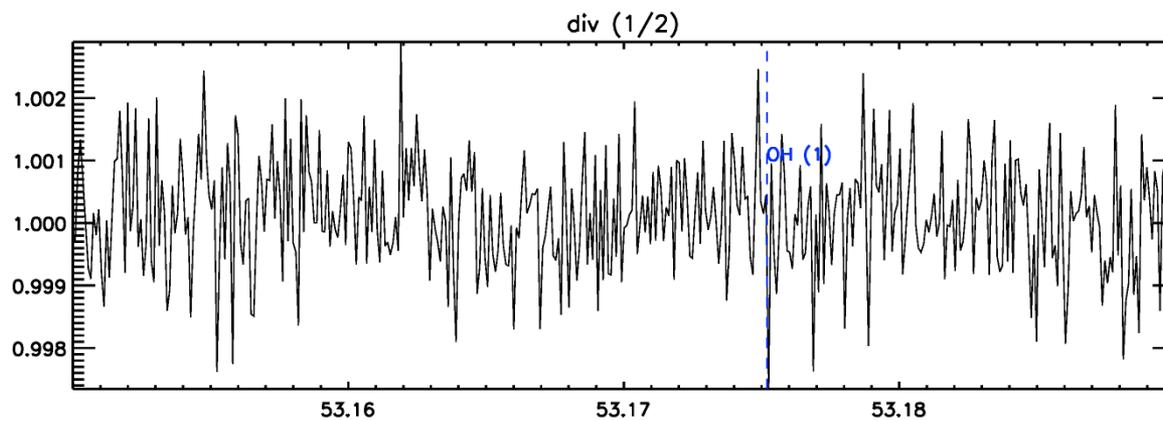


W75N

on, off

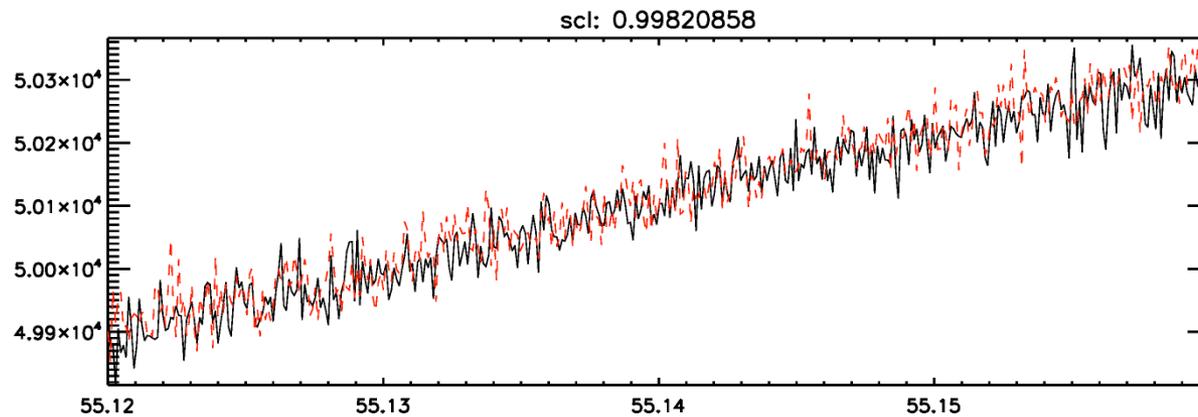


on/off



W75N

on, off



on/off

