

Extragalactic Water Megamasers using ALMA Band 5

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The APEX telescope

Swedish and ESO Time



The ALMA pathfinder observations were performed using an ALMA Band 5 receiver on APEX (APEX SEPIA Band 5).

Motivation. Water megamaser galaxies have been the object of extensive study at 22 GHz, since the discovery that the emission traces a sub-parsec scale portion of the circumnuclear disk in NGC 4258, within 1 pc of the supermassive black hole (SMBH). Very Long Baseline Interferometry (VLBI) observations of the masers have provided detailed information on the kinematics and structure of active galactic nucleus (AGN) circumnuclear disks. These can also be used to perform maser cosmology and have yielded high-accuracy Hubble constant estimates. Here we study mm/submm megamasers.

In this work we have made the first detection of 183 GHz megamaser emission towards AGN NGC 4945 and have also studied emission from ULIRG Arp 220.

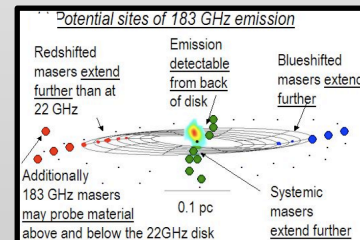
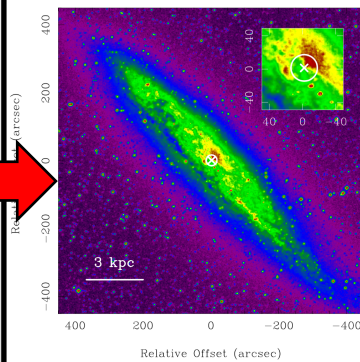
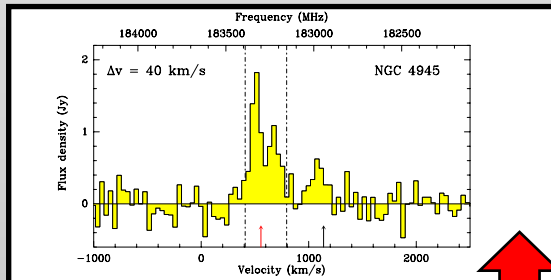
Arp 220
Galametz et al. 2016

NGC 4945

Humphreys et al. 2016

NGC 4945 from the Palomar Sky Survey.

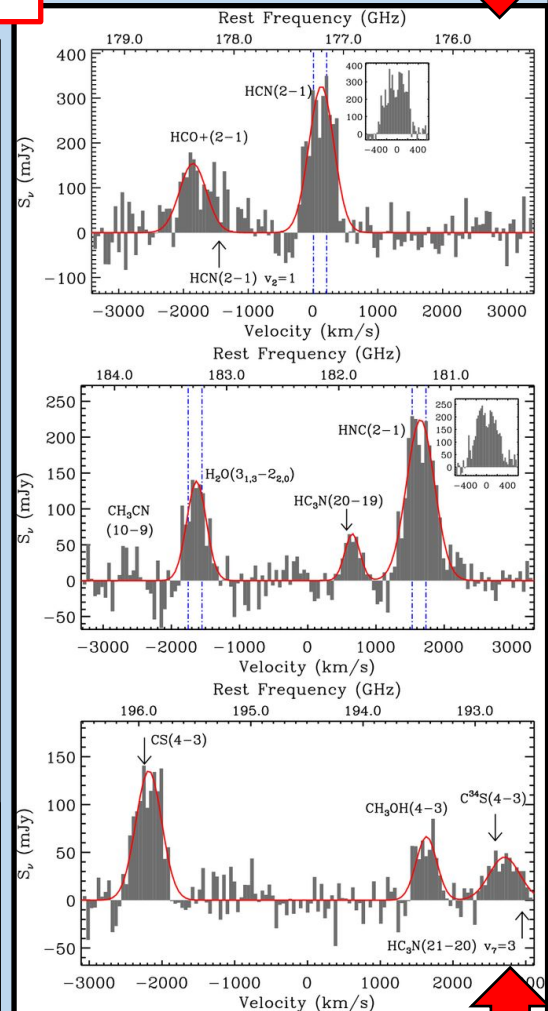
The cross indicates the position for NGC 4945 used in our APEX SEPIA Band 5 observations: $\alpha_{2000} = 13:05:27.28$, $\delta_{2000} = -49:28:04.4$. The circle indicates the half-power beamwidth (HPBW) of the APEX observations. At a sky frequency of 182.981 GHz this corresponds to $31.8''$, or 570 pc at a distance of 3.7 Mpc.



Emission is believed to originate from the AGN circumnuclear disk.

183 GHz H₂O megamaser observations towards NGC 4945 (1h).

The plotted spectral resolution is 40 km s^{-1} . The red arrow indicates the approximate galactic systemic velocity of 556 km s^{-1} . The dashed lines indicate the velocity range of 22 GHz H₂O megamaser emission determined by Greenhill et al. (1997), about 410 to 800 km s^{-1} . The black arrow denotes the velocity of a marginally significant feature in the 321 GHz spectrum reported by Hagiwara et al. (2016) (the strongest features at 321 GHz occurred between about 650 to 750 km s^{-1}). The velocity scale is radio LSR.



References:

Cernicharo et al. 2006, ApJ, 646, L49
Galametz et al. 2016, MNRAS, 462, L36
Greenhill et al. 1997, ApJ, 481, L23
Hagiwara et al. 2016, ApJ, 827, 69
Humphreys et al. 2016, A&A, 592, L13

For Arp 220, 183 GHz emission is believed to originate from $\sim 10^6$ star-forming cores (Cernicharo et al. 2006).

SEPIA Band 5 observations towards Arp 220 (6.2 h).

The plotted spectral resolution is 50 km s^{-1} . We observe strong water and methanol emission as well as many tracers of the dense gas (HCN, HNC, HCO⁺, CS, HC₃N, C³⁴S). Insets show the HCN and HNC double-peak profiles at a 25 km s^{-1} resolution (x-axis: velocity relative to the centre of the line). We overlay the position of their respective peaks on the H₂O, HCN and HNC lines (blue).