Astrophysical Masers and their Environments
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Maser science at Tidbinbilla

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Abstract. The 70 m antenna at Canberra Deep Space Communication Complex (Tidbinbilla) is the largest and most sensitive dish in the southern hemisphere, working at 1, 3, 13 and 18 cm, and as such is in high demand from astronomers both in Australia and overseas. In this paper we present the current status of the single dish spectroscopy system and highlight some recent results in maser science.

1. 12 mm system and spectrometer

The Canberra Deep Space Communications Complex (CDSCC) at Tidbinbilla is part of NASA's Deep Space Network (DSN) and is home to the largest and most sensitive single dish in the southern hemisphere. This 70-m antenna is primarily used for spacecraft tracking but, as part of the Host Country agreement with NASA, a fraction of time on the antenna is allocated for independent scientific activities sponsored by the Australian Government. This time allocation, typically 300 hours per year, is divided into single-dish and VLBI observing. Access to this time is obtained via proposal through the ATNF and is open to anyone.

Of particular interest is the 12 mm (18–26 GHz) system. With a SEFD of 60 Jy it is 10 times more sensitive than the current Parkes system and when the Parkes 12 mm receiver is upgraded will still be 3.5 times more sensitive. The 12 mm system at Tidbinbilla currently operates with an on-axis feed and provides dual-polarisation output with an instantaneous available bandwidth of 600 MHz. An upgrade is currently underway to provide a simultaneous off-axis beam to allow simultaneous on- and off-source spectra to be taken, effectively halving the required observing time for pointed observations.

Currently Tidbinbilla is equipped with a Parkes Multibeam correlator block which allows two IFs to be correlated at a maximum bandwidth of 64 MHz. For more information see http://www.atnf.csiro.au/observers/tidbinbilla. It is hoped that a new spectrometer will soon be obtained to provide sufficient bandwidth and channelisation to handle all four IFs from the upgraded front-end.

2. Galactic masers

Ellingsen *et al.* (2004) searched for 19.9 GHz methanol masers in star-forming regions using the 70 m telescope and found six new sources. The results indicate a strong correlation between 19.9 GHz methanol masers and the Class II methanol masers associated with 6035 MHz OH masers.

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Valdettaro *et al.* (2007) performed a high sensitivity survey of water masers in bright rimmed clouds compressed by ionization fronts from nearly massive stars. They found masers from seven bright rimmed interstellar clouds out of 44 such regions. The low detection rate suggests that low-mass star formation is the most natural outcome of such external compression.

Deacon *et al.* (2007) observed a sample of 85 post-Asymptotic Giant Branch (post-AGB) candidate stars, selected on the basis of their OH 1612 MHz and far-infrared properties. New detections of water masers were identified for 21 stars. The source b292 is a young post-AGB star that is highly likely to be a 'water fountain' source with highly collimated, high velocity (up to 210 km/s) water masers. (See Chapman *et al.* in these proceedings.)

3. Extragalactic masers

Greenhill *et al.* (2003a) discovered water maser emission in seven AGN using a custom-built 4096 channel spectrometer with a bandwidth of 5300 km/s. A continuation of the search was made, resulting in new detection in eight more AGN (Kondratko *et al.* 2006). Greenhill *et al.* (2003a) also discovered high velocity components in the Seyfert nucleus of the Circinus galaxy.

Tarchi *et al.* (2007, in preparation) have been searching for water maser emission toward a sample comprised of all galaxies with Dec. < 30 deg with IRAS 100 micron fluxes > 50 Jy in order to confirm the relation between FIR flux and water maser detection rate found in the northern hemisphere (Henkel *et al.* 2005). While this survey is still on going, so far they have detected water masers in one of the sources in the sample.

Greenhill *et al.* (2003b) presented water maser VLBI maps of the the Circinus galaxy obtained by the Australian Long Baseline Array (LBA) in which the Tidbinbilla 70m played a key role as the most sensitive antenna in the array. The outflowing masers are irregularly distributed above and below a warped, edge-on accretion disk (maximum rotation speed 260 km/s), with relative outflow velocities up to $\pm$ 160 km/s, projected along the line of sight.

Greenhill *et al.* (1997) have discovered that the water maser lines in the Circinus galaxy vary on time scales as short as a few minutes. Follow up observations were made at Tidbinbilla by McCallum *et al.* (2005) and the same phenomena were confirmed. McCallum *et al.* (2005) showed that this rapid variability can be explained by interstellar scintillation, similar to that seen in a significant number of flat-spectrum AGN.

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Photos (clockwise from top left): James Moran, James Moran, Andrej Sobolev, Miller Goss

Top row: Professor Xingwu Zheng with Associate Professor Zhaofen Ling (left)
Vicki Drazenovic, Todd Hunter and Crystal Brogan (right)
Bottom row: James and Sheena Caswell (left),
Michael Gaylard and Leszek Blaszkiewicz (right)

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