Wind speeds of metal poor AGB and RSG stars

Steve Goldman, Lennard-Jones Laboratories, Keele University, ST55BG, UK

Jacco van Loon, James Green, Hiroshi Imai, Martin Groenewegen, Ambra Nanni, Albert Zijlstra, Greg Sloan, Mikako Matsuura, Peter Wood

Abstract

We report the discovery of three new circumstellar OH masers in the LMC using the Australia Telescope Compact Array (ATCA). Additionally, we have 6 **new** reliable wind speeds for OH maser emitting stars in the LMC, bringing the total number of reliable wind speeds to 11. These results will allow us to test and refine dust-driven wind theory, and the dependence on metallicity and luminosity of the mass loss of red giants and supergiants.

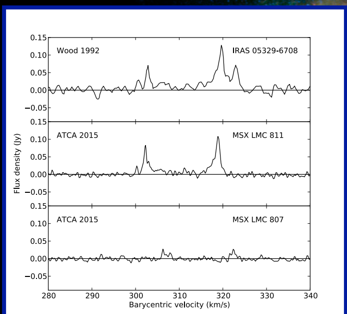
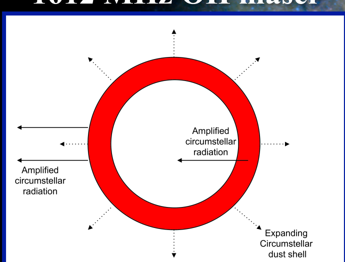


Figure 1: The maser source IRAS 05329-6708, originally detected by Parkes (Wood et al. 1992), has been shown not just to originate from the IRAS counterpart, but from a contribution of the two maser sources MSX LMC 811 and the newly discovered MSX LMC 807. The superior angular resolution of the ATCA has allowed us to resolve these sources where Parkes could not.

1612 MHz OH maser



Expansion velocities and Mass loss

Circumstellar masers allow us to probe the winds of highly evolved stars (AGB, and RSG) at distances that CO line emission cannot. From a 1612 MHz circumstellar OH maser profile, we get a stars final expansion velocity from half the peak separation. The final radial wind speed of our targets is dependent on radiation pressure and collisional coupling of dust grains within the gas. We can use this phenomenon to measure the wind speed as well as the mass-loss rate, as most of the mass lost is in the form of gas. The wind speed is also dependent on the dust-to-gas ratio and the luminosity which makes it a valuable diagnostic of the dust formation and radiation driven wind mechanism.

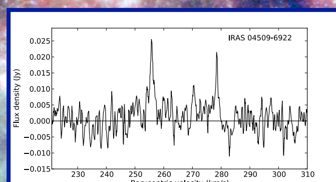


Figure 2: New OH maser detection IRAS 04509-6922

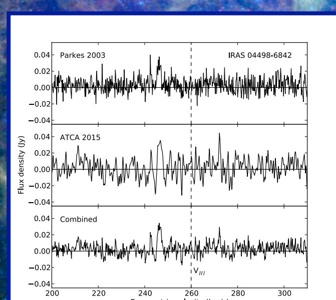


Figure 3: The original IRAS 04498-6842 detection, discovered with Parkes (Marshall et al. 2004), showed an unclear maser profile. From new ATCA observations we have been able to identify the second peak and obtain a reliable wind speed. The HI velocity from Parkes multibeam data (shown as V HI) agrees well with the systemic velocity from our maser profile.

Metallicity and Luminosity

We can simulate populations from an earlier universe by probing metal-deficient areas like the LMC at a half solar. The metallicity dependence of the wind speed was found when comparing OH masers in the Galactic Centre to those in the LMC; our improved sample is plotted in the adjacent figure.

Just as important as metallicity is the dependence on luminosity where, unlike stars in the Milky Way, luminosity measurements in the LMC are much more accurate. We have fit all available reliable photometry from 2MASS, DENIS, WISE, AKARI, MSX, IRAS, and Spitzer, to *DUSTY* models (Ivezić et al. 1995) using a chi squared fitting technique to obtain luminosities. As these stars are highly variable, and we have multi-epoch photometry values, our fitting attempts to lie between these stellar variations. While luminosities are more accurate from accurate distance measurements, we will have a considerable uncertainty that stems from the stellar variability.

We expect fewer maser detections at lower metallicities as they are pumped by IR radiation, which is consequently due to the presence of circumstellar dust. Nevertheless, detections at these levels, will allow us to find the point at which radiation pressure is no longer enough to overcome the star's gravitational influence

At this point, no OH masers have ever been detected in the SMC, with few in the LMC (van Loon 2012, Goldman et al. in prep). Our recent programme using the Australia Telescope Compact Array has successfully increased the LMC maser sample by a third and doubled the number of reliable wind speeds.

Future Work

This is an ongoing programme that will continue to search for circumstellar masers toward our best candidates in low metallicity environments.

We will compare our observed winds speeds to the wind speeds calculated by the *DUSTY* code. We will then derive gas-to-dust ratios to determine the dust formation efficiency at low metallicity, but also to test the predictions for a dust driven wind and hence determine whether the winds are indeed driven by radiation pressure.

These results will allow us to better understand the contribution of sun-sized stars to the interstellar medium, and to the regeneration of the universe.

Please contact with ideas for new ATCA data, or potential maser candidates at the email address listed.

The Effects of Metallicity and Luminosity on Stellar Winds

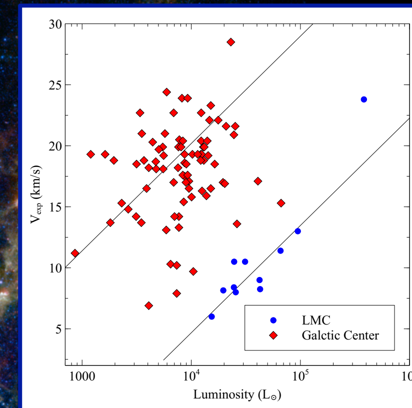


Figure 4: The derived wind speed as a function of luminosity for our sample of OH/IR stars in the LMC.

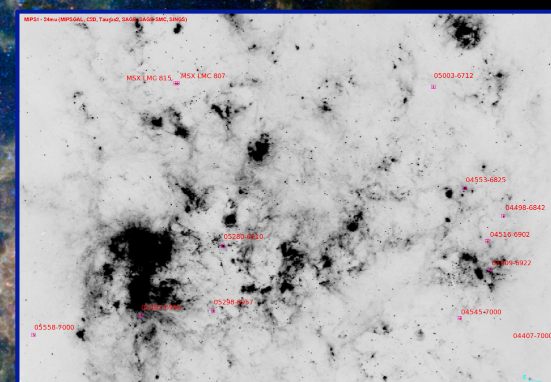


Figure 5: Our current sample of OH maser emitting stars in the Large Magellanic Cloud super-imposed on a MIPS 24 micron image (Meixner et al. 2006). We have six Australia Telescope Compact Array fields of the Large Magellanic Cloud at 1420, 1612, 1665, 1667, 1720, and 2100 (continuum) MHZ.

References: Ivezić U., Nenkova M., & Elitzur M., 1995, ApJ, 445, 415; Marshall J. et al., 2004, MNRAS, 355, 1348; Meixner M. et al., 2006, AJ, 132, 2268; van Loon J. Th., 2012, (arXiv:1210.0983); Wood P.R., Whiteoak J.B., Hughes S.M.G. et al., 1992, ApJ 397, 552

s.r.goldman@keele.ac.uk

KPA KEELE POSTGRADUATE ASSOCIATION

ROYAL ASTRONOMICAL SOCIETY 1820

Keele University