Astrophysical Applications of Stellar Pulsation
ASP Conference Series, Vol. 83, 1995
R. S. Stobie and P. A. Whitelock, eds.

Obscured AGB Stars in the LMC

Albert Zijlstra, Cecile Loup, Rens Waters, Patricia Whitelock and Francois Guglielmo

Abstract. We have carried out a search for obscured AGB stars in the LMC, observing fields in the vicinity of faint IRAS sources. About 25 heavily reddened AGB stars were found, with bolometric magnitudes close to the classical AGB limit of $M_{bol} = -7.1$. 10-μm photometry for 5 sources show that these are oxygen-rich; they are similar to the Galactic OH/IR stars. Mass-loss rates vary between 5×10^{-4} and 2×10^{-6} $M_{\odot}$ yr^{-1}. We find no evidence that the mass-loss rates vary with luminosity. Neither do the mass-loss rates differ in a clear systematic way between the SMC and the LMC. The expansion velocities appear to be slightly lower in the LMC than in the Galaxy. All of the luminous stars for which periods are available have luminosities significantly above the period-luminosity relation derived for optical LMC Miras.

1. Survey

Mass-losing, obscured AGB stars have only recently been found in the LMC (Reid 1991, Wood et al. 1992). Although few are known, they are very important to relate the mass-loss phase on the AGB to the stellar evolution: they are the only high-mass-loss AGB stars for which an accurate distance is known. To increase the sample, we have carried out an infrared survey of candidate IRAS sources in the LMC. We selected IRAS sources from two deep catalogues: Schwering & Israel (1989) and Reid et al. (1990), based on flux density (for an AGB star one expects typically $f_{12} \approx 0.3$ mJy) and the 12 versus 25μm colour. The SIMBAD database was used to find possible optical counterparts. Many sources had no known identification; the ones which did were mostly identified as supergiants.

2. Results

About 25 obscured AGB stars were discovered, some detected only in the K-band. Their bolometric magnitudes are mostly between −6.0 and −7.2. A number of reddened supergiants (significantly more luminous than the AGB stars) were also found. Together with earlier detections, there are now 39 obscured AGB stars known in the Magellanic Clouds.

We obtained 10μm photometry for five sources using ESO's TIMMI camera. Three filters were used: N-band, a narrow-band filter centred at 9.8μm (the silicate feature) and a narrow-band filter centred at 11.3μm (SiC). These three filters allow us to separate oxygen-rich from carbon-rich stars. The colours of

https://doi.org/10.1017/S0252921100037830 Published online by Cambridge University Press

the LMC stars indicate they are oxygen-rich, with (except for one) the silicate feature in emission. Two of the LMC stars have a very strong silicate feature: in our Galaxy this is only seen in stars with faint 12μm emission and low mass-loss rates, where the entire 12μm flux is due to silicate emission. The LMC stars mimic this behaviour while being much more luminous than these Galactic stars.

We derive dust mass-loss rates from the near-infrared–mid-infrared colours. Derived values vary from -5.75 to about -8.0 (in $\log M_\odot\,\mathrm{yr}^{-1}$). For a reasonable dust-to-gas ratio of 400, the total mass-loss rates are between a few times 10^{-4} and a few times 10^{-7}. Within our sample, there is no evidence that the values depend on luminosity, nor do we find any systematic difference between the LMC and SMC (albeit with only 5 SMC stars).

Expansion velocities are available for only four of the IRAS-detected AGB stars in the LMC, in all cases based on the OH detections by Wood et al. (1992). To compare these objects to Galactic OH/IR stars we selected all Galactic OH/IR stars which have also been detected in CO. Distances are estimated by assuming a luminosity of $10^4 L_\odot$. The CO gives an independent check on the OH expansion velocity. There is a slight tendency for the LMC stars to have lower expansion velocities. The difference is about 10–20%, although there is insufficient data to draw a firm conclusion. We note that Wood et al. derive a larger difference of about 50% from the same data: the present conclusion is based on a slightly different way of determining the expansion velocity from noisy OH spectra. In either case, the lower LMC metallicity appears to affect the outflow velocity of the stellar wind.

A period–luminosity relation for LMC Miras has been derived by Feast et al. (1989), based on stars with periods less than 420 days. The relation is quite tight, and is promising for future use in distance determinations for nearby galaxies. However, the relation cannot be easily confirmed for Galactic stars because of the poorly known distances. Periods are available for a number of the IRAS-detected AGB stars in the LMC. We find that the longer-period variables fall far above the relations, which clearly are not valid at longer periods. There is in fact little indication for any PL relation at long periods. Part of this may be due to evolution in luminosity due to convective-envelope burning. The PL relation may also widen if the envelope mass evolves significantly, which can be expected for higher-mass stars which will loose most of their mass on the AGB.

References

Feast M.W., Glass I.S., Whitelock P.A., & Catchpole R.M., 1989, MNRAS, 241, 375

Reid I.N., Tinney C.G., & Mould J.R., 1990, ApJ, 348, 98

Reid I.N., 1991, ApJ, 382, 143

Schwering P.B.W., & Israel F.P., 1990, A catalog of IRAS sources in the Magellanic Clouds (Kluwer, Dordrecht)

Wood P.R., Whiteoak J.B., Hughes M.G., Bessell M.S., Gardner F.F., & Hyland A.R., 1992, ApJ, 397, 552