OH/IR STARS IN THE LARGE MAGELLANIC CLOUD: THE OBSERVATIONS

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In 1985 we began a search for OH/IR objects in the Magellanic Clouds. The first detection was reported by Wood, Bessell & Whiteoak (1986). Subsequent searches have yielded several of these objects and other highly-evolved stars obscured by thick circumstellar shells.

The 1612-MHz OH observations were made using the Parkes 64-m radio telescope. Most of the observations utilized a dual-channel cryogenic receiver providing a system temperature of around 38 K on cold sky. The OH spectra were obtained with the Parkes digital correlator split into 512-channel segments. Bandwidths of 2 MHz provided a resolution of 7.8 kHz (equivalent to 1.5 km s^{-1} in radial velocity) after Hanning smoothing. The mode of observation has been described by Whiteoak and Gardner (1976). Typically, an integration period of 60 minutes was used; this yielded a detection limit (3σ) of around 50 mJy for an OH feature. Detected emission was reobserved with a 1-MHz bandwidth . A search was also made for 1665-MHz OH emission.

Our basic sample of objects was selected from the IRAS point source catalog. A few Harvard variables known to be bright asymptotic giant branch (AGB) stars were also included. Objects with flux densities above 0.7 Jy at 25 μm wavelength (S_{25}) were chosen, provided that they satisfied $0.5 > \log(S_{25}/S_{12}) > -0.1$ and were not obvious HII regions or clusters.

1612 MHz observations were obtained for 39 positions. Maser emission was detected in six cases, all in the LMC. Most of the profiles show a pair of narrow features typical of Galactic OH/IR objects. Fig. 1 shows the profile containing the most intense emission. Emission at 1665 MHz was also detected in two cases. Table 1 lists the detected OH/IR objects and associated OH results. At 1612 MHz, the peak flux densities of the two main components are listed. V_{exp}, the stellar wind expansion velocity, is assumed to be half the velocity separation of the outer edges of these components, and V* is the mean value of the corresponding velocities.

IRAS 05280-6910 has atypical OH/IR spectra showing a series of narrow 1612-MHz features between 248 and 295 km s^{-1} (Fig. 2) and a brighter 1665-MHz feature at 240 km s^{-1}. The spectra are not unlike those for the Galactic object IRAS 15405-4945 which te Lintel Hekkert *et al.* (1988) have suggested belongs to a small group of OH/IR stars showing bipolar mass loss. Pointing observations using the 1665 MHz feature yielded a position of RA(1950) = 05h27m56s ±6s, Dec(1950) = -69°09'45" ±30". It is similar to the IRAS position for the object (05h28m00s, -69°09'25"), and places the object near the centre of cluster NGC 1984.

IRAS sources were also observed with the 2.3-m telescope at Siding Spring Observatory and the Anglo-Australian Telescope (AAT). The limiting K magnitude was 11 for the 2.3 telescope, 12.5 for the AAT. An area within 30 arcsec of the selected IRAS position was searched. J, H and L' magnitudes were obtained for detected objects. Table 2 lists the detections. The intensities, in particular those of the detected OH/IR stars, were found to vary; Fig. 3 shows an example. All the periods are very long, exceeding 1000 days; this also occurs for some of the Galactic OH/IR stars (Herman & Habing 1985; Engels *et al.* 1983). Assuming an LMC distance modulus of 18.5, bolometric luminosities (M_{bol}) were estimated from mean magnitudes.

Fig. 4 shows M_{bol} plotted against log period (P) for optically detected long-period variables in the LMC (Wood, Bessell & Fox 1983; Reid, Glass & Catchpole 1988; Hughes & Wood 1990) and for the OH/IR objects of Table 3. It appears that the IRAS sources form longer-period extensions of both the supergiant and AGB sequences.

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The LMC objects appear to have expansion velocities about half those of their Galactic counterparts with similar luminosities. The terminal velocity of the stellar winds in late-type stars may be due to the effects of radiation pressure acting on grains in the circumstellar material, with the grains dragging the gas along with them (e.g. Knapp 1986; Zuckerman & Dyck 1986; Jura 1986). This leads to an expansion velocity proportional to $k^{1/2}$, where k is the opacity of the dusty material. Thus the smaller velocities in the LMC might reflect a lower abundance of grains.

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Table 1. Detected LMC OH/IR Objects

IRAS	S_{1612} (Jy)	S_{1665} (Jy)	V_{exp} (km s^{-1})	V*
04545-7000	0.14,0.03	<0.04	9.5	266
04553-6825	0.39,0.20	0.08,0.13	9.5	260
05280-6910	0.09,0.07	0.31	22.5	272
05298-6957	0.24,0.13	<0.06	12.5	282
05329-6708	0.07,0.13	<0.05	12.0	312
05402-6956	0.07,0.07		12.5	272

Table 2. Near-IR Detections

IRAS	IRAS	IRAS
00477-7343	00521-7054	01039-7305
04509-6922	04516-6902	04530-6916
04545-7000	04553-6825	04571-6954
05216-6753	05244-6832	05247-6941
05261-6614	05294-7104	05298-6957
05325-6743	05329-6708	05389-6922
05402-6956