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Expected Differences between AGB Stars in the LMC and the SMC Due to Differences in Chemical Composition

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Abstract.
Certain aspects of the AGB population, such as the relative number of M and N stars, the mass loss rates, and the initial masses of carbon–oxygen cores, depend on the initial heavy element abundance Z. I have calculated synthetic populations of AGB stars for different initial Z values taking into consideration the evolution of single and close binary stars. I present the results of population syntheses of AGB stars in clusters as a function of different initial chemical compositions. The relation for the tip luminosity of AGB stars versus cluster age as a function of Z is presented and is used to determine the ages for a number of clusters in the LMC and the SMC, including clusters with no previous age determinations.

Population simulations show that for low heavy element abundance ($Z = 0.001$) few M stars are formed with respect to the number of carbon stars. However, the total number of all AGB stars in clusters is not affected by the initial chemical composition.

As a result of the evolution of close binary components after the mass exchange, an increase in the range of limiting values of the thermal pulsing AGB star luminosities is expected. The difference between the maximum luminosity on the AGB of single star and the luminosity of a star after a mass exchange event in a close binary system may be as great as 1 magnitude for very young clusters. The specific value is a function of the chemical composition. For old clusters the difference is small.

The AGB star models predict that the maximum luminosity reached along the AGB is a function of the stellar initial mass. Therefore, knowing the bolometric magnitude of the brightest star in a cluster, one can derive the initial mass of star now on the AGB, and thus the age of the cluster. This method was used by Frantsman (1988). I have redetermined the cluster ages using the new results of AGB modeling taking into account the differences of initial chemical composition. Table 1 shows my results. The first column denotes the cluster, the second - heavy element abundance Z, the third – the luminosity of the most luminous star in the cluster (Westerlund et al. 1991), the fourth column - cluster ages t determined by calibration curves, and the last column – the ages T, determined by classical methods.

Table 1. The ages of the MC clusters. The age t was obtained using the maximum luminosity of the cluster AGB stars. The age T was obtained by classical methods.

Cluster	Z	M_{bol}	$t(10^9)yr$	$T(10^9)yr$
NGC 1783	0.008	-5.15	0.28	0.2
				0.9
NGC 1831	0.02	-5.23	0.22	0.55
				0.186
NGC 1846	0.008	-5.14	0.28	
NGC 1852	0.008	-5.20	0.27	
NGC 1866	0.008	-6.04	0.10	0.09
NGC 1916	0.008	-4.97	0.3–1.2	
NGC 1978	0.008	-5.18	0.25	2.1
				0.45
NGC 1987	0.008	-5.28	0.25	0.48
NGC 2107	0.008	-5.73	0.18	0.22
NGC 2108	0.008	-5.46	0.22	0.52
NGC 2121		-5.36	0.24	0.39
			0.47	0.7
NGC 2134		-5.72	0.18	0.087
			0.19	0.19
NGC 2154	0.008	-5.27	0.26	
NGC 2190	0.015	-5.05	0.25	0.81
				1.0
NGC 2209	0.008	-5.36	0.24	0.91
	0.002		0.45	0.7
NGC 2213	0.008	-5.30	0.25	0.9-1.6
NGC 2231	0.008–0.01	-4.91	0.32–1.0	0.55
				1.2
NGC 152	0.002	-5.02	2.29	0.5
				1.3
NGC 339	0.002	-4.83	3.24	3.0
NGC 411	0.002	-4.91	2.82	1.5
				1.8
NGC 419	0.002	-5.19	0.79	0.67
L11	0.002	-4.79	3.47	3.5
L44	0.002	-4.93	2.69	
L47	0.002	-5.28	0.40	
L113	0.002	-4.80	3.47	4.0
				5.0
K3	0.002	-4.51	5.75	4.5
				8.0

References

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Westerlund, B.E., et al. 1991, A&AS, 91, 425

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