The Impact of Large-Scale Surveys on Pulsating Star Research
ASP Conference Series, Vol. 203, 2000
L. Szabados & D. W. Kurtz, eds.

Mixing in the SMC Stars: Implication for Cepheids

D. Cordier, T. Lejeune, Y. Lebreton, M.-J. Goupil

DASGAL, Observatoire de Paris-Meudon, Meudon, France and Astronomisches Institut der Universität Basel, Binningen, Switzerland

Abstract. We compare the recent OGLE 2 data of stars in the Small Magellanic Cloud (SMC) with stellar evolutionary models of low metallicity computed with the updated and numerically accurate code CESAM. The conversion between theoretical and observational data has been carefully done using the BaSel Library. This enables us to derive new observational constraints at SMC chemical composition: on the overshooting parameter $\alpha_{\rm over}$ during the main sequence, and on the mixing-length parameter $\alpha_{\rm MLT}$ for the red giant branch. The occurrence of an instability strip-crossing episode is strongly related to these mixing parameters.

1. Theoretical Models

The evolution of stars in the mass range 3–7 $M_{\odot}$ has been computed for the SMC chemical composition ($X_0 = 0.745, Z_0 = 0.004, [\mathrm{Fe/H}] \sim -0.7$) from the zero age main sequence to the end of core He burning. Details about the stellar models will be given in a forthcoming paper (Cordier et al., in preparation). The BaSel stellar library by Lejeune, Cuisinier, & Buser (1998) has been used to obtain colour–magnitude diagrams from theoretical luminosities and effective temperatures.

2. Constraints on Mixing Parameters

In the figure are plotted two 3 $M_{\odot}$ evolutionary sequences: the continuous track T0.0 is a sequence without overshooting ($\alpha_{\rm over} = 0.0$), whereas the dashed line T0.2 includes overshooting with $\alpha_{\rm over} = 0.2$. We estimated that the sequence with overshooting encompasses 97% of the observed stars while without core overshooting only 84% of the observed stars are accounted for. On the other hand, we compared observed star numbers N_1 and N_2 to (theoretical) time scales τ_1 and τ_2, related with boxes 1 and 2. We found for the T0.0 track ($\alpha_{\rm over} = 0.0$) a ratio τ_2/τ_1 =0.06, while it amounts to τ_2/τ_1 =0.13 for the T0.2 track ($\alpha_{\rm over} = 0.2$). Using the OGLE 2 data, we found $N_2/N_1 = 0.15$. Observations are therefore in favour of an overshooting parameter $\alpha_{\rm over} \sim 0.2$ at low metallicity.

We have computed two tracks at 5 $M_{\odot}$ with different mixing length parameters on the RGB: $\alpha_{\rm MLT} = 1.6$ (dot-dashed track) and 1.3 (continuous line). As expected, with a smaller $\alpha_{\rm MLT}$ the theoretical RGB is redder, improving the agreement with OGLE 2 data. On the other hand, the blue loop exten-

https://doi.org/10.1017/S0252921100058115 Published online by Cambridge University Press

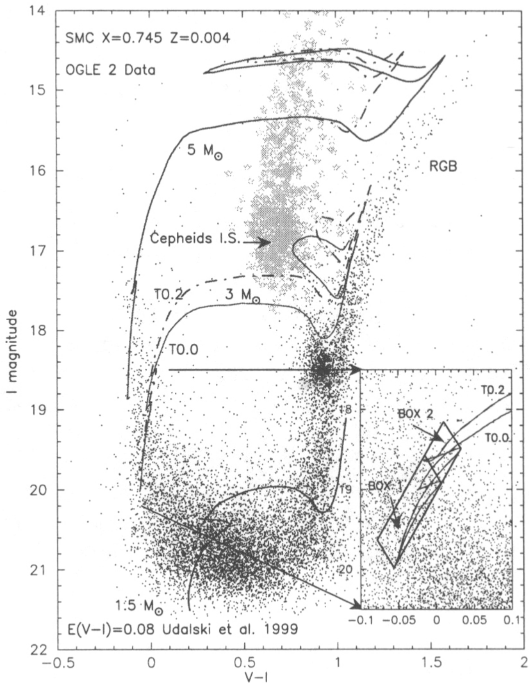

Figure 1. OGLE 2 data and our evolutionary models.

sion is unaffected by such (small) changes in $\alpha_{\rm MLT}$. Thus low values of $\alpha_{\rm MLT}$ are favoured by observations (but other effects could also intervene), although they are not expected from present 2-D hydrodynamical simulations at SMC metallicities and low (RGB) surface gravities (Ludwig, private communication). Concerning the post-RGB stages, the blue loops at low mass (i.e. 3 $M_\odot$) do not entirely cover the observational Cepheid instability strip (I.S.) and the situation worsens when the overshooting amount increases. The mismatch could be due to a shortcoming in the stellar models, or to a problem involving the conversion from theoretical quantities (L, $T_{\rm eff}$) to observational ones (I, $V-I$). In conclusion, OGLE 2 data provide us new and interesting constraints on mixing parameters of the evolutionary models, but further investigations are necessary to understand and try to reduce the remaining discrepancies.

References

Lejeune, T., Cuisinier, F., & Buser, R. 1998, A&AS, 130, 65

Udalski, A., Soszyński, I., Szymański, M., Kubiak, M., Pietrzyński, G., Woźniak, P., & Żebruń, K. 1999, Acta Astron., 49, 1

https://doi.org/10.1017/S0252921100058115 Published online by Cambridge University Press