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BORN AGAIN STARS AND THEIR OFFSPRING

M. M. Miller Bertolami[1,2] and L. G. Althaus[1,2]

We present full evolutionary models of stars that underwent late helium flashes during their post-AGB evolution for a wide range of stellar masses.

Specifically we considered both the very late thermal pulse (VLTP) which is experienced by the star during the hot white dwarf (WD) cooling track; and the late thermal pulse (LTP) scenario that occurs during the post-AGB evolution when H burning is still active (see Blöcker 2001 and Herwig 2001 for references). Both scenarios lead ultimately to the formation of an H-deficient central star of a planetary nebula (CSPN) ([WC] CSPN and PG1159 stages) but as a result of different processes. While in VLTP most hydrogen is burnt, LTP leads to H-deficiency through dilution of the remaining thin envelope (see Althaus et al. (2005a,b) for details).

We find that evolution after the VLTP is dependant on the mass of the remnant star. In particular, the double loop feature in the HR-diagram found in previous works (Lawlor & Mac Donald 2003, Herwig 2003 and Miller Bertolami et al. 2006) is only present for remnant masses of $0.55 \lesssim M \lesssim 0.61$. Born again times are of 6 to 9 yrs for models with $M < 0.6 M_\odot$, of about 40 years for the 0.609 $M_\odot$ model and much larger (about 200 yrs) for the more massive models. The $^{12}C/^{13}C$ ratio of post-VLTP models (between 5-8) is closer (although still larger) than the one derived for Sakurai's Object ($1.5 \lesssim {}^{12}C/^{13}C \lesssim 5$, Asplund 1999). Although our less masive models are able to reproduce qualitatively both the timescale and the $^{12}C/^{13}C$ ratio of Sakurai's object[3], they still fail to reproduce it quantitatively.

An important result is regarding the overall location of the models in the log g-Teff diagram during the PG1159 stage (see Fig. 1). Our models are somewhat hotter than previous models of He burning objects (Wood & Faulkner 1986 and O'Brian & Kawaler as presented in Dreizler & Heber 1998) while similar to the 0.604 track presented by Werner & Herwig (2006) which is based on similar physical assumptions (in particular third dredge up events during the Thermally Pulsing(TP)-AGB). This supports the claim by Werner & Herwig (2006) that location of the models in the log g-Teff diagram is sensitive to the modeling of the previous AGB evolution.

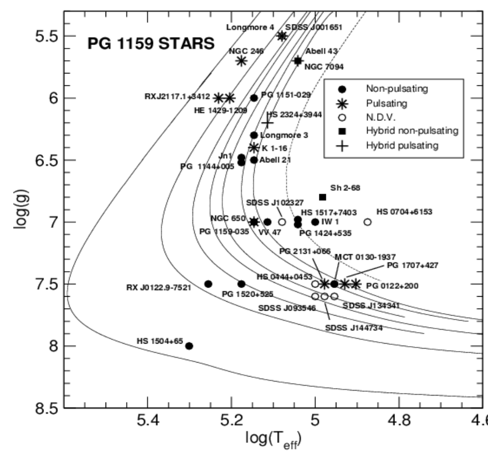

Fig. 1. Location of the post-VLTP models in the log g-T_{eff} diagram (with remnant masses of 0.87, 0.664, 0.609, 0.584, 0.565, 0.542, 0.53 $M_\odot$). Broken line marks de location of the He-rich post-LTP 0.512 $M_\odot$ model.

The dichotomy of ^{14}N suface abundances displayed by PG1159 is easily explained by the two evolutionary channels explored in this work (LTP and VLTP episodes)

Also we find that He-enriched PG1159 may be the result of low mass stars that depart from the AGB before reaching the TP-AGB and that underwent their first thermal pulse as a LTP (see Miller Bertolami & Althaus 2006 for details).

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[1]Facultad de Ciencias Astronómicas, Universidad Nacional de La Plata, Argentina.
[2]Instituto de Astrofísica de La Plata - CONICET, Argentina.

[3]Without any ad hoc reduction of mixing efficiency.