PLANETARY NEBULAE: THEIR EVOLUTION AND ROLE IN THE UNIVERSE
IAU Symposium, Vol. 209, 2003
S. Kwok, M. Dopita, and R. Sutherland, eds.

Spectral Analysis of the LMC [WC] Star SMP 61

G. Gräfener [1], W.-R. Hamann [1] & M. Peña [2]

[1] *Department of Physics, University of Potsdam, Germany*

[2] *UNAM, México*

Abstract. HST UV and optical spectra of the early-type [WC] star SMP 61 in the LMC are analyzed by means of line blanketed non-LTE models for expanding atmospheres. The known distance to the LMC allows a reliable determination of the stellar parameters. The low iron surface abundance of the object possibly indicates a preceding evolution through a very late thermal pulse (VLTP).

HST spectroscopy of LMC stars allows for the determination of reliable stellar parameters (especially $L_\star$, $R_\star$ and $\dot{M}$) due to the known distance and the moderate interstellar extinction towards the LMC. A disadvantage is the large distance, which leads to a strong nebular contamination because the nebula of SMP 61 is so compact that it is nearly covered by the spectroscopic slit. For the subtraction of the nebular contribution we use a theoretical nebular continuum from Peña et al. (1997) to compensate the Balmer jump, which is clearly visible in the observation.

The spectral analysis of SMP 61 is performed with up-to-date non-LTE models for expanding atmospheres which account for iron group line blanketing and clumping (see e.g. Hamann et al., these proceedings; Gräfener et al. 2002). Complex model atoms of He, C, O, Si and the iron group are considered. The spectral fit is presented in Hamann et al. (these proceedings). The derived luminosity ($L_\star = 10^{3.9}\,\mathrm{L}_\odot$ with $E_{B-V} = 0.122\,\mathrm{mag}$) corresponds exactly to the standard value, which is expected for a central star with $M_\star \approx 0.6\ \mathrm{M}_\odot$. With a clumping factor of $D = 4$ (corresponding to a volume filling factor of 1/4) we obtain a mass loss rate of $\dot{M} = 10^{-6.17}\,\mathrm{M}_\odot\,\mathrm{yr}^{-1}$ while the terminal wind velocity is $v_\infty = 1400\,\mathrm{km/s}$.

Apart from a narrower line width, the spectral appearance of SMP 61 is very similar to the well known massive WC 5 star WR 111 (Hillier & Miller 1999, Gräfener et al. 2002). Consequently, we derive a similar stellar temperature and surface composition ($T_\star = 87.5\,\mathrm{kK}$ with $R_\star = 0.39\,R_\odot$ and $X_\mathrm{C} = 0.5$, $X_\mathrm{O} = 0.03$). The carbon mass fraction is in accordance with recent results of Crowther et al. (these proceedings) who derives similar values for a representative sample of galactic [WC] central stars.

As demonstrated in Fig. 1, our model with standard iron abundance (1/4 solar for LMC central stars) produces too strong iron features in the UV (the so-called "iron forest" around 1300 Å). A model with lower iron abundance (1/30 solar) shows much weaker iron features which are below the detection limit of the observation. A detailed analysis yields an upper limit for the iron abundance of

https://doi.org/10.1017/S0074180900209765 Published online by Cambridge University Press

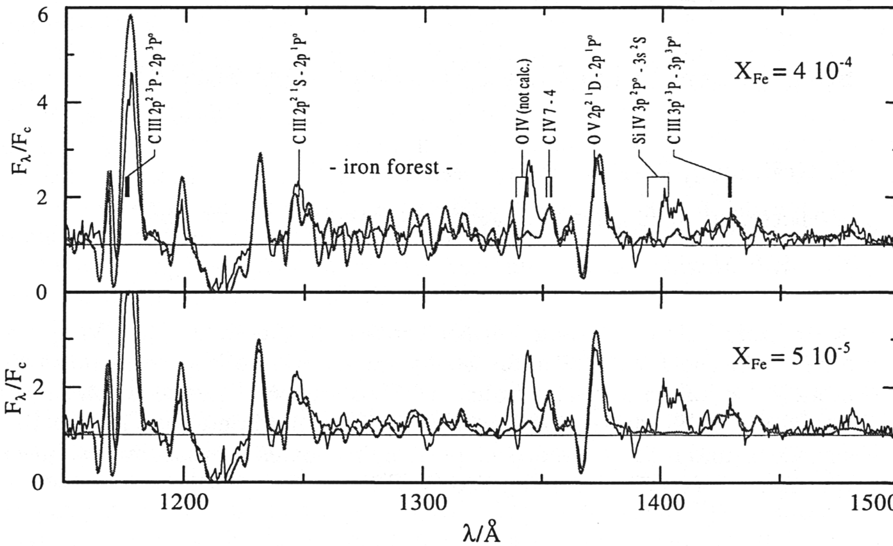

Figure 1. The iron forest of the HST UV spectrum (thin line) in comparison to model calculations (grey) with $X_{\rm Fe} = 4\,10^{-4}$ (1/4 solar) and $X_{\rm Fe} = 5\,10^{-5}$ (1/30 solar). The model with the "standard" value of $X_{\rm Fe} = 4\,10^{-4}$ clearly shows iron features that are not observed.

$\approx 1/15$ solar. This result is in line with the detection of a strong iron depletion for A 78, a PG 1159-type central star and probable *descendant* of a [WC] central star (Werner et al., these proceedings). As pointed out by Herwig, Lugaro & Werner (these proceedings) such an iron deficiency can be explained by the destruction of Fe in the neutron-capture nucleosynthesis during a VLTP.

References

Gräfener G., Koesterke L., Hamann W.-R. 2002, submitted to A&A

Hillier D. J., & Miller D. L. 1999, ApJ 519, 354

Peña M., Ruiz M. T., Torres-Peimbert S. 1997, A&A 324, 674