Scientific Requirements for Extremely Large Telescopes
Proceedings IAU Symposium No. 232, 2005
P. Whitelock, M. Dennefeld & B. Leibundgut, eds.

doi:10.1017/S1743921306000718

Abundance analysis of symbiotic stars

J. Mikołajewska[1], M. Gromadzki[1], and K.H. Hinkle[2]

[1]Copernicus Astronomical Center, Warsaw, Poland

[2]National Optical Astronomy Observatory, Tucson, USA

Abstract. Metallicity may play an important role in the symbiotic phenomenon. Unfortunately, chemical abundances of symbiotic stars have been thus far poorly studied. Ongoing abundance analysis of a sample of over 30 symbiotic stars based on high-resolution, near-infrared spectra obtained with the Phoenix spectrometer on Gemini South telescope will allow for the first time to address properly the metallicity problem as well as provide important information about the past history of these binaries.

Keywords. Stars: binaries, symbiotic, abundances, mass loss

Symbiotic stars are interacting binaries with a cool red giant primary and a hot white dwarf secondary. It is generally believed that the symbiotic appearance and activity is triggered by high mass loss rate of the giant (e.g. Mikołajewska 2003, and references therein), possibly due to its enhanced metallicity (e.g. Jorissen 2003). There are other binary star families, namely barium stars and technetium-poor S star, with red giants and a white dwarf companion, and orbital elements similar to those of symbiotic systems. However, they do not exhibit symbiotic activity. Among the most intriguing problems posed by these binaries is the fact that there are no extrinsic C or S stars among the symbiotic giants, that is cool components polluted by C-rich matter from the former TP-AGB companion. Since there is very strong evidence that the hot companion is a white dwarf and that at least in some systems its mass is higher than 0.5 $M_{\odot}$ and so it must go through the TP-AGB phase (e.g. Mikołajewska 2003) it has been suggested that the symbiotic stars belong to a high metallicity population (Jorissen 2003). There are however contradictory arguments in this respect.

In particular, photospheric abundances obtained for AG Dra, BD-21 3873 and He 2-467, belonging to so called *yellow* symbiotic systems containing a K giant, showed that they all are metal poor with [Fe/H] $\leqslant -1$ and s-process overabundant (Smith *et al.* 1996, 1997; Pereira *et al.* 1998), and are probably related to the low-metallicity relatives of Ba stars. On the other hand, HD 330036, AS 201 and StHA 190 belonging to another small subclass of symbiotic stars, named *D-type* systems with G-type giants and warm dust shells, have high $v_{\rm g} \sin i$, [Fe/H] ~ 0, and are s-process overabundant (Smith *et al.* 2001; Pereira *et al.* 2005).

The majority of symbiotic systems, however, contain M-type giants, and their photospheric abundances have not yet been investigated. There is also no published information about the presence of s-process elements in these red symbiotic systems (Schmidt *et al.* 2005, and references therein). Whitelock & Munari (1992) studied near infrared colours of a large sample of symbiotic stars and found that they are similar to those of the Bulge-like stars. They suggested that the symbiotic giants may be related to the metal-rich M stars found in the Galactic Bulge and elsewhere, i.e. they have low masses, and higher than solar metallicity. They also noted that the mass-loss rates of the symbiotic giants, although systematically greater than the one of the local bright giants, are similar to those of the Bulge-like stars. Their findings, however, have not been confirmed by direct estimates of elemental abundances. In particular, the CNO abundance ratios deduced from UV emission lines for 24 symbiotic stars are best fitted by normal red giants (Nussbaumer *et al.* 1988). Moreover, analysis of the first-overtone CO absorption features in K-band spectra of 7 northern and 6 southern symbiotic systems gave subsolar carbon abundances and $^{12}C/^{13}C$ ratios in all cases (Schild *et al.* 1992; Schmidt & Mikołajewska 2003; Schmidt *et al.* 2005), which indicates that the surveyed symbiotic giants are indistinguishable from local normal M giants, in agreement with the abundance studies based on nebular emission lines. A direct high resolution spectroscopic determination of the photospheric chemical abundances of red symbiotic giants is needed to settle that question.

Thus far such an analysis has been performed only for the brightest symbiotic system, CH Cyg (Schmidt *et al.* 2005). The iron abundance for CH Cyg is found to be solar, [Fe/H]=0.0±0.19, and the isotopic ratios of $^{12}C/^{13}C$ and $^{16}O/^{1}7O$ are close to the mean values for single M giants that have experienced the first dredge-up. It seems that the absence of chemical peculiarities similar to those shown by Ba stars can be accounted for by the relatively high metallicity of CH Cyg. This analysis has also shown that the mean C/O ratio derived from emission lines agrees with that from the absorption line analysis, however C/N and O/N ratios show significant differences between the two methods, which means that the method based on emission lines may at least in some systems seriously overestimate the N abundance. Again, the photospheric abundances for the symbiotic red giants are necessary to address this issue properly.

We are currently working on a detailed abundance analysis of a sample of over 30 symbiotic stars based on high-resolution, near infrared spectra obtained with the Phoenix spectrometer on Gemini South telescope, and using the method of standard LTE analysis and atmosphere models, and spectrum synthesis, the same as was employed by Schmidt *et al.* (2005). As an example, we show in Fig. 1 the spectra for the symbiotic star SY Mus together with our synthetic atomic and molecular spectra. We expect that our study will provide definite answer to the metallicity problem in symbiotic stars as well as provide important information about the past history of these systems.

Acknowledgements

This research has been partly supported by KBN grant 1P03D 017 27.

References

Jorissen, A. 2003, in: R.L.M. Corradi, J. Mikołajewska & T.J. Mahoney (eds.) *Symbiotic stars probing stellar evolution, ASP Conf. Ser.* 303, 25

Mikołajewska, J. 2003, in: R.L.M. Corradi, J. Mikołjewska, T.J. Mahoney (eds.) *Symbiotic stars probing stellar evolution, ASP Conf. Ser.* 303, 9

Nussbaumer, H., Schild, H., Schmid, H.M. & Vogel, M. 1988, *A&A* 198, 179

Pereira, C.B., Smith, V.V. & Cunha, K. 1998, *AJ* 116, 1977

Pereira, C.B., Smith, V.V. & Cunha, K. 2005, *A&A* 429, 993

Schild, H., Boyle, S.J. & Schmid H.M. 1992, *MNRAS* 258, 95

Schmidt, M.R. & Mikołajewska, J. 2003, *ASP Conf. Ser.* 303, 163

Schmidt, M.R., Zacs, L., Mikołajewska, J. & Hinkle, K.H. 2005, *A&A*, in press

Smith, V.V., Cunha, K., Jorissen, A. & Boffin, H.M.J. 1996, *A&A* 315, 179

Smith, V.V., Cunha, K., Jorissen, A. & Boffin, H.M.J. 1997, *A&A* 324, 97

Smith, V.V., Pereira, C.B. & Cunha, K. 2001, *ApJ* 556, L55

Whitelock, P.A. & Munari, U. 1992, *A&A* 255, 171

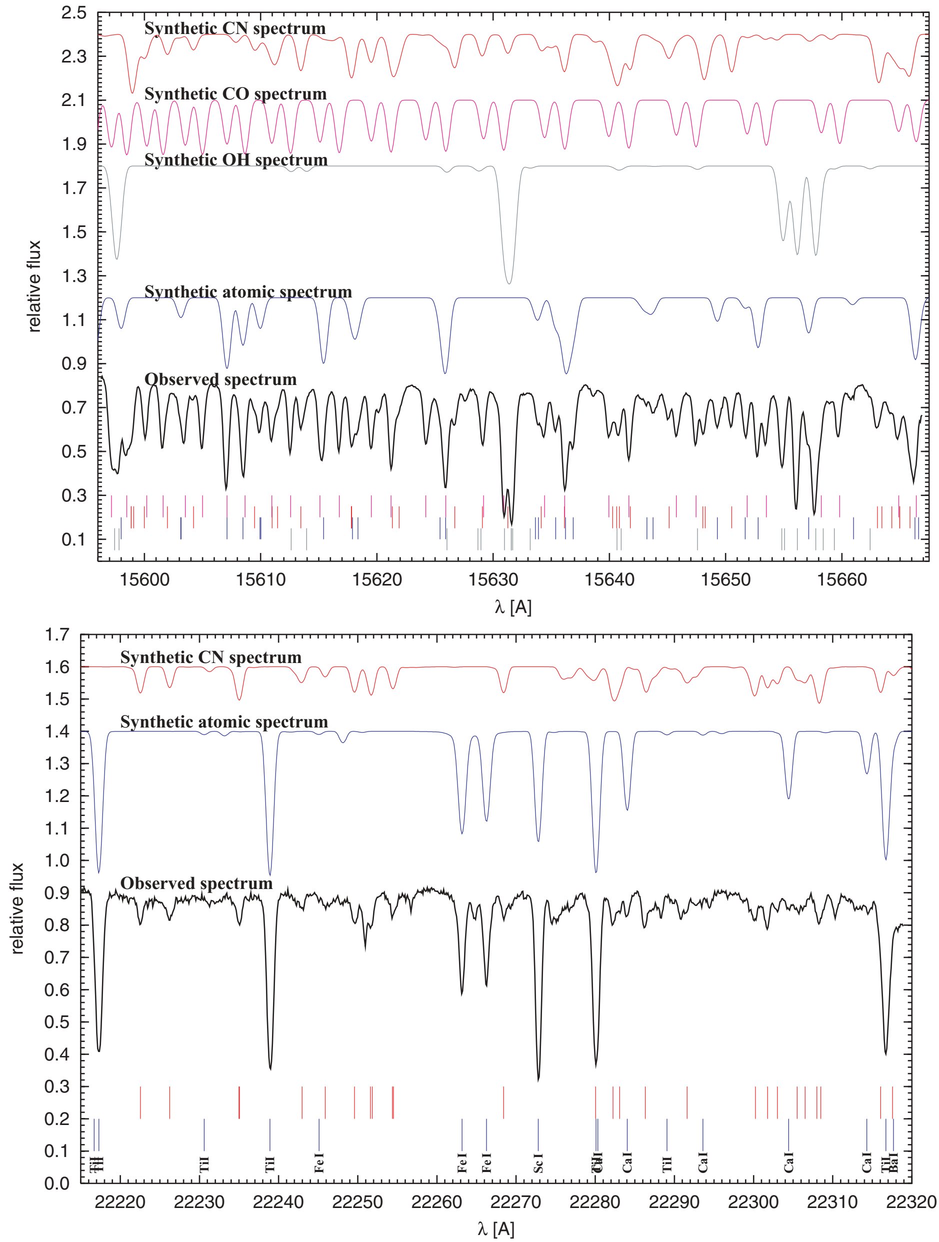

Figure 1. Phoenix spectra of SY Mus together with our synthetic spectra.

https://doi.org/10.1017/S1743921306000718 Published online by Cambridge University Press