Planetary Nebulae in our Galaxy and Beyond
Proceedings IAU Symposium No. 234, 2006
M. J. Barlow & R. H. Méndez, eds.

doi:10.1017/S1743921306003590

The Nature of the Low Metallicity PN: SBS 1150+599A (=G135.9+55.9)

G. H. Jacoby[1], P. M. Garnavich[2], H. E. Bond[3], A. Noriega-Crespo[4], J. Quinn[2], J. S. Gallagher[2], and D. Garcia-Galili[5]

[1]WIYN Observatory, 950 N. Cherry Ave., Tucson, AZ 85712, USA
email: jacoby@wiyn.org

[2]Dept. of Physics, 225 Nieuwland Science Hall, Univ of Notre Dame, Notre Dame, IN 46556,
email: pgarnavi@nd.edu, jgallag3@nd.edu

[3]STScI, 3700 San Martin Dr., Baltimore, MD 21218,
email: bond@stsci.edu

[4]SIRTF Science Center, Caltech, 220-6, Pasadena, CA 91125,
email: alberto@ipac.caltech.edu

[5]Marlboro College, South Road, Marlboro, VT 05344

Abstract. We have observed SBS 1150+599A spectroscopically in the UV using HST to derive C/H $\sim$ 7.6 and N/H $\sim$ 7.0 for the first time. The central star temperature is now better constrained to $\sim$130,000K, but still is not well determined. This uncertainty dominates the error in O/H, which has been the subject of debate, yet with these data, SBS 1150+599A has the lowest O/H of any PN. Furthermore, the physics of this object are so extreme that minor differences in atomic modeling impact the composition analysis strongly. We also find that the binary central star, based on photometric and kinematic variations, exhibits CV-like properties with an amplitude of 13% and an orbital period of 3.924 hours.

Keywords. abundances, CV, binary

SBS 1150+599A has several rare properties: it is one of a handfull of PN in the Galactic halo, it has a short-period (3.924 hr) binary central star (Napiwotzki *et al.* (2005)), and its chemical abundances are among the lowest known for a PN (Tovmassian *et al.* (2001), Jacoby *et al.* (2002), Richer *et al.* (2002), Péquignot & Tsamis (2005)). However, these authors have not been able to agree on the value of [O/H] to better than 1 dex. The main point of contention is the adopted central star temperature, T_{eff}, a key parameter that has defied efforts to be measured accurately. This paper presents new HST observations in the UV that help to reduce the uncertainties, especially the abundances of N/H and C/H, and emission-line ratios that further constrain T_{eff}.

Due to its low metallicity, SBS 1150+599A exhibits very few measurable emission lines. Mostly, we see lines from hydrogen and doubly ionized helium. In addition, the high temperature central star (100,000-140,000 K) ionizes the nebula to a very high state and depopulates levels that form bright optical emission lines. Thus, the usual line ratios ([OIII] λ5007 / [OII] λ3727; [SIII] λ6312 / [SII] λ6720; HeII λ4686 / HeI λ5876) that indicate T_{eff} cannot be used. Although the UV nitrogen lines are weak in the HST data (Figure 1), we can measure NV λ1240 / NIV λ1486 to constrain T_{eff} to $\sim$130,000 K. The HST data also allow the measurement of N/H and C/H which affect the value for O/H through their cooling of the nebula and consequent impact on the electron temperature.

With improved parameters, we compare the composition of SBS 1150+599A to other halo PN and the Sun. Figure 2 illustrates that SBS 1150+599A continues to exhibit

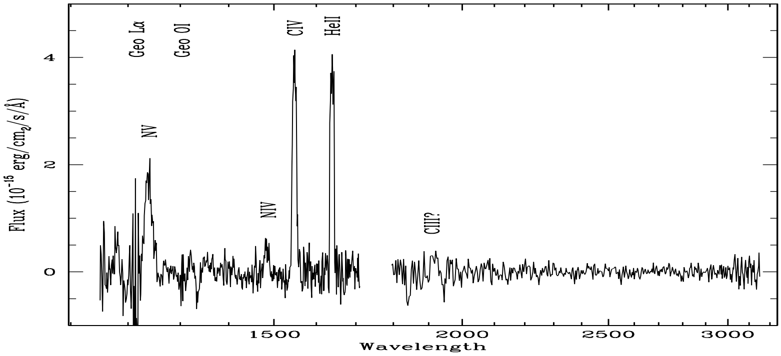

Figure 1. HST spectrum: The data from grating 230 shows no lines, but provides upper limits

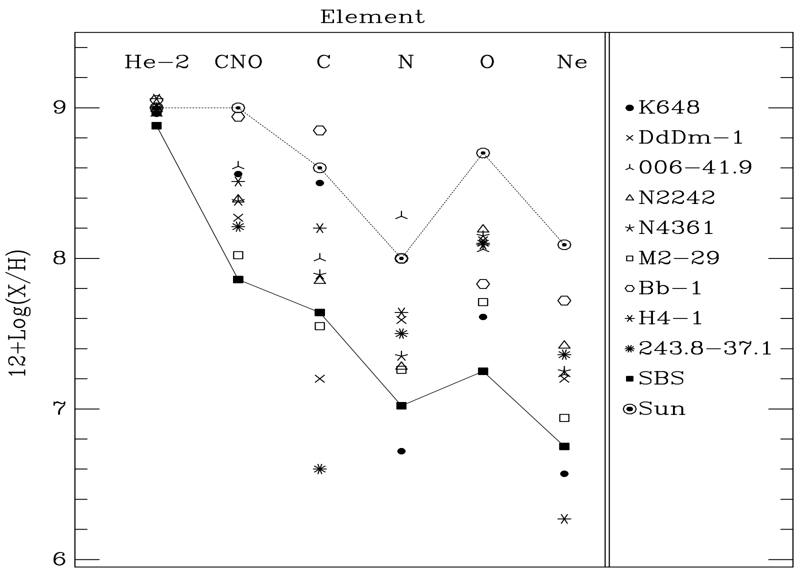

Figure 2. A comparison of the abundances among the halo PN (Howard *et al.* (1997)).

extreme characteristics, especially for O/H (as first suggested by Tovmassian *et al.* (2001)), for helium, and for CNO in total. We find that O/H is 30-40 times lower than in the Sun, but the extreme nature of SBS 1150+599A challenges the physics adopted for photoionization models, resulting in sytematic uncertainties of ∼15%.

References

Howard, J.W., Henry, R.B.C., & McCartney, S. 1997, *MNRAS* 284, 465

Jacoby, G.H., Feldmeier, J.J., Claver, C.F., Garnavich, P.M., Noriega-Crespo, A., Bond, H.E., & Quinn, J. 2002, *AJ* 124, 3340

Napiwotzki, R., Tovmassian, G., Richer, M.G., Stasińska, G., Peña, M., Drechsel, H., Dreizler, S., & Rauch, T. 2005, *astro/ph* 0509801

Péquignot, D., & Tsamis, Y.G. 2005, *A&A* 430, 187

Richer, M.G., Tovmassian, G., Stasińska, G., Jameson, R.F., Dobbie, P.D., Veillet, C., Gutierrez, C., & Prada, F. 2002, *A&A* 395, 929

Tovmassian, G.H., Stasinska, G., Chavushyan, V.H., Zharikov, S.V., Gutierrez, C., & Prada, F. 2001, *A&A* 370, 456

https://doi.org/10.1017/S1743921306003590 Published online by Cambridge University Press