

LETTER TO THE EDITOR

U Scorpii 2010 outburst: observational evidence of an underlying ONeMg white dwarf (Corrigendum)

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We have found a computational error in the application of formula (1) of the paper. When this is corrected the [Ne/O] ratios computed from the 2010 April 11 and May 12 U Sco nebular spectra are -0.4 and -0.7^1 respectively, suggesting only a mild Ne enrichment in the ejecta, possibly consistent with a CO white dwarf (WD). The [Ne/O] ratio computed for V832 Vel (Table 3 in Della Valle et al. 2001), which we used as cross check, also results in lower values than initially estimated in the range -0.3 to $+0.2$, depending on the considered spectrum/epoch. Note, however, that V832 Vel is an ONe nova (Shore et al. 2003).

Most important, the use of the $[\text{Ne III}]\lambda 3869/[\text{O III}]\lambda 5007$ flux ratio for approximating the ejecta abundances is not reliable when n_e is higher than the critical density of the individual lines. In particular, electron densities higher than $\sim 10^6 \text{ cm}^{-3}$ (the $[\text{O III}]$ and $[\text{Ne III}]$ $^1\text{D}_2$ critical densities are $\sim 7 \times 10^5 \text{ cm}^{-3}$ and $\sim 7.9 \times 10^6 \text{ cm}^{-3}$, respectively, Osterbrock 1989) produce $F(3869)/F(5007)$ flux ratios >1 even for solar abundances (following Seaton 1975 and Ferland & Shields 1978 derivations), which makes the conclusion of enhanced Ne abundances ambiguous. It is interesting to note that most of the known ONe novae for which there are optical spectra in the literature showed $F(3869)/F(5007)$ flux ratios in the range ~ 1 – 2 over several epochs during their late decline (QU Vul, Saizar et al. 1992; V351 Pup, Saizar et al. 1996; V382 Vel, Della Valle et al. 2002; V1974 Cyg, Vanlandingham et al. 2005; V1065 Cen, Helton et al. 2010; V959 Mon, Shore et al. 2013). The only remarkable exceptions were V838 Her and V4160 Sgr with flux ratios in the range 20 – 46 and 2 – 7 , respectively (Schwarz et al. 2007). These same objects show a flux ratio $[\text{O III}](1)/[\text{O III}](2) < 5$ – 10 for few to several hundreds of days after maximum, indicating densities in excess of 10^6 cm^{-3} (Seaton 1975). In addition, high-energy incident flux will favor higher ionization energy transitions (e.g. [Ne V] as observed in the bluer optical spectra) which “reduces” the intensity of the lower ionization energy lines. It is therefore necessary to compare all the ionization levels observing the UV range as well, where the O^{3+} and O^{4+} transitions occur.

While the optical nebular spectra of the U Sco 2010 outburst show strong [Ne V], [Ne III], and, possibly, weak [Ne IV] $\lambda 4714$, they are no sufficient diagnostic of the ejecta density and temperature. Hence, lacking a nebular phase UV spectrum for the

most recent and the past outbursts, the Ne abundance and, in particular, the composition of the progenitor WD remain undetermined. It remains true, however, that the IUE spectra of U Sco taken during the early decline of the 1978 outburst showed post-iron curtain spectra characterized by P-Cyg profiles with deep and broad absorption troughs in the resonance lines $\text{Si IV}\lambda 1400$ and $\text{C IV}\lambda 1550$ (Williams et al. 1981), as typical of ONe novae (e.g. Shore et al. 2003). P-Cyg line profiles have occasionally been observed in a few CO novae as well (i.e. OS And, Schwarz et al. 1997 and nova LMC 1988a, Schwarz et al. 1998), however, their “edge velocities” are a few to several 1000 km s^{-1} lower than in ONe novae and their absorption depth is somewhat less pronounced, indicating a smaller covering factor. U Sco P-Cyg profiles in the UV spectra closely match those of novae such as V1974 Cyg and V832 Vel. We conclude noting that the two Large Magellanic Cloud (LMC) recurrent novae (RNe) of the U Sco type observed in 2005 and 2009 (i.e., YY Dor and nova LMC 2009) have very strong Ne lines in their optical nebular spectra, resembling known ONe classical novae. At the same time, the similar overall spectral evolution and line characteristics of U Sco and the LMC RNe suggest that they have a common progenitor, whatever its nature (Mason et al., in prep.).

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¹ Adopting $T_e = 12\,000 \text{ K}$, as estimated in the original paper.