Low-resolution Optical Spectroscopy of Recently Discovered Accreting-only Symbiotic Star THA 15–31

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Abstract

Recently, the discovery and characterization of a new accreting-only symbiotic star THA 15–31 was presented. Motivated by the suggestion that the optical spectrum of the star might show the emission lines with higher ionization potential in comparison with previously studied epochs, we have obtained a low-resolution spectrum of this target. The spectrum does not reveal the presence of suggested He II emission lines. Moreover, the near-UV excess seems to be even less prominent now in comparison with the previous observations, suggesting a decrease in mass transfer and accretion rate. The search for He II emission lines should be repeated when the accretion rate is higher.

1. Introduction

The discovery and characterization of a new accreting-only symbiotic star THA 15–31 (α_{2000} = 16:08:36.903, δ_{2000} = −40:16:20.381) was recently presented by Munari et al. (2022). They claimed that the system consists of an M6 red giant and an accretion companion, presumably a white dwarf (WD), whose presence is demonstrated especially by the UV emission originating in an optically thick accretion disk. The X-Shooter spectrum that the authors analyzed in the paper was acquired in 2012 April and showed emission lines of H i, He i and Fe ii. There were no He ii lines in the spectrum obtained in 2012. On the other hand, based on the Swift/UVOT observations acquired in 2021 April, Munari et al. (2022) claimed that at least at that epoch, He ii 4686 Å should have been detectable. However, no optical spectrum was obtained to confirm this assumption.

2. Observational Data

As no optical spectrum obtained more recently than 2012 was analyzed by Munari et al. (2022) or elsewhere in the literature, we decided to acquire a new low-resolution spectrum of THA 15–31 using remotely controlled setup (Alpy600 spectrograph mounted at 30 cm Ritchey–Chretien telescope located in Chile). A total of nine individual spectra were obtained, each with an exposure time of 1200 s. Their median corresponding to JD 2,459,650.778 (2022 March 12) is shown in the upper panel of Figure 1(A). The obtained spectrum was de-reddened adopting the extinction value $E(B-V) = 0.38$ mag (Munari et al. 2022). We also applied an absolute flux scale to the spectrum using the APASS $V = 15.06$ mag (Henden et al. 2015) such that convolution of the spectrum with the Johnson V filter agrees with the V mag. This scaling is approximate, as the spectrum and photometry were not obtained at the same time. The spectrum is available in the ARAS database [5] (Teyssier 2019).

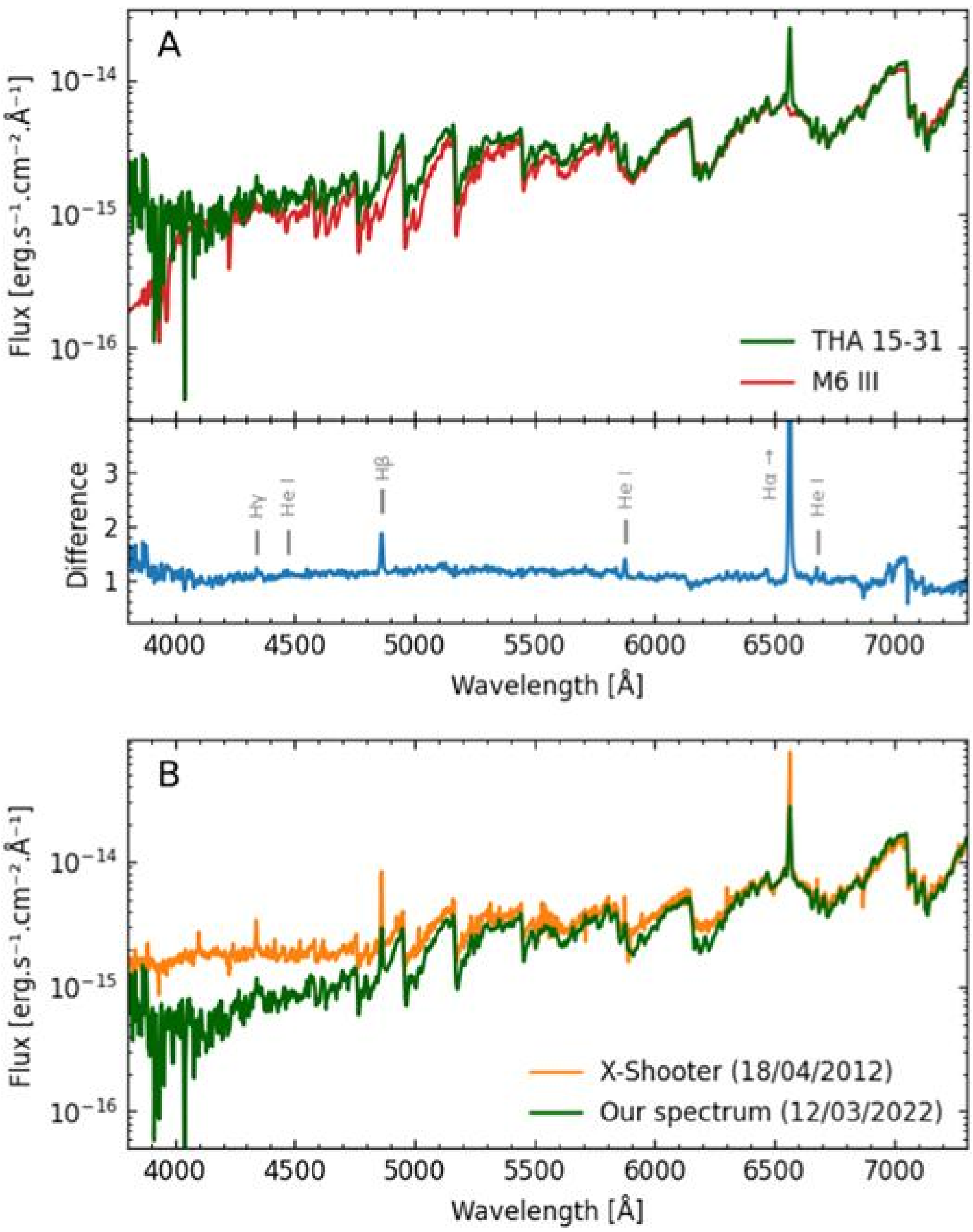

Figure 1. Low-resolution spectroscopy of THA 15–31. Panel A: De-reddened spectrum of THA 15–31 (green line) together with the intrinsic spectrum of M6 III star (red line; Fluks et al. 1994). Bottom part (blue line) shows the difference between the observed spectrum and spectrum of M6 III star. The identification of strongest emission lines is given in the figure. Panel B: Comparison of the two optical spectra of studied system. Our spectrum and the X-Shooter spectrum are shown in green and orange, respectively.

3. Results and Discussion

The red part of the spectrum resembles the spectrum of M6 III red giant (upper panel of Figure 1(A)). Additionally, the spectrum clearly shows the presence of strong Hα and Hβ

lines. After subtracting the intrinsic spectrum of M6 III star obtained from the library of Fluks et al. (1994), other emission lines were detected whose presence was not obvious from the observed spectrum at the first sight (see the lower panel of Figure 1(A)). We have detected several He i, faint Hγ and possibly also some Fe ii lines in emission. These findings are consistent with the results obtained by Munari et al. (2022).

We have not detected any evidence of the presence of He ii in our spectrum. It might be that the He ii 4686 Å line (typically the strongest one) was, if present, too faint to be detected in our low-resolution spectrum. On the other hand, it seems that the excess in the blue part of the spectrum was even less prominent than the excess observed in the spectrum obtained in 2012. Comparison of our spectrum with the X-Shooter one obtained from the ESO Archive Science Portal[6] is shown in Figure 1(B). This indicates that the emission of the hot component is variable. The fact that it is significantly lower than in 2021 and 2012 might explain the non-detection of predicted He ii lines.

Our findings suggest some similarity between THA 15–31 and SU Lyn. The latter was suggested to be an accreting-only symbiotic system, representative of a large hidden population of symbiotic stars not showing prominent emission lines, by Mukai et al. (2016). Its interacting nature was revealed by the presence of hard X-ray radiation and prominent UV excess. The optical behavior of SU Lyn was extensively reviewed by Munari et al. (2021). Among other findings, they highlighted that while in 2015 December weak hydrogen Balmer lines were observed in emission in the optical spectra of SU Lyn together with a mild near-UV excess, in 2017 February no trace of binary nature could be spotted in the optical spectra. It resembled the spectrum of a single red giant. Recently, Iłkiewicz et al. (2022) suggested that the components of SU Lyn interacted only transiently for a short time, during which it resembled a classical symbiotic star and remained hidden afterwards.

As both the weak emission lines and the near-UV excess originate in the accretion disk, their variability indicates changes in the mass transfer and accretion rates (Munari et al. 2021). If same is true for THA 15–31, that would suggest that the accretion rate is now lower than in 2012 and 2021. It would still be higher than the accretion rate of SU Lyn in its low accretion state when the emission lines completely disappeared. We still detect the emission lines in our spectrum of THA 15–31 even though at least the Balmer lines seem to be less prominent in the recent spectrum as they were in 2012.

Iłkiewicz et al. (2022) suggested that SU Lyn might evolve toward a stable classical symbiotic star, when the mass loss of the red giant will increase during its evolution (at least by an order of magnitude from the current value of ~10^{-10} $M_{\odot}$ yr^{-1}). They also claimed that the accretion rate still would not be sufficient to ignite the nuclear shell burning on the WD surface. That requires an accretion rate between ~10^{-7} and 10^{-8} $M_{\odot}$ yr^{-1} (e.g., Nomoto et al. 2007) depending on the mass of the WD. On the other hand, if the current accretion rate of THA 15–31 (assuming WD secondary) would increase by around an order of magnitude (which is probable because the giant is not yet an AGB star; Munari et al. 2022), this system might evolve toward a shell-burning symbiotic stars.

4. Conclusions

We obtained a low-resolution spectrum of THA 15–31, newly discovered accreting-only symbiotic star (Munari et al. 2022). Our effort was motivated by the suggestion that it might show the emission lines with higher ionization potential (especially He ii) in comparison with the only available optical spectrum obtained in 2012. Our low-resolution spectrum did not revealed the presence of He ii emission lines. Moreover, the near-UV excess seems to be even less prominent now than it was in 2012, suggesting a decrease in mass transfer and accretion rate in THA 15–31. This suggests that the conditions are now different in comparison with the situation in 2021 and the search for He ii in emission should be repeated when the accretion rate is higher.

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