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SED Machine Spectra for HO Puppis and V722 Tauri

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Abstract

We present low-resolution spectra collected with the Spectral Energy Distribution Machine (SEDM) for an IW And-type dwarf nova, HO Puppis, and a Be star, V722 Tauri. The SEDM is an integrated field unit spectrograph mounted on the 60 inch telescope at the Palomar Observatory, with a spectral resolution of $R \sim 100$ in the optical wavelength range. The Hα emission line was clearly detected for the bright Be star V722 Tauri at ~12.5 mag, but barely detected in the spectra for the ~13.7 mag HO Puppis. Our SEDM observations could be used as guidance for observing similar objects with the SEDM, as well as other $R \sim 100$ spectrographs, in the future.

HO Puppis (hereafter HO Pup), recently confirmed to be an IW And-type dwarf nova (Kimura et al. 2020a; Lee et al. 2021), was previously listed as a Be star candidate without spectroscopic observations (prior to 2018). In 2017, HO Pup was selected in our program studying the variability of Be stars (Ngeow et al. 2019) due to its unusual light-curve behavior (for more details, see Lee et al. 2021). Therefore, we initiated a series of spectroscopic observations with the primary goal of identifying the Hα emission line from HO Pup. These observations were carried out from 2018 to 2020 with the low-resolution spectrograph SEDM (Spectral Energy Distribution Machine; Ben-Ami et al. 2012; Ritter et al. 2014; Blagorodnova et al. 2018, mounted on the Palomar P60 Telescope), two medium-resolution spectrographs BOES Kim et al. (2002) Bohyunsan Optical Echelle Spectrograph; and the DBSP (Double-Beam Spectrograph; Oke and Gunn 1982, mounted on the Palomar Hale Telescope), and the high-resolution spectrograph ESPaDOnS (Echelle SpectroPolarimetric Device for the Observation of Stars; mounted on the CanadaÐ FranceÐHawaii Telescope). Spectra taken from BOES, DBSP and ESPaDOnS, together with the related results, have been published in Lee et al. (2021) and will not be repeated here. The aim of this Note is to present the spectra taken with the SEDM.

Since the SEDM is an integrated field unit spectrograph with a low spectral resolution of $R \sim 100$, we included a known Be star V722 Tauri (hereafter V722 Tau; Joy 1949; Kohoutek and Wehmeyer 1997) to be observed with the SEDM to

cross-check the obtained spectra. Both HO Pup and V722 Tau were added to the target list of SEDM and the queue observations were carried out seven and eight times, respectively, between 2018 October 10 and November 10, with exposure times varying between 270 s and 600 s. Given the nature of queue observing mode, HO Pup and V722 Tau may not necessarily be observed on the same nights. The collected data were automatically processed with the `pysedm` reduction pipeline (Rigault et al. 2019). Figure 1 presents four and six usable spectra for HO Pup and V722 Tau, respectively. A few of the HO Pup and V722 Tau spectra were affected by bad weather and, hence, were discarded.

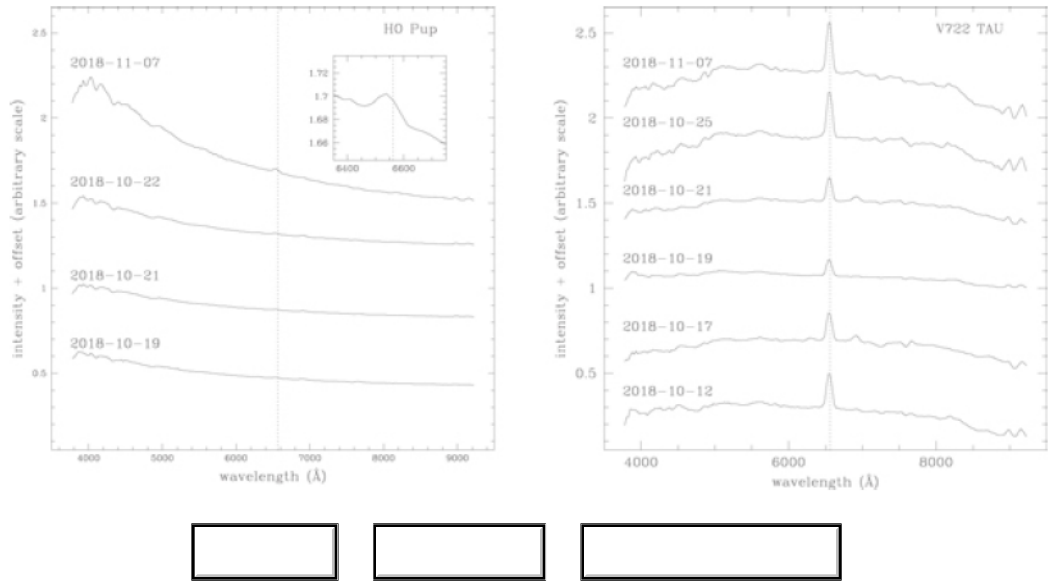

Figure 1. Time-series spectra for HO Pup (left panel) and V722 Tau (right panel) taken from the SEDM. The inset figure in the left panel is an enlarged version of the spectrum taken on 2018 November 7, centered on the Hα line. The vertical dashed lines indicate the rest wavelength of the Hα line. The 10 time-series SEDM spectra are available as data behind the Figure.(The data used to create this figure are available.)

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Based on medium-to-high-resolution spectra collected from larger-aperture telescopes, a weak Hα emission line for HO Pup was clearly detected (Lee et al.

2021). In contrast, the Hα line was barely detected in the SEDM spectra, for example, in the spectrum taken on 2018 November 7 (see left panel of Figure 1). On the other hand, the strong and obvious Hα emission line was detected for V722 Tau, as shown in the right panel of Figure 1, for all dates. We also note that the Hα emission line for V722 Tau is blueshifted by -515 ± 36 km s^{-1}, an average value from the six SEDM spectra presented in the left panel of Figure 1, converted from the centroids of a fitted Gaussian function to the Hα emission line. This value is inconsistent with the measured radial velocity of -23 km s^{-1} found in Joy (1949) based on a single spectrum taken more than half a century ago. We believe our value is more accurate and reliable because it is based on multiple spectra taken with a modern spectrograph (i.e., the SEDM).

The V-band apparent magnitudes for HO Pop and V722 Tau are 13.74 mag and 12.47 mag (Jayasinghe et al. 2018), respectively. As expected, it should be straightforward for SEDM to identify the Hα emission line for bright Be stars, such as V722 Tau. On the contrary, the Hα emission line for HO Pop, a relatively bright dwarf nova, is hardly detected by the SEDM. Even though disks are presented in both Be stars and dwarf novae, the strengths of their Hα emission lines are affected by the different physical conditions on the disks. The spectra collected in this work can provide guidance in observing similar Be stars and/or dwarf novae with the SEDM, or other spectrographs with $R \sim 100$, in the future.

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TANGO Consortium of Taiwan, the University of Wisconsin at Milwaukee, and Lawrence Berkeley National Laboratories. Operations are conducted by COO, IPAC, and UW.

Facility: PO:1.5 m. -

Software: `pysedm` (Rigault et al. 2019).

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