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PQ Ser UNVEILED - NOT A CATAclySMIC VARIABLE

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PQ Ser first appeared in the HIPPARCOS catalog as HIP 76538 (Perryman et al., 1997) and then it was listed as a nova-like cataclysmic variable (CV) by Kazarovets et al. (1999). It appears in many places under the classification of a nova-like (NL) cataclysmic variable (CV). Examples include the HIPPARCOS catalog, SIMBAD, and the AAVSO databases, and the Downes et al. CV catalog. Many of these sources also list the spectral class as F0, which is an apparent contradiction with NL: . Because PQ Ser is among the brightest stars listed as a CV, it is a tempting target for high resolution spectroscopy or high time resolution studies, for which the bright apparent magnitude of 8.1 is an obvious advantage.

Despite the fact that it is one of the brightest CVs known in the northern hemisphere, there is very little literature data on PQ Ser, including a lack of published spectra that might clarify its nature. NL CVs are semi-detached binary systems in which a white dwarf accretes material from a low-mass, low main sequence star (K/M dwarf) with mass transfer rates of $\sim 10^{-9}$ - $10^{-8} M_{\odot} \text{yr}^{-1}$. Typical orbital periods of those systems are less than 8 hours, therefore orbitally-induced variations are commonly present in their light curves. Due to their relatively high mass transfer rate, their spectra are dominated by accretion-induced lines, the most prominent of which are Balmer emission lines, HeI and HeII emission. Here we present time-resolved photometry and high-resolution spectra of the star, discussing its nature, arguing that it is an F0 star, and not a CV.

Spectra were obtained with the Echelle Spectrograph on du Pont 2.5-m telescope of the Las Campanas Observatories during 2010-Feb-16 (UT). The Echelle Spectrograph provides wavelength coverage from 3700-9000Å at a typical resolution of $\sim 40,000$. For our observations, we used the 1 arcsecond slit and no CCD binning. Spectrum of a ThAr lamp was obtained for wavelength calibration at the position of the telescope, before object observations. Through the night, the sky was clear and the moon 90 degrees away from the target, however scattered sunlight from the full moon is still present in the blue side of the spectra despite our careful sky subtraction. With this setup, we obtained three spectra of PQ Ser using exposure times of 900 sec, which were in turn median-coadded to produce the final spectrum presented and discussed in this communication. For data processing and reductions we used IRAF's¹ echelle package.

¹IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

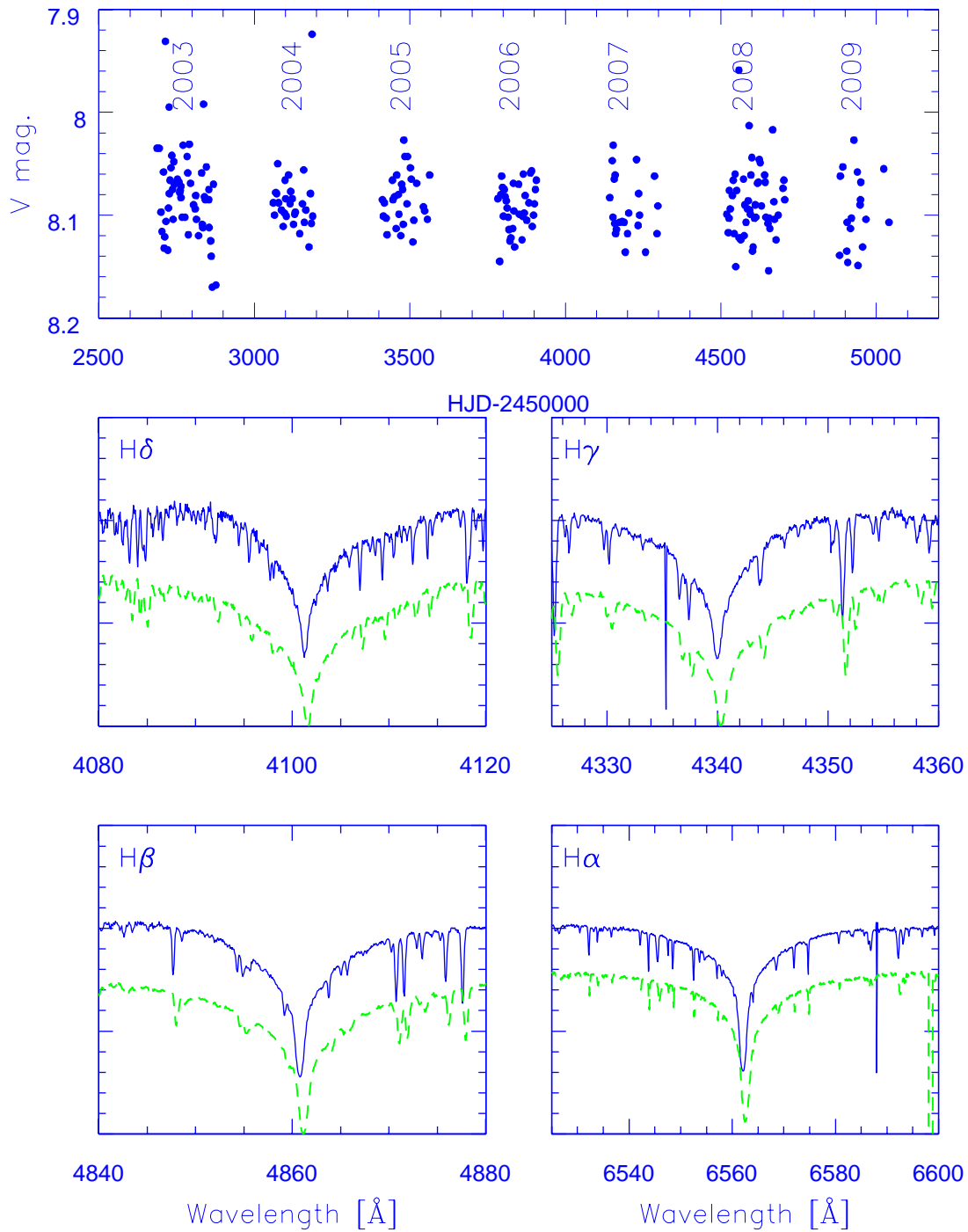


Figure 1. Top panel: ASAS light curve of PQ Ser. Typical error bars are 0.04 mag, which are omitted for clarity. Middle and bottom panels: Balmer lines from the median combined echelle spectra of PQ Ser are presented in blue continuous lines (HJD=2455608.860313). The F0V star HD 32537 is also plotted with green dashed lines for comparison. The striking similarities of the spectrum of HD 32537 with the spectrum of PQ Ser confirms its classification as an F0V star.

PQ Ser is also included in the All Sky Automated Survey (ASAS; Pojmanski, 2002) target list, and was observed with a V filter since 2003-February-15. Data reductions were conducted with the ASAS pipeline and the final output of the photometry is provided in the ASAS database, along with photometry errors. The data are flagged based on the photometric quality of the frame; we retained only data of grades A and B (best quality). The final light curve consists of 238 points spread over 6.4 years.

The full ASAS light curve (all seven years of photometric monitoring) is presented in the top panel of Figure 1. Overall, the long-term light curve is smooth, having an amplitude of 0.15 mag and no long-term trend nor any features (such as low states or small outbursts) which sometimes appear in nova-like CVs. We used the Peranso period analysis software to obtain Lomb-Scarle periodograms. A possible peak at 0.1019d has low significance and the data folded on this period showed no significant pattern. There is good overall evidence that PQ Ser is indeed variable, from the original HIPPARCOS detection of variability, to the Nichols et al. (2010) variability study of Chandra guide stars (0.02 mag change over 8 hrs). However, we see no indication of periodicities in the ASAS photometry.

The middle and bottom panels show the Balmer line regions of the averaged echelle spectrum of PQ Ser. In general, CaII H and K, all Balmer lines, NaD and the CaII IR triplet lines are in absorption, with complete lack of any emission component or any HeI or HeII emission lines, which are usual indications of an accretion disk. According to the Simbad database, this object is classified as F0. We used the ELODIE² database to retrieve a number of similar-resolution F0 stars, and compare them with the spectrum of PQ Ser. A good match is HD 32537 (F0V), which is also shown in Figure 1 (green dashed lines). The two stars exhibit strong Balmer absorption, with traces of low excitation metal lines of Fe I, Ca I and Mn I absorption, characteristic of the class.

We also checked the individual spectra for short-term secular variations in the line profiles that could indicate RV variations and the presence of a companion; we could not find any.

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²<http://atlas.obs-hp.fr/elodie/>