

VV Cephei Eclipse Campaign 2017/19

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Abstract

VV Cephei is an eclipsing binary star system with the second longest known period (7430 days, or 20.4 years). The VV Cephei eclipse is beginning in August of 2017. The eclipse lasts nearly two years (~650 days) from 1st to 4th contact. A campaign is planned for the next eclipse of VV Cephei. This paper will provide information on VV Cephei, explain the campaign goals and provide an invitation to observers to do photometry and/or spectroscopy.

1.0 Introduction

The binary star system VV Cephei is a cool red supergiant star (M2 Iab) with a smaller hot blue companion star (B0-2V). The primary star of VV Cephei is a massive red supergiant star, with an estimated mass of about 20 solar masses. The two stars in this binary are well-separated and significant mass transfer between the stars does not occur. Primary eclipse occurs when the brighter M supergiant primary eclipses the fainter B star companion. VV Cep is a 5th visual magnitude system that varies from 4.9 to 5.4 in the visual band. The eclipse lasts nearly two years and is slightly shorter duration than that of Epsilon Aurigae (Epsilon Aurigae = 670 days, VV Cephei = 650 days). Due to its high declination (+64 degrees) VV Cephei is circumpolar and well suited for year-around observations in the northern hemisphere. While the eclipse is two years away, out-of-eclipse observations are needed now.

2.0 VV Cephei Star System

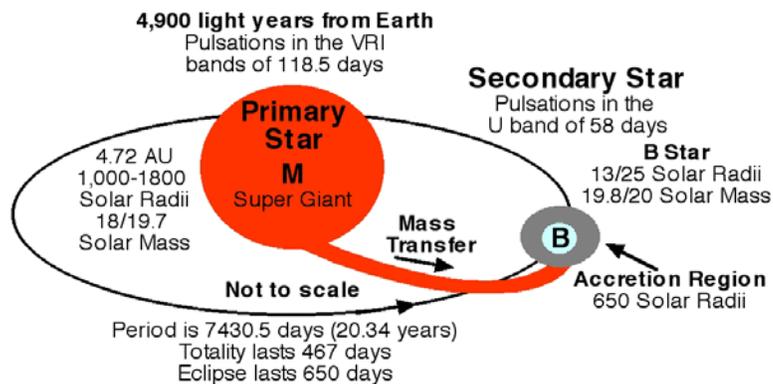


Fig. 1: VV Cephei System Schematic

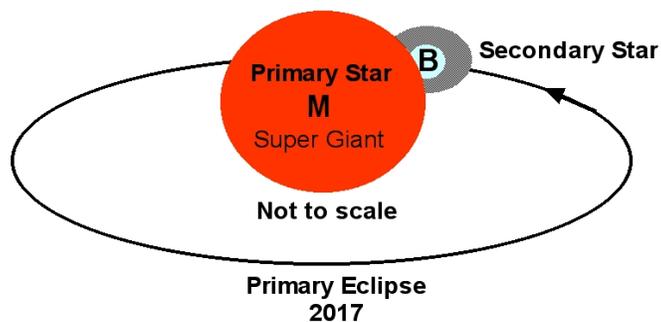


Fig. 2: VV Cephei Primary Eclipse 2017
the small and hotter B stars passes behind the large and cooler M star.

3. VV Cephei Data

Other Identifiers:

HR 8383, HD 208816, HIP 108317

R.A. (2000) 21h 56m 39.1s DEC. (2000) +63d 37' 32.01"

Distance: 4900 light years Diameter (solar dimeters): 1000 – 1800

Epoch: JD 2,435,931.4 Period: 7430.5 days/(20.34 years)

Ingress/Egress: based on 1998 eclipse 84 /99 days

Totality: 467 days (from 1998 eclipse)373 days (Pollmann),

Duration: 650 days (from 1998 data), 673 days (Pollmann)

Next eclipse timing:

T1- 04 August 2017, JD 2,457,970 (early evening)

T2- 27 October 2017, JD 2,458,054 (early evening)

T0- Mid 01 June 2018 , JD 2,458,288 (early evening)

T3- 06 February 2019, JD 2,458,521 (early evening)

T4- 16 May 2019, JD 2,458,620 (late evening)

4. The VV Cephei Campaign

A campaign has been started to cover the 2017 eclipse of VV Cephei. A Campaign web site has been created at <http://www.ap.smu.ca/~pbennett/vvcep/campaign2017.html>. Anyone interested in the Campaign is encouraged to periodically visit the web site for the latest information on the Campaign. The following is a very brief summary of what would be useful for the campaign.

5. Spectroscopy

A long baseline of observations outside of eclipse will be very useful, as well as detailed monitoring during the eclipse phase. Hydrogen alpha, at least out-of-eclipse, provides a measure of accretion luminosity around the hot star. The spectrum of the primary star is M2 Iab (or M2 Iab_e) and the secondary star a B0-2 V.

5.1 Low-Resolution Spectroscopy

Low-resolution spectroscopy will not be able to provide sufficient resolution to measure EW, V/R or RV. However, it does have the advantages of showing a complete visible spectrum window and with a short exposure. The ALPY 600 (R=600) is ideal for this as seen in the 180 second exposure using an ALPY 600 in Figure 5 and 6. Use of an ALPY for low-resolution observations is encouraged -- just not so much for hydrogen alpha, but for other absorption lines (Na D, K I, etc).



Fig. 3: ALPY 600 VV Cephei RAW Spectrum

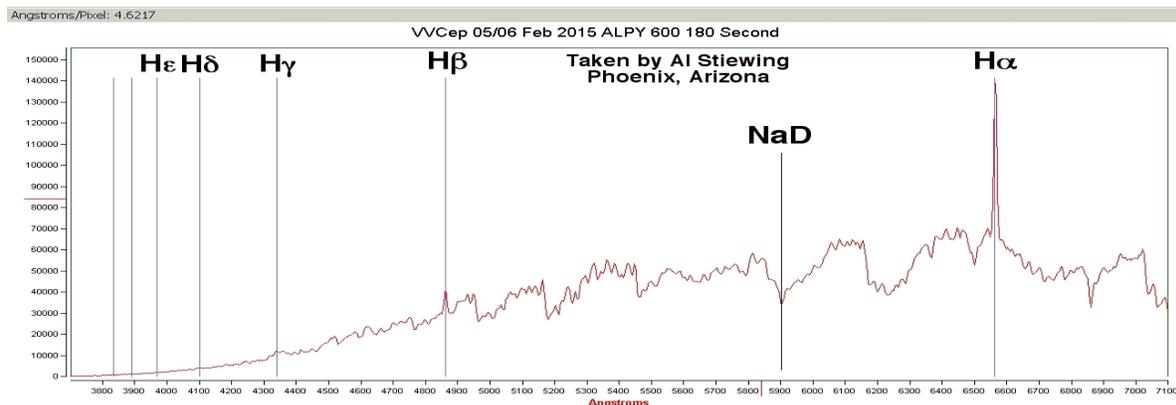


Fig. 4: ALPY 600 VV Cephei Spectrum Line Profile

5.2 High-Resolution H α Spectroscopy

A Lhires III or equivalent spectrograph with a 2400 line/mm grating is suggested for the high-resolution work. The star system's optical spectrum is characterized by strong Balmer and Fe II emission lines. Out-of-eclipse VV Cephei displays dual large hydrogen alpha emission lines that disappear during the eclipse.

The VV Cephei H α line, usually appears double with two emission components present, see Fig. 5. Further characteristics are defined by taking the intensity ratio of the left (shorter wavelength or "Violet") component and dividing it by the right (longer wavelength or "Red") component This is the so-called V/R ratio of the two components. The intensity variations of the V and R components provide important information about the peak strength as measure for the mass and/or density of the gas in the disk, expressed as equivalent width of the emission, and the direction of movement of the corresponding gas region within the disk. At the beginning of the eclipse the V line should decrease to the continuum as the left side of the gas cloud is eclipsed. The R line should continue with minor changes until the right side of the gas cloud is eclipsed.

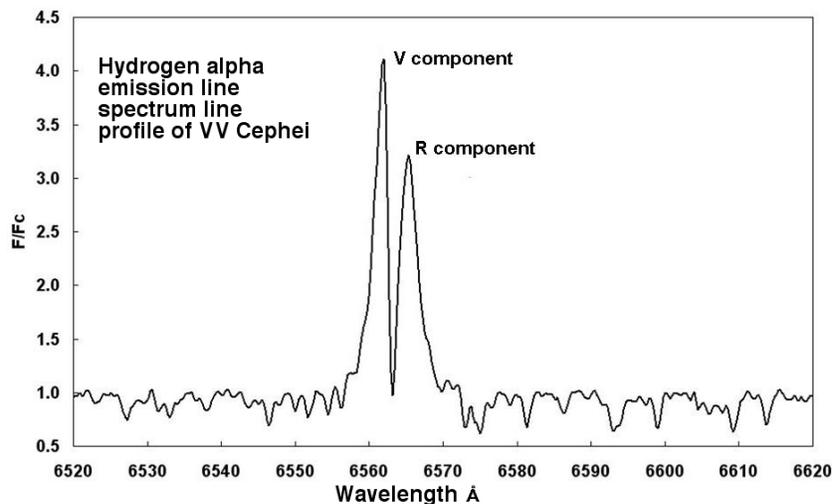


Fig. 5: V/R of VV Cephei's H α (Pollmann)

The violet and the red components of the VV Cephei spectrum's line profile can be linked to the radiation of the gas shell around the Be star. Due to its counter clockwise rotation around the central star, in relation to the line of sight of the observer, it results in a blue shift by moving towards the observer (V-component) and a red shift by moving away (R-component) from the observer.

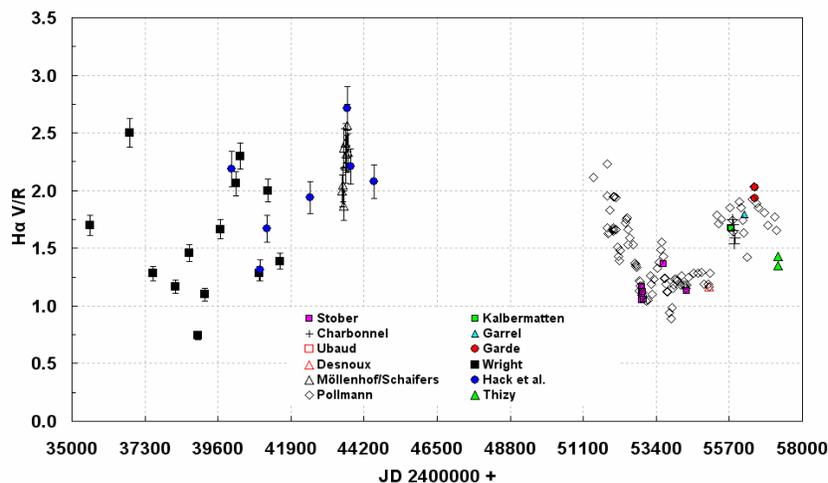


Fig. 6: Long-term monitoring of the V/R ratio outside the eclipses of 1956/57 and 1976-78 by Wright (1977), Hack et al. (1992) and Möllenhof & Schäifers (1981) combined with data of the ARAS group since November 2000 (JD 2451413)