

## LIGHT CURVES FROM THE AAVSO INTERNATIONAL DATABASE

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### Abstract

Light curves of eleven variable stars of different types composed of data obtained from the AAVSO International Database are shown and briefly described. The stars are V Hya, VX Sgr, X Cam, WW Vul, CI Cyg, V1500 Cyg, SS Cyg, AM Her, SU UMa, Z Cam, and RS Oph.

### 1. Introduction

The AAVSO International Database contains over 7.5 million observations of about 3600 known and suspected variable stars. Data from 1961 to date of about 5.5 million observations are stored in AAVSO computers in a database that is accessible. Data from 1911 to 1963 have been digitized and are presently being processed so that they can be merged with the current database. Light curves of unedited "raw" observations of all program stars were handplotted until 1988; since then they have been computer-generated at AAVSO Headquarters.

AAVSO observations from 1911 to 1961 have been published in *Popular Astronomy*, *Harvard Annals*, and *AAVSO Quarterly Reports*. A large portion of the data from 1961 to date have not yet been published due to the fact that the data have not been evaluated completely. Some data from 1961 to date have been published in *AAVSO Reports*, which contain 700- to 1000-day-interval data or light curves on a large number of stars, and in *AAVSO Monographs*, which contain 20 years or more of data on one star per Monograph. For example, *AAVSO Reports 28* and *29* contain light curves and/or observations from 1961 to 1963 of 464 long period variables and 394 other types of variables, respectively. *AAVSO Report 30* contains light curves of 446 long period variables from 1963 to 1966, and *AAVSO Report 38* contains 557 light curves of long period variables from 1974 to 1977. The following monographs have been published:

*AAVSO Monograph 1* (SS Cygni Light Curves 1896 - 1985)  
*AAVSO Monograph 2* (U Geminorum Light Curves 1855 - 1985)  
*AAVSO Monograph 3* (R Scuti Light Curves 1963 - 1985)  
*AAVSO Monograph 4* (R Coronae Borealis Light Curves 1843 - 1990)  
*AAVSO Monograph 5* (RY Sagittarii Light Curves 1892 - 1990)  
*AAVSO Monograph 1, Suppl. 1* (SS Cygni Light Curves 1985 - 1990)  
*AAVSO Monograph 2, Suppl. 1* (U Geminorum Light Curves 1985 - 1990)  
*AAVSO Monograph 3, Suppl. 1* (R Scuti Light Curves 1985 - 1990)

In this paper, sample light curves are given of eleven variable stars of different types to show for each star the general behavior - long-term and in some cases also short-term - and to indicate the wealth of information contained in the AAVSO International Database. About 995 observers contributed observations to the light curves of ten of the variables, not including SS Cygni. This paper was originally given in the form of a quiz to attendees of the 1993 Spring Meeting held in Berkeley, California. The light curves without the names of the stars were shown to the

audience and they were asked to guess the name of the star. The audience did extremely well in identifying the light curves. The reader is encouraged to look at each light curve without looking at the header and guess the name of the variable star from the light curve.

## 2. Observations

The light curves of the eleven stars shown in Figures 1 through 4 were prepared with computer software developed at AAVSO Headquarters by Grant Foster for use on the AAVSO computers. Table 1 gives specific information on each star from the *General Catalogue of Variable Stars* (Kholopov *et al.* 1985) and the AAVSO International Database. Below we describe briefly each of the stars.

### 1046-20 V Hydrae

This semiregular, carbon variable star has short-term and long-term variability. Its short-term pulsation period is 530.7 days and its long-term period is close to 20 years. In Figure 1a, a light curve of V Hya made up of 2,969 observations is given, covering Julian Date (JD) 2437600 - 2449100 (October 1961 - April 1993).

### 1802-22 VX Sagittarii

Figure 1b shows the light curve of VX Sgr for JD 2437500 - 2449100 (July 1961 - April 1993) and is made up of 2,576 observations. The interesting feature of the light curve of this semiregular variable with a 732-day period is the varying amplitude and maximum and minimum levels of the cycles.

### 0432+74 X Camelopardalis

This circumpolar, Mira-type long period variable has been closely monitored by observers for decades. Figure 1c is a long term light curve of X Cam, made up of 10,000 observations for the interval JD 2437600 - 2448800 (October 1961 - June 1992). Figure 1d, covering the interval JD 2443500 - 2445500 (December 1977 - June 1983) and made up of 1,817 observations, shows the varying maximum and minimum levels of the cycles. Although this star is a fairly periodic Mira variable, the shape of the light curve varies significantly from one cycle to the next.

### 1921+21 WW Vulpeculae

The interesting features of the light curve of this irregular variable with an early-type spectrum are the quasiperiodic minima and the varying level of the maxima, as seen in Figure 2a. This light curve covers the time interval JD 2437800 - 2449100 (May 1962 - April 1993) and is made up of 4,837 observations.

### 1946+35 CI Cygni

This eclipsing symbiotic star also shows quasiperiodic outbursts of varying amplitude, as seen in the light curve in Figure 2b, covering JD 2439600 - 2448500 (April 1967 - August 1991) and containing 10,000 observations. Deep eclipses of varying amplitude are clearly seen in Figure 2b around JD 2442630 and 2443500.

### 2108+47 V1500 Cygni

Figure 2c shows the light curve of this very fast nova of 1975. The light curve made up of 6,369 observations covers the interval JD 2442600 - 2444600 (July 1975 - December 1980).

### 2138+43 SS Cygni

Figure 2d is a light curve of the brightest northern dwarf nova-type cataclysmic

variable, and covers the interval JD 2437000 - 2448719 (March 1960 - April 1992). The light curve is made up of 10,831 one-day means of observations. Interesting features of the light curve in Figure 2d are the varying quiescent brightness, the varying amplitude of outbursts, and the varying frequency of outburst. The frequency of the outbursts appears to increase and the amplitude to decrease when the quiescent level is bright.

#### 1813+49 AM Herculis

Figure 3a, the light curve of this magnetic cataclysmic variable made up of 5,517 observations from the interval JD 2443000 - 2449000 (August 1976 - January 1993), shows clearly the bright "up" and faint "down" states which are characteristic of this type of variable.

#### 0803+62 SU Ursae Majoris

This dwarf nova-type cataclysmic variable of the SU UMa class is the prototype of its kind, with frequent, faint, short outbursts and infrequent, bright, long superoutbursts. Figure 3b shows its light curve for JD 2446000 - 2449000 (October 1984 - January 1993) made up of 9,836 observations. Figure 3c shows the interval JD 2448100 - 2448400 (July 1990 to May 1991), during which both the normal outbursts and the superoutbursts disappeared and the star stayed in its quiescent state for months. Figure 3d covers the interval JD 2448500 - 2448800 (August 1991 - June 1992), when the star resumed its regular behavior with the frequent, faint, and short normal outbursts and infrequent, bright, and long superoutbursts.

#### 0814+73 Z Camelopardalis

The signature of dwarf nova-type cataclysmic variables of the Z Cam class is the standstill, or relatively constant brightness, that occurs nonperiodically. A standstill generally occurs one third of the way from maximum to minimum, and after the standstill ends the star generally continues to fade to minimum. Figure 4a shows the light curve made up of 10,000 observations of Z Cam for the interval JD 2437600 - 2443000 (October 1961 - August 1976). Several standstills of varying duration are seen during this interval. The light curve in Figure 4b, made up of 10,000 observations covering JD 2443000 - 2446000 (August 1976 - October 1984), is a continuation of the light curve in Figure 4a and shows several more standstills during this time. Figure 4c, covering the interval JD 2444500 - 2444800 (September 1980 - July 1981), shows the general behavior of the star at the end of a standstill when the star fades to minimum, and then at the start of another standstill.

#### 1744-06 RS Ophiuchi

This recurrent nova has had five reported outbursts, in 1898, 1933, 1958, 1967, and 1985. Light curves of the outbursts are very similar to each other. The AAVSO International Database contains observations since 1920. RS Oph is the only known recurrent nova that shows significant light fluctuations between outbursts. Figure 4d is the light curve of RS Oph made up of 8,733 observations in the interval JD 2437000 - 2444000 (March 1960 - May 1979). This light curve shows the 1967 outburst of RS Oph and the significant fluctuations during the subsequent quiescent interval.

### 3. Acknowledgments

The efforts and valuable astronomical contributions of thousands of variable star observers worldwide over decades have created the AAVSO International Database that is widely used by astronomers all over the world. The light curves shown in the

this paper are only a small sample of the wealth of information these observations provide. We gratefully acknowledge the vital contributions of variable star observers that created the light curves.

### Reference

Kholopov, P. N. *et al.* 1985, *General Catalogue of Variable Stars*, Fourth Edition, Moscow.

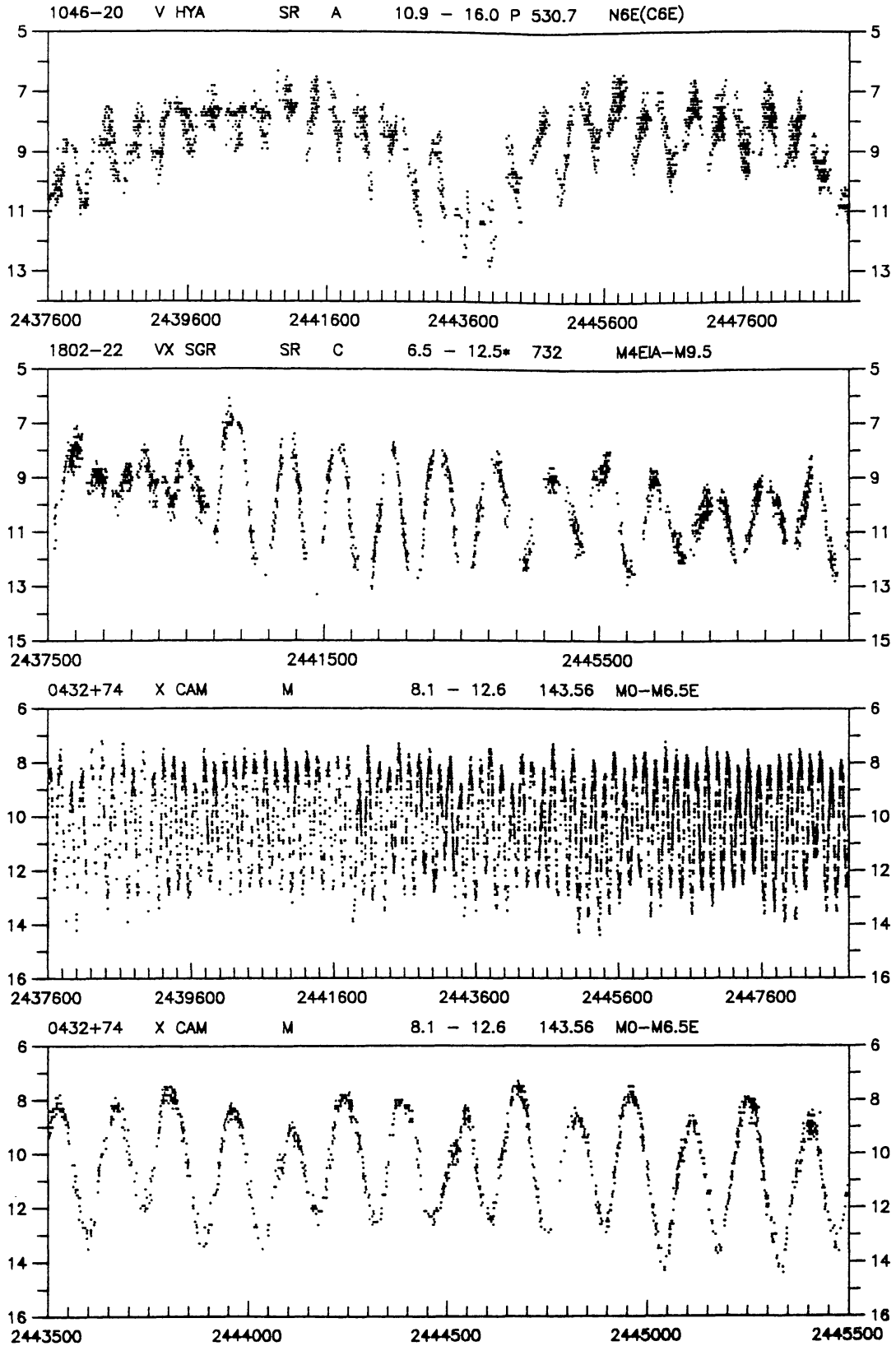


Figure 1. AAVSO light curves of individual observations of V Hydrae (Figure 1a); VX Sagittarii (Figure 1b); and X Camelopardalis (Figures 1c and 1d).

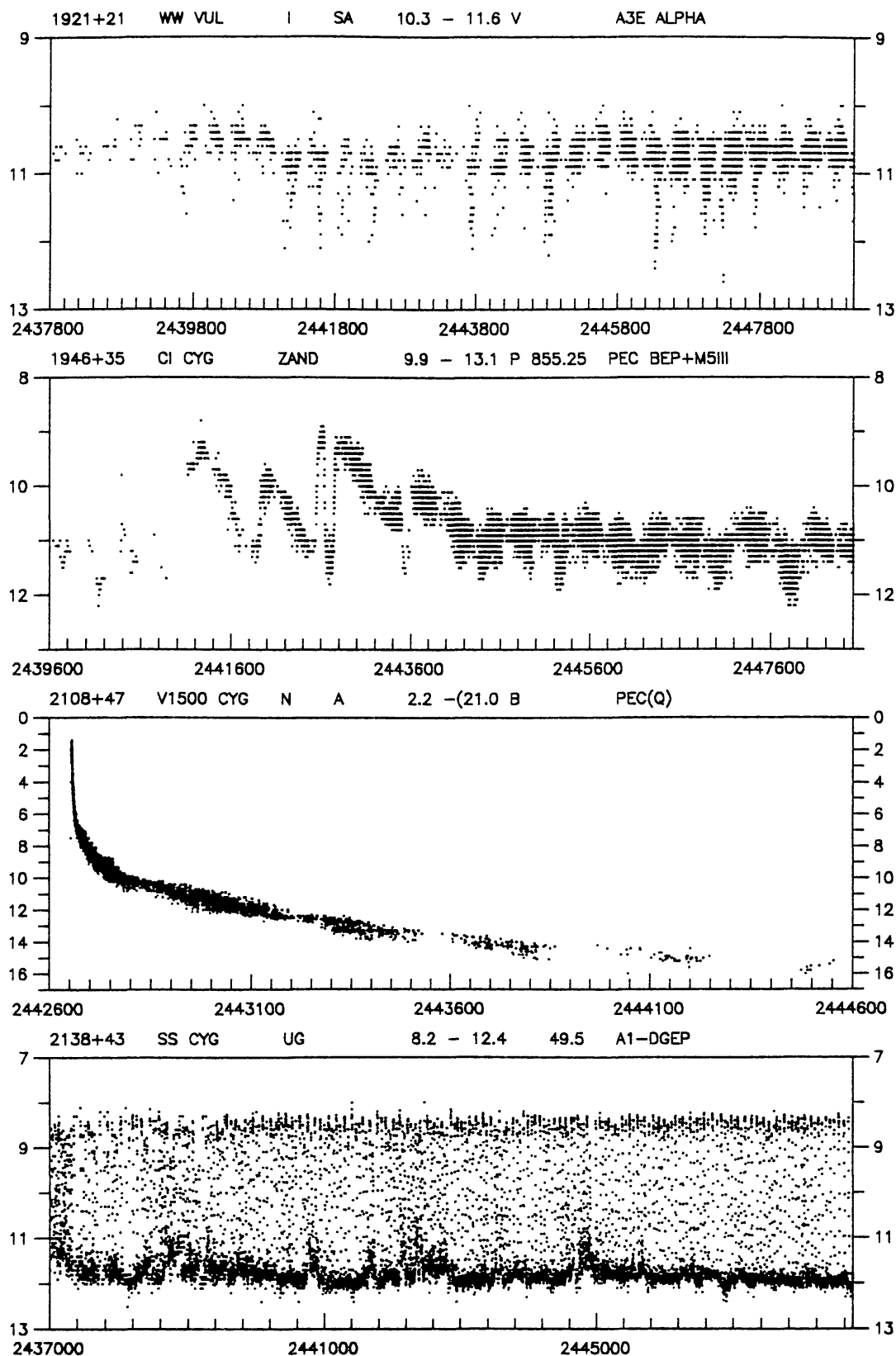


Figure 2. AAVSO light curves of individual observations of WW Vulpeculae (Figure 2a); CI Cygni (Figure 2b); V1500 Cygni (Figure 2c); and 1-day means of observations of SS Cygni (Figure 2d).

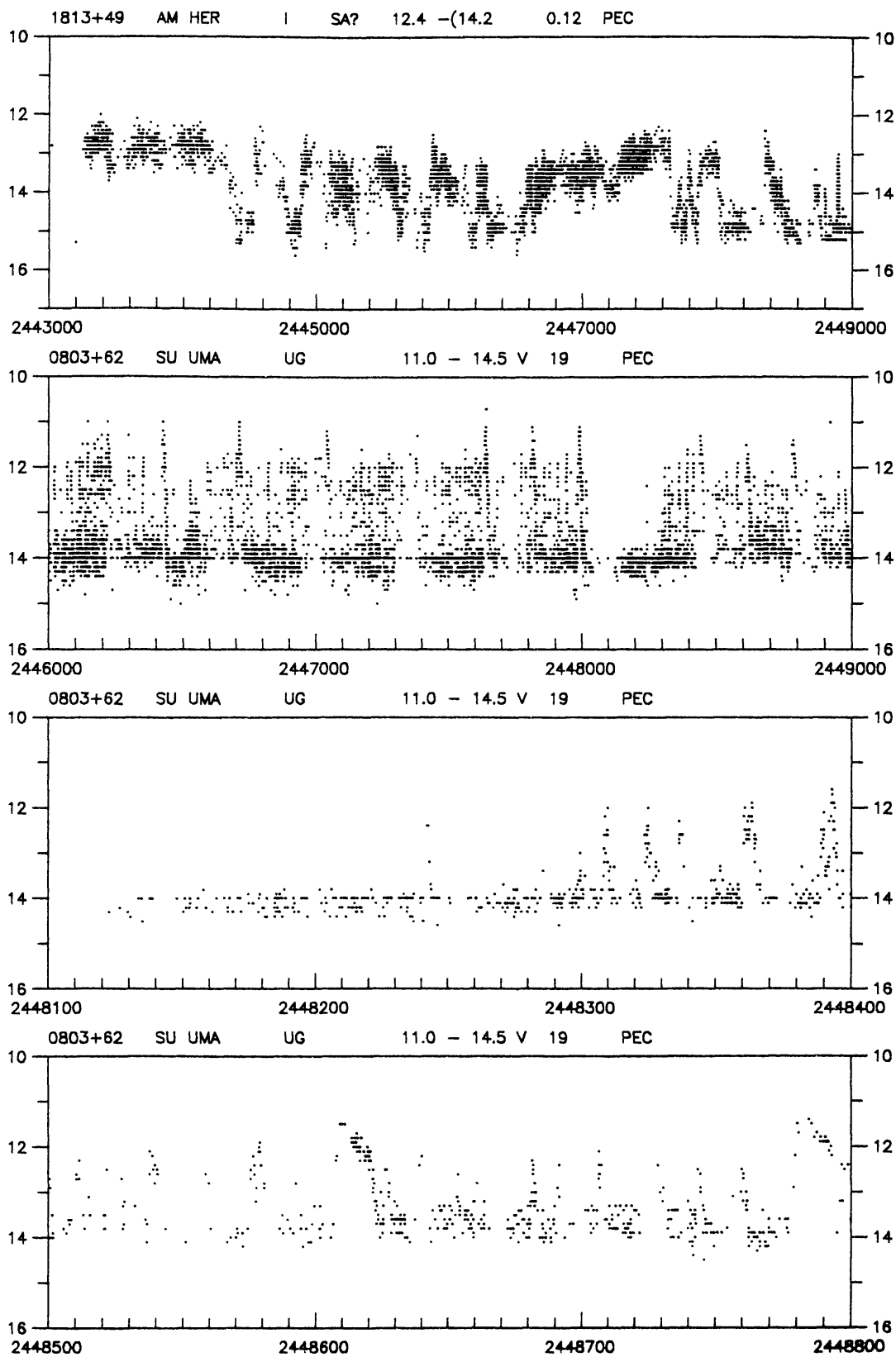


Figure 3. AAVSO light curves of individual observations of AM Herculis (Figure 3a); and SU Ursae Majoris (Figures 3b, 3c, 3d).



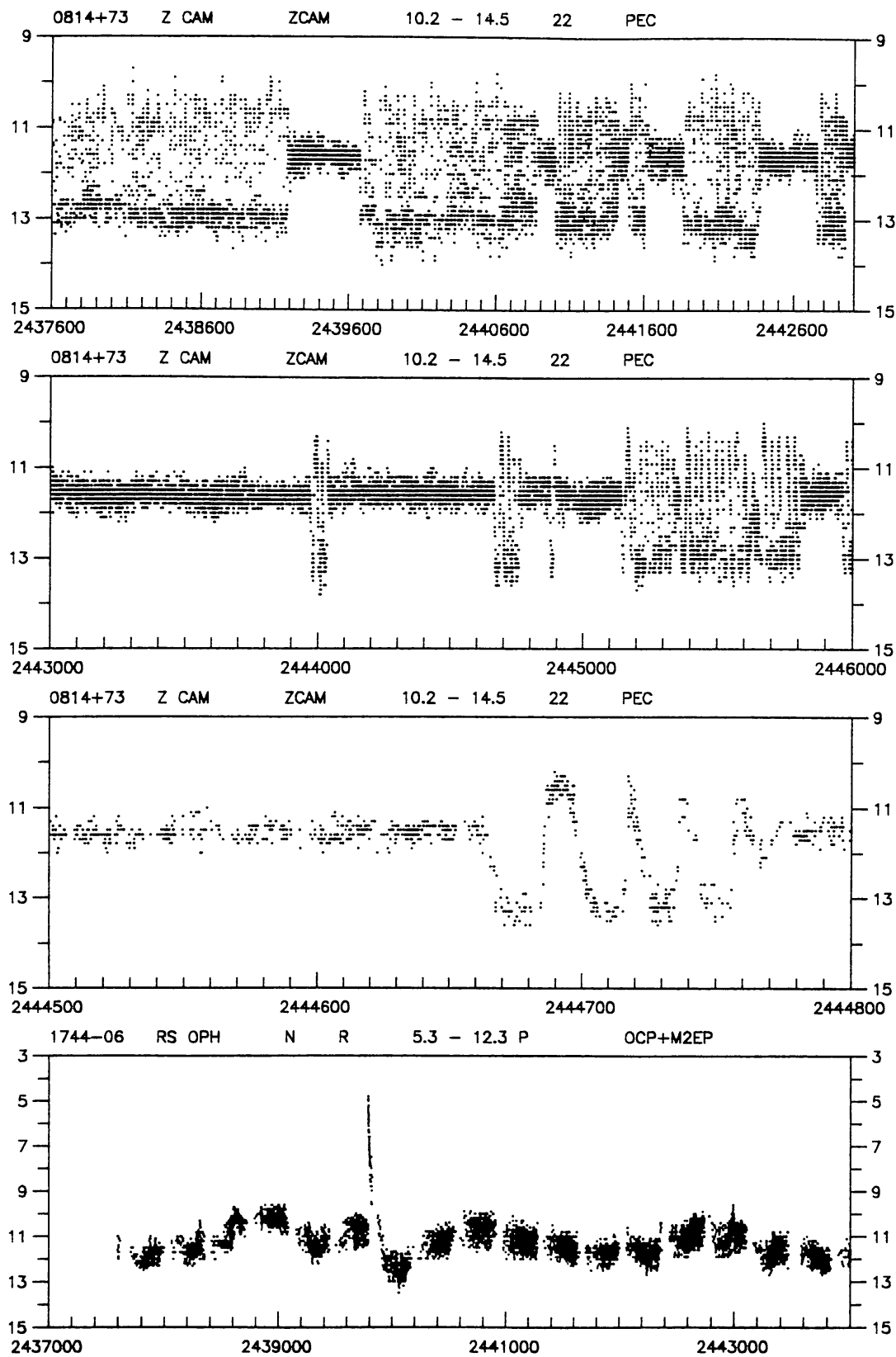


Figure 4. AAVSO light curves of individual observations of Z Camelopardalis (Figures 4a, 4b, 4c); and RS Ophiuchi (Figure 4d).