THE UNUSUAL CATACLYSMIC VARIABLE S193

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Abstract

We present light curves of the recently identified cataclysmic variable S193. This object shows periodic or quasi-periodic oscillations on a time scale of minutes as well as an unusual historical light curve. Observations by the AAVSO are badly needed to better understand the nature of this object.

1. Introduction

Emission lines in the spectra of stellar objects can be a signal of exciting phenomena. The 433rd entry in the Stephenson and Sanduleak (1977) catalog of hydrogen emission stars turned out to be the bizarre black hole candidate SS433. While the 193rd object in the Stephenson (1986) catalog may not be quite that strange, it still can show some surprises. S193 was found to be a cataclysmic variable by Downes and Keyes (1988) in the course of their spectroscopic survey through the S and SS catalogs. Subsequent photometry and spectroscopy over the past four years show light and spectral variations on time scales of minutes, hours, and days. These extensive studies, however, have not revealed the system's orbital period. Even the classification of S193 into a subtype of the cataclysmic variables has been difficult to establish. Monitoring of this star by members of the AAVSO is urged in order to determine the nature of this unusual object.

2. Short Time Scale Variations

Photometric monitoring of cataclysmic variables (CVs) over a period of hours can sometimes reveal eclipses or other light variations due to orbital motion. This is the easy way to determine the binary period. S193 was first observed with the 0.76-m telescope at the Manastash Ridge Observatory of the University of Washington in September of 1988. Two typical light curves, covering 3.5 hours each, are shown in Figure 1. No obvious eclipse or orbital variation is seen, however, fluctuations with a peak to peak amplitude of 30% are clearly present. While random 'flickering' in CVs is very common, the variations in S193 appear fairly periodic. Analysis of the light curves from 1988 and 1989 indicates a period of 19 minutes is often present, but periods of 16 and 32 minutes also appear. Modulations in this range with amplitudes of more than 10% suggest that S193 may be a member of the DQ Herculis class of CV. The white dwarfs in these stars accrete material from the disk onto their magnetic poles. If S193 were a DQ Her star, then the 19-minute period in the light

variation would reflect the rotation period of the white dwarf. X-ray emission, characteristic of DQ Her type variables, has been detected by the Ginga and ROSAT satellites.

Subsequent photometry of S193 suggests the periodicity is not stable, contrary to the DQ Her model. Instead, the variations may be 'quasi-periodic oscillations' which have been observed in dwarf novae during outburst. These variations are due to accretion instabilities and can appear periodic over short intervals. This suggests S193 is a 'nova-like' CV with its accretion disk constantly in outburst. If this is the case, then the amplitude of these quasi-periodic oscillations is surprisingly great. UV and optical spectra also show strong disk emission, indicating a high accretion rate. But, the historical light curve suggests the star undergoes periods when the accretion is extremely slow, more like that found in quiescent dwarf novae.

3. The Historical Light Curve

The Harvard plate collection is a valuable database containing photographs over a century old. The collection is especially useful for studying the history of stars only recently discovered to be variable. Fortunately, the position and brightness of S193 meant it was recorded on nearly 1000 patrol plates since 1897. A sequence of comparison stars was established around the variable, and estimates of the brightness relative to the stars in the sequence were made by eye. The magnitudes of the sequence stars were then estimated from their radius on the Palomar Survey plates using a calibration by Bond (1986). Since most of the plates analyzed were 'O' emulsions, the magnitude estimates are close to the Johnson B band. Figure 2 shows the light curve of S193 during most of the 20th century. The large gap in the 1950's was caused by a loss of funding for the patrol camera program.

Clearly, S193 spends most of its time in a high state near a blue magnitude of 12. It can, however, drop by 1.5 to 2 magnitudes and remain in this low state for days or months. The behavior of S193 in the 1970's is particularly bizarre. The star varied erratically between 12th and 13th magnitude for almost eight years, spending much of its time between the high and low states. In 1983 it returned again to its bright state with a few excursions to fainter magnitudes. The last recorded drop in brightness was in October 1989 during observations with the IUE satellite.

The light curve of this star is very peculiar and requires better temporal coverage to understand its behavior. We urge observers to monitor this object and we include a finding chart with magnitudes from the *Space Telescope Guide Star Catalog* (Lasker *et al.* 1988) to use as comparison stars.

References

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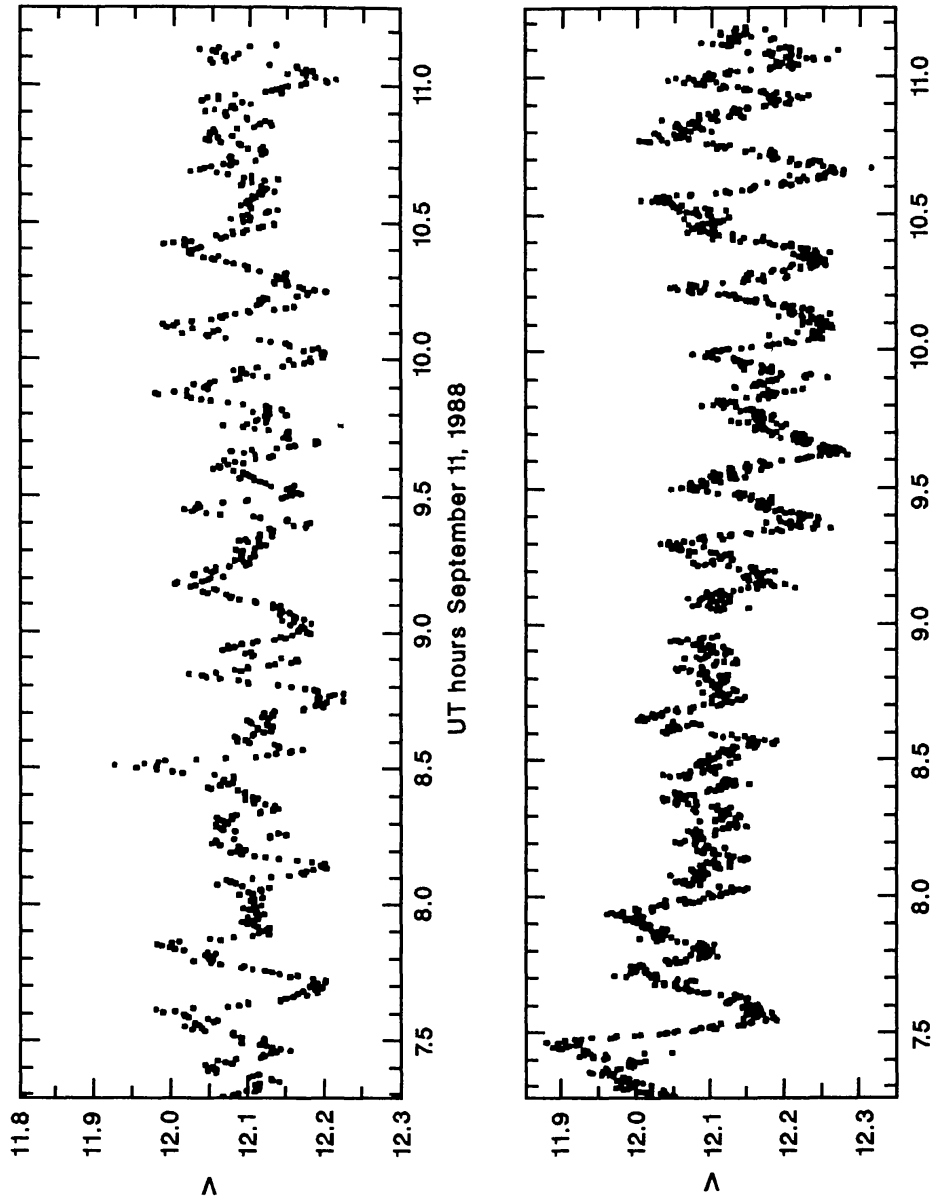

Figure 1. Typical visual light curves of S193 over a 3.5-hour period. The data were taken with the 0.76-m telescope of the Manastash Ridge Observatory and a two-channel photoelectric photometer. Analysis of the light curves reveals a periodicity near 19 minutes.

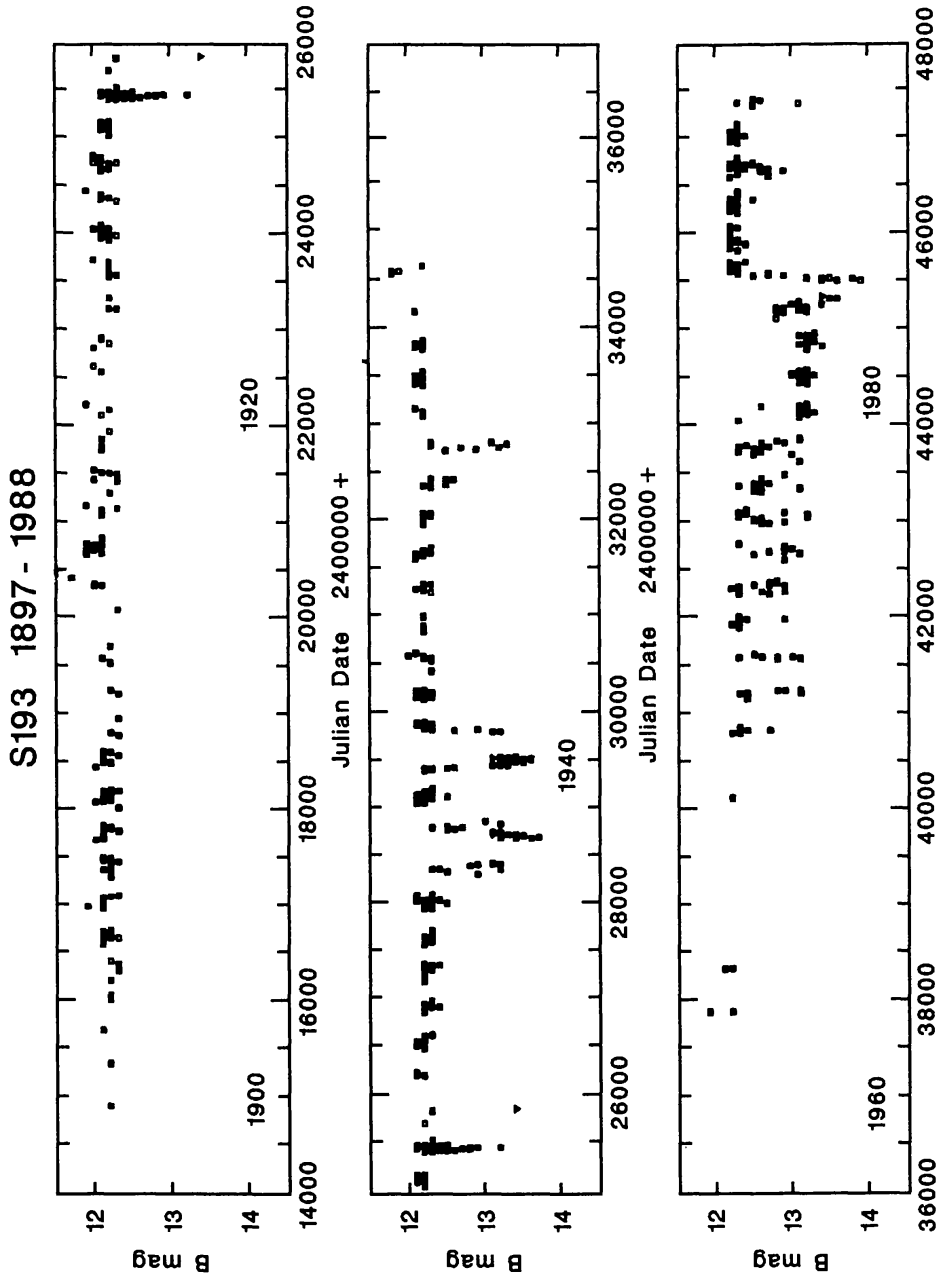

Figure 2. The historical light curve of S193 based on magnitude estimates from the plates of the Harvard collection. The time axis is in Julian Days starting in 1897 and ending in 1988. The star is normally near B = 12, but can fade two magnitudes in a few days. The unusual nature of this light curve demonstrates the need to monitor S193.

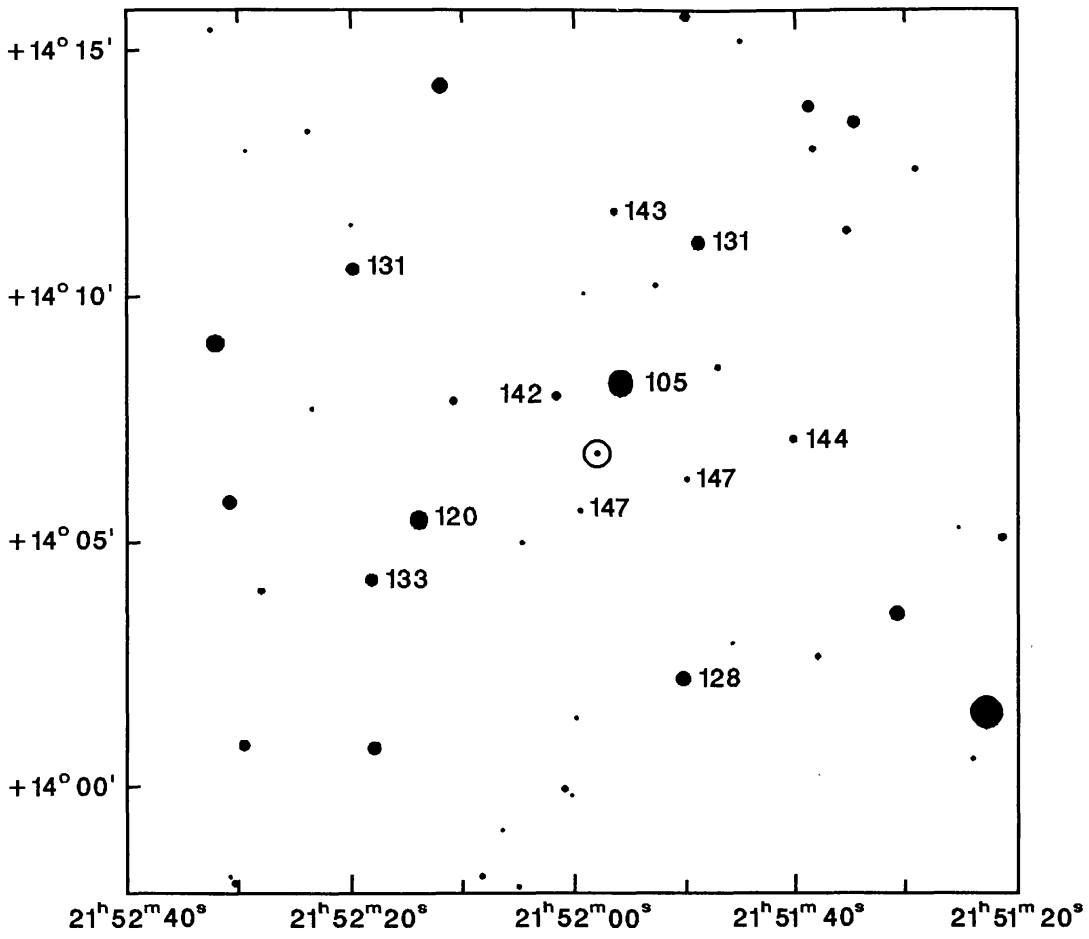

Figure 3. A finding chart for S193. The epoch 2000 coordinates of S193 are $21^h51^m57.9^s$ +14° 06'54" and the same epoch is used for the chart. The range of variation is expected to be between visual magnitudes 12.0 and 14.0. The magnitudes of the comparison stars are from the *Space Telescope Guide Star Catalog* and should be used with caution.