THE FLARE ACTIVITY OF THE
UV CETI SYSTEM, 1966 - 1988

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ABSTRACT U-filter photometric observations of the UV Ceti system spanning 22 years have been analyzed. Using a conservative flare detection limit of \( \log L(\text{flare maximum}) > 27.5 \text{ ergs/sec} \), definite variations in the flare frequency as a function of time were detected. There is some evidence for a cyclic behavior similar to that found on the sun.

INTRODUCTION

UV Ceti is a visual binary consisting of two late dMe stars; it is the prototype of the class of variables known as flare stars, dating to the discovery of stellar flares by Luyten in 1948. Simultaneous photometry and spectroscopy have shown that both stars flare. Time resolved photometry in the U-filter obtained since the mid 1960's from McDonald Observatory and Cerro Tololo Inter-American Observatory has resulted in 1766 recorded flare maxima during 334.5 hours of observing time. The early results have been published by W. Kunkel, M. Zarate, T. Moffett and C. Lacy, covering the period 1966-1976. We have obtained additional data at McDonald Observatory between 1979 and 1987, and at the Bulgarian National Observatory in 1988. The entire data set has been analyzed together, to investigate if the flare activity of UV Ceti varies with time in a manner similar to the solar activity cycle.

RESULTS

The observations were taken under widely varying conditions. In particular, the telescope aperture, integration times, and sky background (due to moonlight) generally changed with each observing run. After taking into account the varying
signal-to-noise ratio of the observations, we decided to include in the analysis only those flares that reach a maximum power greater than $3 \times 10^{27}$ ergs/sec (log L(flare maximum) > 27.5 ergs/sec). This corresponds to a relative flare amplitude of 1.4, a limit conservative enough to ensure complete statistical flare detection even with a small telescope. The price to pay is of course that many small flares observed with 2-meter class telescopes are not used in the analysis.

There are 808 flares in the 1966-1988 sample that are large enough to be included. Our measure of flare activity is taken to be the frequency of flares with amplitudes larger than 1.4. For each run we have counted the number of flares, $N$, and computed the amount of observing time, $T$, so a simple division gives flare frequency $N/T$. This parameter is plotted as a function of time in Figure 1. We have assumed that flares occur randomly in time within each observing run so the error estimate is taken to be $\sqrt{N/T}$.

The range of parameter values in Figure 1 is larger than the typical error bars and a wavelike pattern suggests a possible cyclic behavior with a period of some 10 to 15 years. To test the variability claim, we take as the null hypothesis in a chi-square test that no variability occurs in UV Ceti. The average flare frequency for the entire time interval 1966-1988 is 2.42 flares per hour. For each observing run we can calculate the expected number of flares and compare to the number actually observed. The chi-square statistic $\sum (O - C)^2/C$ is then 88.87. For 18 degrees of freedom the probability for this to occur by chance is less than 0.0005. We therefore reject the null hypothesis and conclude that real variations in the flare frequency of UV Ceti have been detected. The largest deviations are more than 3 sigma from the average value.

![Figure 1: Flare frequency vs. time for the UV Ceti system. See text for details.](image-url)