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LOOKING ON FLARES WITH CCD

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ABSTRACT

We present the Programme of Monitoring of Flare Stars in the Orion aggregate by CCD based Photometer mounted at the Newtonian focus of 70/98/210-cm meniscus telescope through glass imaging quality C1 filter (3900Å/800Å) with a time resolution of 0.5-1.0 min.

I. INTRODUCTION

The star DH CAR flare was discovered accidentally by Hertzsprung in 1924 when he was looking plates taken in the direction of the constellation CARINA. After discovery of flare of red dwarf star L726-8 by Carpenter, now called UV Ceti, Luyten expressed the opinion that the flare explanation must be directly related to the stellar energy sources. The first list of field flare stars was prepared in the beginnig of 60's (Joy 1960).

Only after the fundamental work of Haro (1953) who discovered flare stars in stellar associations and young clusters the importance of these objects was fully recognized. The flare star system provides one of the most important records of the stellar aggregates. This records can be used to establish the chronology of these systems and test theories of star and aggregate formation. Therefore photometric monitoring of flare stars is very important. Several large and long term monitoring programms have been finished and the results clearly show that more observations are to be carried out with higher time resolution if we want fully understand these objects.

The CCD photometry allows precise monitoring of stellar flare radiation for many stars simultaneously at good time resolution. The photometric precission is as good as that with photoelectric photometry.

II. PHOTOELECTRIC AND PHOTOGRAPHIC OBSERVATIONS

The flare frequency strongly depends on the adopted amplitude of the flares. The minimum value of the amplitude for which a flare can still be reliably detected depends on characteristics of the receiver. Photoelectric and CCD observations allow to detect flare with much smaller amplitude than photographic ones.

At present we have sufficiently correct picture of flare frequency only for flare stars in the solar vicinity, namely for UV Cet type (Gurzadyan 1980, Mirzoyan 1981). It is based on an analysis of the most homogeneous photoelecrtic observations for a large number of flare stars. The total number of flares in some cases (UVCet, CN Leo, Wolf 630) is more than one hundred (Kunkel 1973, Moffett 1974).

The average values of flare frequency and amplitude strongly increase when absolute luminosity decreases. It is smallest in the early subclasses of K and largest in the subclusses M5. As a rule, the flare frequency in U is several times higher than in V. On the other hand, in this spectral range flare stars are considerably, sometimes by three magnitude fainter than in V.

A somewhat different picture is observed in the case of flare stars of stellar associations and clusters where the flare frequency is more than one order of magnitude smaller than in the neighbourhood of the Sun. This is probably the selection effect, since the flare stars in aggregates are normally identified photographically (Gurzadyan 1980, Mirzoyan 1981) by multiple exposure method with exposures 5-10 min. The first attempts to look for flare stars in regions far from the solar neighbourhood were undertaken at the end of 40's (Joj 1949). Haro who was convinced of the evolutionary significance of the flare phenomenon, was one of the first who look for flare stars in stellar associations.

When we speak about flare stars in aggregates, objects are considered for which flares have been recorded with an amplitude more than 0.6-0.7 mag and last at least five minutes. On account of the long exposure times, usually 5-6 min the true amplitude of the flare, reached at the moment of its maximum, cannot be determined.

As a result there is an unavoidable strong selection in observational material, with respect to the statistics and the physical characteristics of flare stars in aggregates. And this explains difficulties which arise every time one tries to compare physical and statistical characteristics of flare stars in aggregates and in the neighbourhood of the Sun, since the later are studied practically only by photoelectric method.

III. THE CCD MONITORING PROGRAMME

The 70/98/210-cm meniscus telescope (Kiladze 1960) is now eqquiped by ST-6 Professional CCD Imaging Camera. It is mounted at Newtonian focus and equipped with a focussing system and a filter wheel. Six filters can be set at a time. The CCD chip is thinned, back illuminated 375 × 242 array with a pixel size of 23 × 25 microns and a readout noise of 30 e. The ST-6 operating software provides various service capabilities such as capturing the image with exposure times from 0.01 sec to one hr, a focusing mode, a track and accumulation mode for automatic guiding and long exposures, dark current and flat field correction, some initial image processing. The image can be saved to a hard or floppy disk in several formats (uncompressed, compressed, TIFF and FITS). The following wide, intermediate and narrow band interference filters (BVRI, Gunn System, H_α, β_1 and β_2, H_γ, HK, OIII 5007, HeII 4686, Si6725, OII3733, OI6300, BaII 4554, 6450, 6000, 5400, 4600, HeI 5870) are all imaging quality and manufactured at Observatory.

The critical parameters of our CCD camera system is a pixel size of 2.3×2.5 sq arcsec on the sky. A typical twilight flat field frame, taken with the meniscus telescope has a best rms over the whole image of one percent. Preliminary reduction of the observational data shows that CCD is sensitive to a wavelength range from 3500 A to 1.2 micron, with a maximum efficiency at 7400 A. There is a secondary maximum at 6000 A.

As was stated above photographic observation of stellar aggregates for identification of the flare stars has a few principal disadvantages. For example: flares of stars with amplitude about two magnitude and duration one minute cannot be recorded by photographic observation with duration 5-10 min. Besides, the limiting magnitude reached in the photographic observation is relatively bright, while the CCD goes by 1.5-2 mag deeper in the 5-10 times shorter exposure.

Taking into account all these principal difficulties we undertake at Abastumani the monitoring programme of flare stars in the Orion association by CCD based photometer attached at Newtonian focus of the 70cm meniscus telescope.

The only disadvantage of CCD relative to the astronomical emulsion is a small field of view - 10 x 14 sq.arcmin. Due to the small field of view we decided to carry out observations in the central part of this aggregates where the Great Orion Nebula is located. At the same time, as is well known, it is the center of flare star system. The small view of CCD will be compensated by the fainter limiting magnitude reached, when the observed number of stars should be strongly increased, at least by a factor of 5-10 (Jones 1988). It should also be noted that it was practically impossible to identify flare stars in this region by the photographic method due to strong radiation of the Great Orion Nebula.

For preliminary observations the C1 glass filter was used with a peak transmission of 0.85 at 3900A and FHWM about 800A. It is very similar to Washington system C filter characteristics. It is centered at 400A redder than the Jonhson U filter which endows the C1 filter with two significant advantages: it is less affected by reddening, and the energy distribution of K-M stars favors detection through the C1 filter when compared with U filter. Consequently, exposure times in C1 are no more than one third of what is required in U to observe late type stars.

We plan to carry out also the CCD observations of this area through the interference filter to suppress the radiation of the Great Orion Nebula in emission lines. Besides, the observation of this region will also be carried out through HK and H_α filters for identification of emission line stars ussing eight degree prism with resolution 3A at HK and 20A at H_α.

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