CCD Monitoring of Flare Stars in Stellar Aggregates

Omar M. Kurtanidze

Abastumani Astrophysical Observatory, 383762 Abastumani, Georgia

1 Introduction

After Haro's fundamental discovery of flare stars in stellar associations and young clusters, their importance was fully recognized. The flare star system provides one of the most important records of the stellar aggregate's history. This record can be used to establish the chronology of these systems and to test theories of star and aggregate formation.

Unfortunately, the observational material contains an unavoidable strong selection with respect to the statistics and the physical characteristics of flare stars in aggregates. This explains the difficulties which arise when one tries to compare physical and statistical characteristics of flare stars in aggregates and in the solar neighborhood, since the latter objects are studied almost exclusively by photoelectric methods. The flare frequency in aggregates is more than one order of magnitude smaller than that of flare stars in the solar neighbourhood. This is probably a selection effect, since the photographic observations in aggregates have been carried out with exposure times 5-10 min. Small amplitude flares cannot be recorded at all. Flare stars in aggregates are usually objects whose recorded flares have amplitudes $> 0\overset{m}{.}6 - 0\overset{m}{.}7$, and which last for at least 5 min. The long exposure masks the true amplitude of the flare.

CCD photometry allows precise monitoring of stellar flare radiation for many stars simultaneously at good temporal resolution. The photometric precision is as good as that with photoelectric photometry. Such observations will provide additional new constraints on stellar evolution.

2 The Telescope and CCD Camera

The Abastumani Observatory 70-cm meniscus telescope has a field of view of 4.8×4.8 square degrees. For spectral observations, it is equipped by 8, 4, 2 and 1° prisms with reciprocal linear dispersions 16.7, 66, 125 and 250 nm/mm at Hγ, respectively (Kiladze 1960).

The model ST-6 Professional CCD Imaging Camera system consists of a camera head, IBM PC XT-type CPU and software. The camera head contains the CCD chip, a two stage thermoelectric cooler and 16-bit A/D converter. It

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is now attached to the 70-cm meniscus telescope through a Newtonian focus photometer which is equipped with a focussing system and filter wheel. The pixel size corresponds to 2.″46 and the readout noise is 30 e. The gain is ≈ 6 e per ADU. A typical twilight flat field frame has a best rms over the whole image of 2%. The CCD is from 350 nm to 1.2 μm, with a maximum efficiency at 740 nm (Kurtanidze et al. 1994).

3 The CCD monitoring programme

Flare stars in aggregates are normally identified photographically (Gurzadyan 1980, Mirzoyan 1981) by the multiple exposure method with exposures 5-10 min. Photographic flare star search in stellar aggregates has several disadvantages: (1) Flares of stars with amplitudes about 2^m and a duration of 1 min cannot be recorded by photographic observation with duration 5-10 min. (2) The limiting magnitude for photographic observations is relatively bright, while the CCD goes by $1.5 - 2^m$ deeper in a 5-10 times shorter exposure. For these reasons, we undertake at Abastumani a monitoring programme of flare stars in the Orion association by a CCD based photometer.

The only disadvantage of CCD relative to the astronomical emulsion is the small field of view – $10' \times 14'$. Therefore we decided to carry out the observations in the central part of this aggregate, where the Great Orion Nebula is located. As is well known, this is the center of the flare star system. The small view of CCD is compensated by the fainter limiting magnitude, and the observed number of stars should strongly increase, at least by a factor 5-10 (Jones et al. 1988). Furthermore, it was practically impossible to identify flare stars in this region by photography because of the strong nebular background radiation.

The C1 glass filter was used for preliminary observations. It has a peak transmission of 85% at 390 nm and a FHWM of about 80 nm, and is similar to the C filter of the Washington system. Its central wavelength is over 40 nm redwards of that of the Johnson U filter, leading to two significant advantages: it is less affected by reddening, and the detection of K-M stars is favored; required exposure times for late type stars in C1 are a factor 3 shorter than those in U.

We plan to carry out also CCD observations of this area through interference filters to suppress the nebular radiation. Observations through H+K and Hα filters for identification of emission line stars are also planned, using the 8° prism with resolution 0.3 nm at H+K and 2 nm at Hα.

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