WIDE-FIELD PHOTOGRAPHIC VERSUS WIDE-FIELD CCD TECHNIQUES IN THE ACTIVITY ANALYSIS OF dM STARS

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1. Introduction

The Galaxy is abundant in red dwarf stars. According to statistical analyses, their majority is unstable. Simultaneously, more than 60% of the variable stars known in the solar vicinity ($r < 20$ pc) are flare stars and taking into account the number of BY Dra stars too the proportion of red dwarfs amongst local variables is superior to three quarters. Their absolute visual magnitudes range from +6 to +17.5 or even more (Szécsényi-Nagy 1986a). During flare events their brightness may reach a maximum corresponding to an enhancement of 1000 - 10,000 times. The amplitude of a large flare in the U band may be as high as 8 - 10 magnitudes. The events take place nonperiodically in unpredictable moments; no unquestionable periodicity has been found in the time distribution of stellar flares. However the activity level of various flare stars is considerably different. Some of them show observable flare ups with a mean frequency of 1 per hour whilst others produce only one event per annum. For the scarcity of the phenomenon, traditional photoelectric photometry of individual stars is not an adequate means to a better understanding of flare stars.

2. The Other Way

Wide-field photographic photometry is definitely more profitable for the possibility of simultaneous recording of the sudden brightness variations of hundreds of objects and for the high limiting magnitude offered by fast Schmidt-cameras in the U spectral band. This latter made the statistical investigation of flare stars and their flare ups in open clusters possible, since their dM type members are too faint (especially in the ultraviolet) to be readily measurable by photometers mounted on moderate-sized telescopes. Some of the younger and richer open clusters are perfectly disposed for such a study (Szécsényi-Nagy 1986b). Their distance modulus is inferior to 7.5 but their angular diameter fits nicely that of the viewing angle of the photographic cameras used in the observing campaigns (Szécsényi-Nagy 1986a). The quasi-uniformity of the emulsions and other important parameters of the photographic procedures permitted the combination of the results of many individual runs and the spatial (Fig. 1) and photometric filtering of the published data which led to more reliable and more convincing conclusions regarding the flare activity of dM stars (Szécsényi-Nagy 1990a).

H. T. MacGillivray et al. (eds.), Astronomy from Wide-Field Imaging, 61–64.

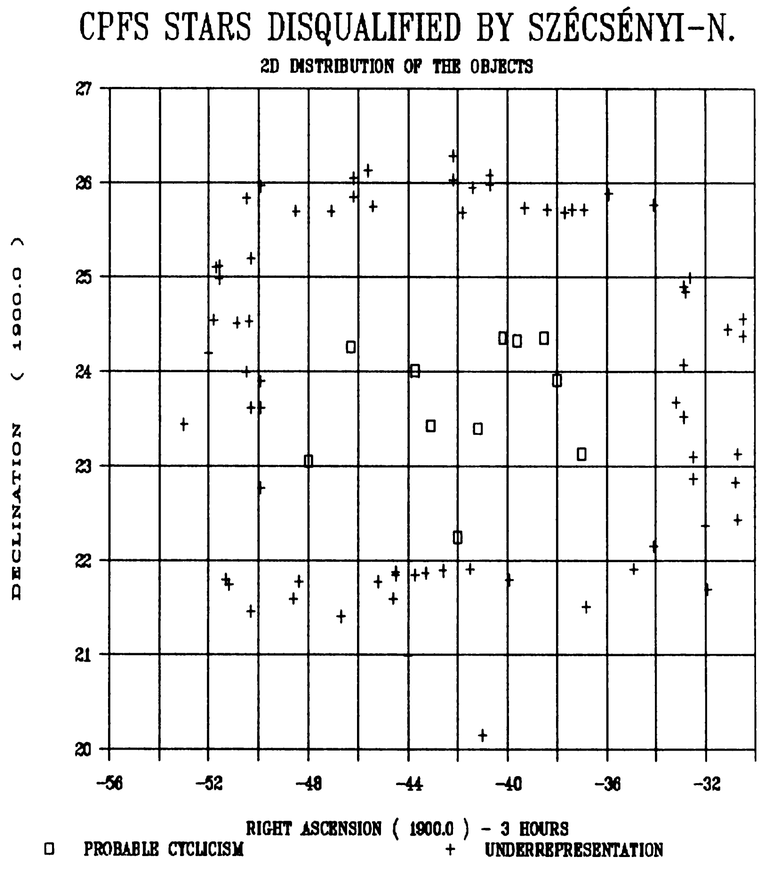

Figure 1.

3. Why Replace Photographic Emulsions by CCD Chips ?

Some of the most attractive advantages of CCDs are:

a) common linearity of the electronic devices;
b) very high quantum efficiency of silicon and its wide spectral sensitivity (with extended UV-wing);
c) wide dynamic range of large-pixel CCDs;
d) longevity and geometric stability of the chips;
e) repeated use of the device (Buy Once Read Out Many times or BOROM);
f) uniformity of the light-sensitive area, or if not then
g) straightforward methods to correct errors like that;
h) immediate digital output of images (computer friendly);
i) small and lightweight.

And their drawbacks:

a) high price (it is definitely decreasing although not with the desired tempo);
b) other difficulties at purchase (COCOM, long and bureaucratic procedures etc.);
c) small dimensions
   i) limited field or
   ii) very low resolution.

At last a GOOD NEWS: the mass production of CCD cameras (video and surveillance) resulted in cheaper units while technical innovations made the manufacturing of 1, 2 or 3 edge buttable chips also possible. These were successfully built in and tested in astronomical applications. The production of giant chips (remember: the first large CCDs developed for the HST measured only 800 x 800 pixels) which grow from one year to the other is a routine today (Sekiguchi 1993). The greatest I have got information of has 26.2 million pixels and measures 6.2 cm by 6.2 cm (it exceeds the dimensions of the frames of the famous large format camera often used in astronomical observations: the Hasselblad). This chip — if it may be used in long exposure mode too and is cheap enough for us — may be the ideal solution.

4. Which CCD Camera to fit the Wide-field Telescopes for Flare Star Research?

Flare stars are mushrooming in younger open clusters of which only some (the nearest ones) occupy really wide sky fields (e.g. exceeding 5 deg in diameter). Going deeper into space their number has to increase and they have to shrink. In order to illustrate these changes let's push my favourite cluster (M 45) to r = 0.5 kpc (i.e. 4 times its actual distance). From that place its member stars must have ample room in a field-of-view of 2 deg. And assuming a 50 to 100 times more effective detection than that of the traditional photographic method the cluster's distance might be doubled once more. The result: detection of the active red dwarf population of large open clusters as far as their limits and the possibility of high precision flare photometry of these objects.

Since the average seeing conditions at the sites of observatories participating in this program are not exceptional, the pixel size of the CCD can be specified as being equal to the FWHM of the seeing disk (1 to 2 arcsec). There are observing sites (Chen 1993) with even less favourable circumstances where the use of very large image pixels (2 to 3 arcsec wide) may be allowed. Taking into account the actual focal length of WFTs 15 to 30 micron pixel size (which is very common on the photonic market) seems to be the best choice (Yanagisawa 1993). CCDs with large pixels generally offer much higher full-well capacity and wider dynamic range than those which contain 5 to 15 micron pixels. The linear dimension of the chip may be obtained from the data field diameter (e.g. a field of 2 deg and seeing of 2 arcsec will result in 3600 pixels which yields 54 mm if the pixel size is 15 micron or 108 mm if it is 30 micron. The first value has recently been surpassed both in pixel number and chip size and to produce 10-12 cm CCDs is only a matter of time). The use of CCD detectors in flare star research and especially in H-alpha emission measurements has been discussed in detail elsewhere (Szécsényi-Nagy 1990b).

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References

Chen, J.-S., 1993. In 'IAU Comm. 9 WG on WFI' Newsletter 4, p. 9.
DALSA INC. *Photonics Spectra*, Vol. 27, Issue 4, p. 67.
Sekiguchi, M. 1993. In 'IAU Comm. 9 WG on WFI' Newsletter 4, p. 9.
Szécsényi-Nagy, G., 1986a. In 'Star Clusters and Associations', eds. B.A. Balázs and G. Szécsényi-Nagy, Budapest, p. 59, and references therein.
Szécsényi-Nagy, G. 1986b. In 'Star Clusters and Associations', eds. B.A. Balázs and G. Szécsényi-Nagy, Budapest, p. 101.
Szécsényi-Nagy, G., 1990a. *Astrophysics and Space Science*, **170**, p. 63.
Szécsényi-Nagy, G., 1990b. In 'Star Clusters and Associations', eds. B.A. Balázs and G. Szécsényi-Nagy, Budapest 1993, p. 55.
Yanagisawa, K., 1993. In 'IAU Comm. 9 WG on WFI' Newsletter 4, p. 9.