Experimental Measurement of Variable Star Brightness by On-line Electronic Computer

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After having introduced the electronic computer at the W. Struve Tartu Astrophysical Observatory, an opportunity to put into practice some measuring and data handling systems presented itself. The simplest measuring of variable star brightnesses by the on-line computer was chosen for the beginning, and for today the first stage has passed with certain success. In the present paper we give a brief report about the work done.

The block-scheme of our apparatus is presented in Figure 1. As an observing instrument the

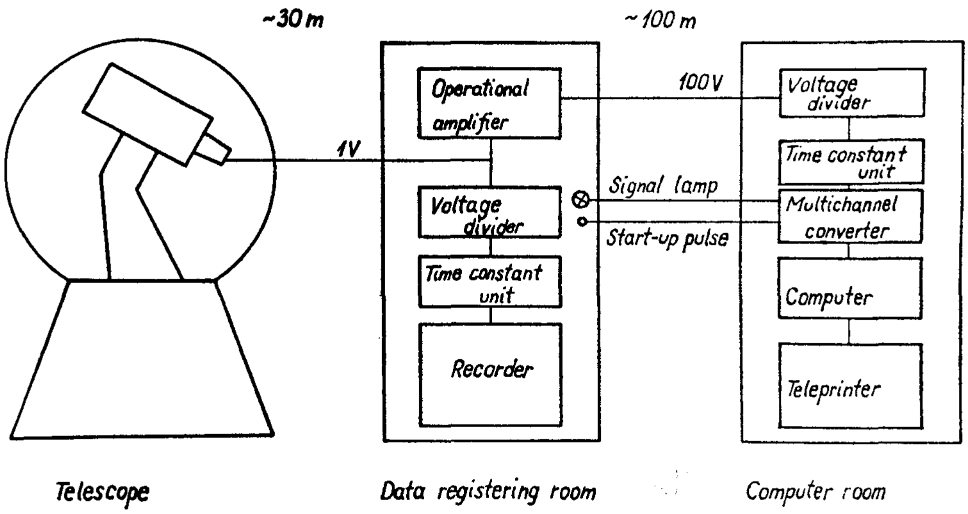

Fig. 1

50 cm reflector with a direct current amplifying photometer is used. From the amplifier located in the photometer box the photocurrent is taken to the data registering room and registered by the recorder. This system is described by Veismann and Kübar (1968) and Massik (1970). Using the operational amplifier, the photocurrent is simultaneously taken into the computer room and fed into the computer by the analog-to-digital converter. After the start-up pulse, on a special cable, the computer finds within a given time interval and with a given measuring frequency the running average of voltage and its mean-square error. The teleprinter output is used. To complete the description of our system, we must confess that the hardest part of our work was the elimination of noise caused by long cables, but the accuracy of battery current measurement tests showed that errors were finally less than 0.2 per cent. We note that this is somewhat better than the linearity of our recorder.

The following programs have been written for the measurements:

1. One measurement with the given averaging time and measuring frequency is carried out after the start-up pulse, and the teleprinter displays the time of the moment when the measurement begins, averaged voltage, and its mean-square error;

2. One measurement is carried out in the way described above, and the next measurements are started immediately; after the stop-pulse, the time of commencement of the first measurement and all measurements with their mean-square errors are printed;

3. The variable star, sky background, and comparison star are measured in the way described earlier, and the teleprinter displays the time of commencement of the first measurement, all three average voltages and their mean-square errors, and the brightness of the variable star with its computed error.

+40281+5 +15000+4

+46810+3 +13742+0 +24182+3 +78839-1 +71064+3 +21113+0

+73308+1 +15742-2

Fig. 2

In Figure 2 an example of teleprinter output is given. The first program is used for adjustment tests, the second for measurements of rapid stellar variations, and the third for brightness measurements.

We now give some examples of results obtained. Measurements of CH Cygni rapid ultraviolet variations were obtained on two nights, then the sky background temporarily interrupted these observations. Our results are shown in Figure 3. Comparison with the ordinary recording measurements shows that agreement is quite good.

Measurement of the brightness of CH Cygni was obtained on several nights, and the results are given in Table 1.

TABLE 1

	Recording			Computer		
Data	V	B–V	U–B	V	B–V	U–B
May 6	7.81	0.92	−0.13	7.80	0.88	−0.14
May 7	7.77	0.84	−0.39	7.79	0.80	−0.41
June 21	7.36	1.25	—	7.38	1.28	—
July 9	7.35	1.31	—	7.35	1.34	—

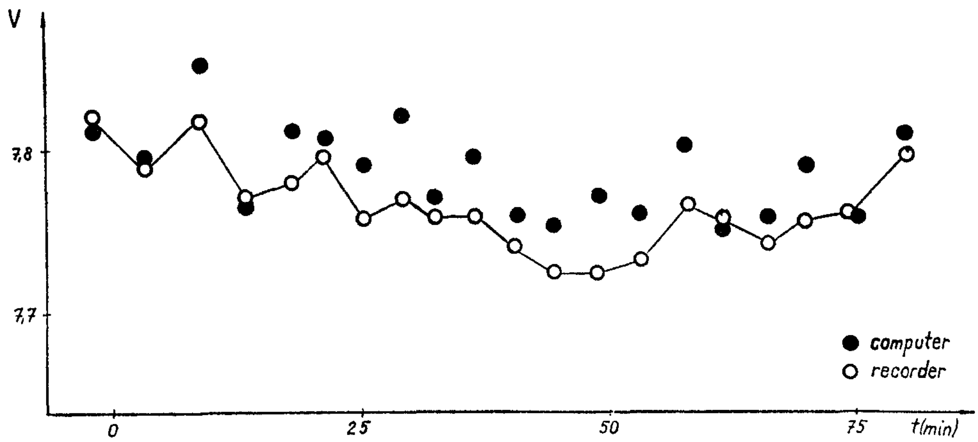

Fig. 3

The brightnesses and colours given in Table 1 show that differences between recording measurements and computer ones are small enough. For some nights we found the differences to be systematic. The V filter observations on the worst night, May 7, are shown in Figure 4. There is a systematic difference $0\overset{m}{.}017 \pm 0\overset{m}{.}007$ but the variations of brightness are in general agreement. We are not able to determine the cause of such differences, but it seems that the more objectively determined computer results are more correct.

Our first experiments show that a measuring and data-handling system for photoelectric observations is possible, and now more developed programs are in preparation.

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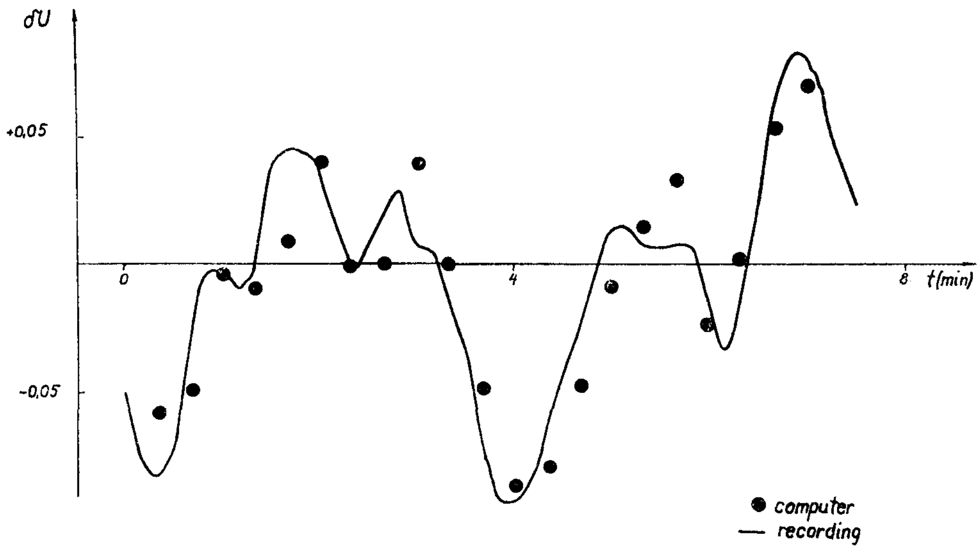

Fig. 4

DISCUSSION

W. Liller: Did you find an 8 min period in CH Cyg?

L. Luud: No, there is no period, you saw only part of the light-curve.

A. A. Hoag: Do you have some element of computer control for the telescope as well as for the data handling? I noticed in your magnitudes an error display—you had both the star observations and the comparison star observations in the same format. Is this achieved automatically—do you observe a variable star and the comparison star in an automatic sequence at the telescope?

L. Luud: The observations are made in a fixed sequence, but the telescope setting is not computer controlled; the cost of computer control is too large to be used for small telescopes.

W. C. Livingston: I assume the time-constant of the recorder is of the simple RC-type, whereas the computer provides an ideal integration. Perhaps this difference might produce your discrepancy between the recorder and computer records—is this possible?

L. Luud: For the computer and for the recorder we have various RC-type units with independently changeable time-constants. The time-constants are always nearly equal, but that of the computer is a little smaller. It is possible that the time-constants could produce some difference between the two records.

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