MONITORING FAINT VARIABLE STARS AT MINIMUM: A WORK IN PROGRESS

Gary Emerson
E. E. Barnard Observatory
34226 Gap Road
Golden, CO 80403

Irene R. Little-Marenin
CASA, CB 389
University of Colorado
Boulder, CO 80309

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Abstract

Many of the AAVSO program variable stars have approximate minimum magnitudes listed only as "<__ magnitude." Intrigued by these "unknowns," the authors decided to monitor these stars at minimum light to measure and, in some cases, derive the lower magnitudes for these objects. As this project evolves, these stars are becoming more interesting. Many of the stars are Miras and change color as they fade. Some of the closer (brighter) stars are also sources of maser emission. Assuming a period-luminosity relation for these stars, we find that most are at distances of greater than 2 kpc, and their maser emission is too faint to be detected.

Because this project is in its infancy, few results can be reported at this time, but observations and observation techniques are discussed. Other CCD-equipped observatories are encouraged to participate in these valuable observations.

1. Introduction

Recently, one of the authors (Emerson) started routine monitoring of a selection of AAVSO program stars with magnitudes fainter than 16 (visual) at minimum to determine the accuracy of the minimum values. The first star monitored, IK Tauri, had a minimum magnitude listed as "fainter-than 16.5," but was not detected at magnitude 18 around the time of minimum (Figure 1).

Further checking of variables such as WW Ser (Figure 2) showed similar magnitude results in V, and when checked in the R and I bands showed the extreme redness of these stars. These results support the inclusion of these objects in the Mira class of variable stars (Mattei 1997), which are known to change color with brightness.

A full understanding of a star's model must include brightness and color data when it is at minimum light. Until the advent of CCDs, making photometric observations at magnitude 18 could be done only with the largest telescopes, on which very little time is available for the study of variable stars.

2. Observational program

Professional-quality CCD cameras are now available for advanced amateurs and small colleges that, when used with a telescope with adequate aperture, will do accurate photometry below magnitude 18. These instruments in the hands of a good observer can produce valuable data to fill in the gaps in our knowledge of these stars at minimum light.

A short list of AAVSO program stars with minimum below magnitude 16 has been

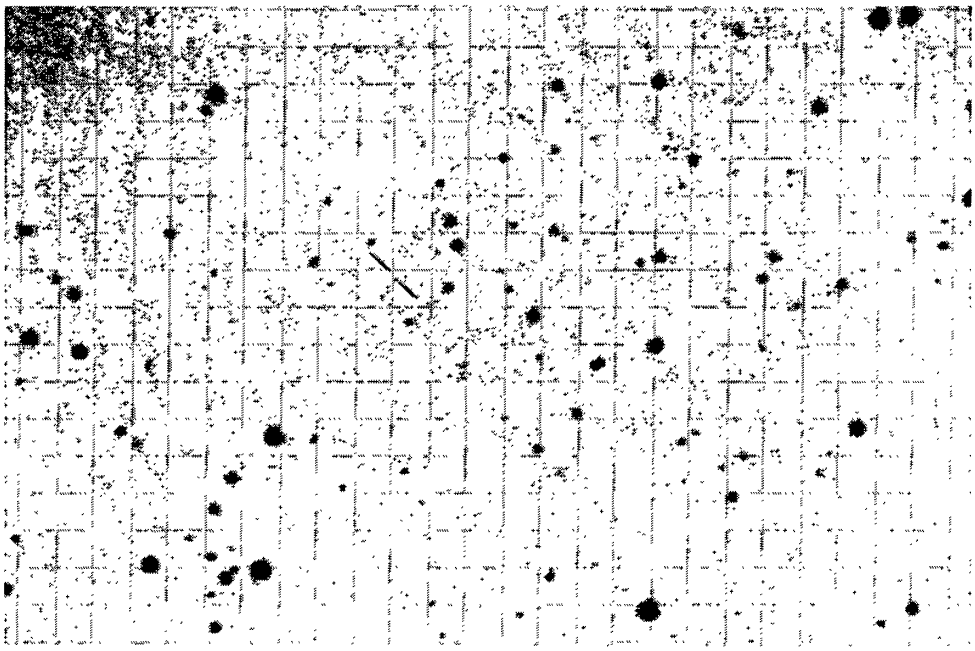

Figure 1. CCD image of IK Tau field in "V" band as the variable is brightening from minimum. Limiting magnitude ~18. North is up and East is to the left. Image is 23 x 13 arcminutes.

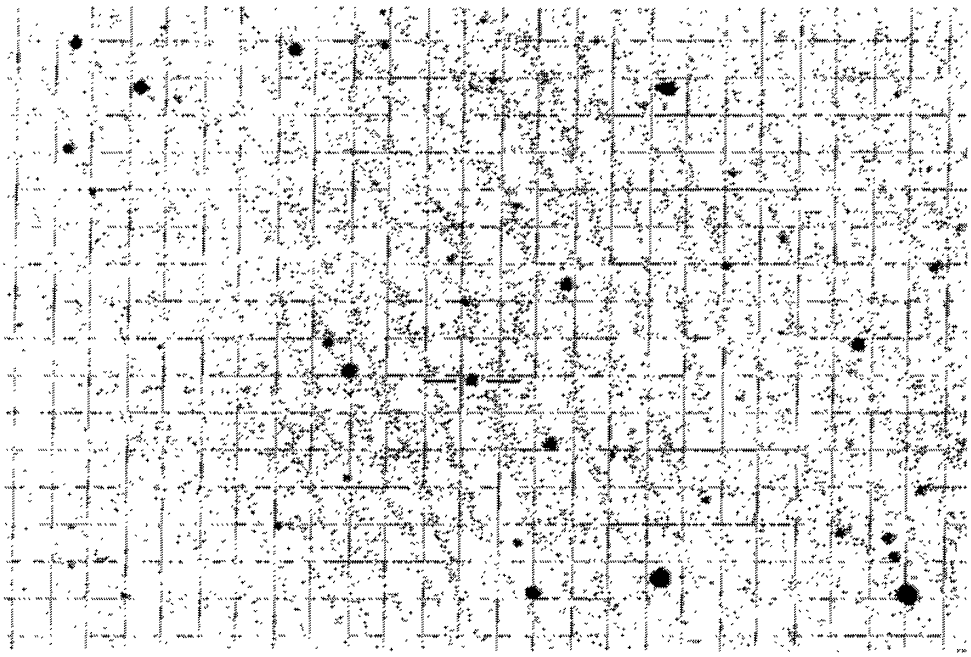

Figure 2. CCD image of WW Ser in "V" band. "V" Mag. = 13.8; "R" Mag. = 10.0; "I" Mag. = 7.9. North is up and East is to the left. Image is 23 x 13 arcminutes.

Table 1. AAVSO program stars selected for monitoring.

Star	*Designation*	*GCVS Min. Mag.(V)*	*Measured Mag. (V)*	*Spectrum*	*Period (D)*
WW Ser	1527+03	<15.8	?	M8e	366
SU Lyr	1850+36	17.0	<17	M	418
VZ Lyr	1905+29b	16	?	M	246
EL Lyr	1909+31	<16.5	?	M	234
QZ Aql	2012+13	<15.5	?	M	214
SS Del	2035+13	<16	<16.5	M	195
DG Cyg	2039+42	17.45	?	M	458
LX Cyg	2152+47a	<17	?	SC	465
AB Cep	2207+54	15.5	<16.0	M8e	324
SX Peg	2245+17	15	?	S	304
SZ And	2255+42	15.8	?	M2	343
DL Peg	2343+15	<15	?	M	180
UW And	0009+28	<14.0	?	M5	244
TY Cas*	0031+62	<17.5	<18.0	M6	645
X Psc	0106+21a	<15	?	M5	350
S Ari	0159+12	15.8	?	M8	292
RT Ari	0259+19	16.5	?	M	263
TW Per	0313+32	<13.5	?	M	335
IK Tau*	0347+11	16.5:	<18.0	M6	470

* Maser emission detected. Types of Maser emissions detected: H_2O, SiO, OH.

selected and observations are being made throughout their cycles (Table 1). The characteristics of these stars are as follows:

- All are "cool" stars, spectral types M and S
- All have minimum below magnitude 16
- All are much brighter in the R and I bands than in V
- Most are visible in the summer sky
- All have long periods (>180 days)
- Colors and magnitudes at minimum are not accurately known

Observers having the necessary equipment and software are encouraged to join in this effort that will be on-going for many years to come. All of these stars need monitoring in V, R, and I standard photometric filters throughout their cycle. More stars may be added to the observing program in the future.

Observation results will be occasionally published to enable observers to monitor the progress in our understanding of these interesting stars.

3. Summary

CCD technology has enabled many small observatories to make observations of Mira variables at minimum magnitudes. These data will enable a more accurate model of these stars to developed. Observers having the necessary equipment to observe stars in "V" down to magnitude 18 are encouraged to make observations of these interesting stars and report them to AAVSO Headquarters.

References

Kholopov, P. N. *et al.* 1985, *General Catalogue of Variable Stars*, 4th ed., Moscow.
Mattei, J. A. 1997, *J. Amer. Assoc. Var. Star Obs.*, **25**, 57.