A NEW MIRA VARIABLE FOR AAVSO OBSERVERS

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Abstract

DHK 1 = LD 103 is a recently discovered Mira variable in Cassiopeia that is suitable for visual observation with moderate-aperture telescopes. Preliminary observations indicate a range of 10.0-13.8 **V** and a period of 360 days. A chart with a visual comparison star sequence is presented, and a promising method for determining such sequences is described.

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1. Discovery

DHK 1 = LD 103 is a recently discovered Mira variable in Cassiopeia at RA $1^h\ 57^m\ 58^s$, Dec. $+58^o$ 03′ 40" (1950), just 3 degrees northwest of the well-known Double Cluster in Perseus. This variable was first reported by Dahlmark (1986), who discovered it during a systematic photographic search for new variables and assigned the preliminary designation LD 103. Dahlmark's estimates on about 30 photographs from 1967 to 1985 ranged between 9.8 and 12.0 **V**. He found a large color index of +3.8 **B - V**, but he did not determine the type of variation or a period.

Kaiser (1987) discovered the variable independently as part of a continuing photographic nova patrol using 35mm Ektachrome 400 color-slide film and a Projection Blink Comparator (PROBLICOM) (MacRobert 1988) and assigned the preliminary designation DHK 1. Baldwin established a visual step sequence for comparison stars, and we have made 78 visual observations from JD 2447114-621. We have also estimated DHK 1 on the nova patrol slides of the region. Our observations, with the visual estimates converted from the preliminary step scale to visual magnitudes, are plotted in Figure 1 (lower portion).

We estimate the full range to be almost four magnitudes, 10.0-13.8 **V**. Our minimum is much deeper than Dahlmark's faintest observation, but he only observed the variable during a limited summer season each year and presumably missed the phases of faintest light.

2. Light Variation

DHK 1 is clearly a Mira-type variable. Preliminary light elements (Kaiser et al. 1989) are:

$$JD_{(max)} = 2447220 + 360^d\ E. \qquad (1)$$

The difference between the heights of the two maxima recorded on the nova patrol slides, and the difference between the brightest observation by Dahlmark at 9.8 **V** compared to the visual maximum in Figure 1 at 11.2 **V**, indicate that the maxima can vary by at least one magnitude.

The color-slide observations are more than one magnitude brighter than the telescopic visual observations, an effect we attribute to an exaggerated response by the Ektachrome 400 film's red layer to this very red star. Because the color-slide estimates cannot be converted in any simple way to the **V** scale, they are plotted in Figure 1 on a separate step scale in which the units are about 0.1 magnitude.

3. Establishing the Comparison Sequence

Figure 2 is a chart showing the location of DHK 1 and a visual comparison star sequence determined photographically by Kaiser. The field of the variable and the nearby cluster NGC 957 were photographed consecutively with equal exposures using a 20-cm Schmidt-Cassegrain telescope, 35mm panchromatic Tri-X film, and Lumicon's Yellow and Cyan filters, which define a passband of 4800-5800 angstroms with peak transmission at 5200. This passband produces stellar images on a scale nearly in accord with their **V** magnitudes.

The two negatives were then superimposed, and known photoelectric **V** magnitudes of stars in NGC 957 (Hoag et al. 1961) were used to estimate the magnitudes of comparison stars for DHK 1. Background fog on the top film makes star images on the bottom film appear less dark, so the estimates were repeated with the two negatives stacked in reverse order and the mean of the two estimates was adopted.

The two sets of estimates differed by only $\pm$0.1 magnitude in no inconsistent way, indicating that the errors of this method are no greater than the errors inherent in the visual estimation of photographic star images. Since the cluster with known magnitudes and the variable field were photographed within a few minutes of each other with the same equipment, at almost identical altitudes in the sky, and the exposures were made and developed on the same roll of film, the zero point of the comparison sequence's magnitude scale should also be reasonably accurate.

Visual observers have long sought simple methods for determining comparison star magnitudes for variables that do not have published sequences (see, e.g., Pennell 1970; Hers 1986). In the absence of a photoelectric photometer and a telescope large enough to measure the comparison stars directly, or an iris photometer to perform magnitude transfers on photographic plates, the procedure outlined here seems to work well. Tests of this simple method are continuing, and the results will be presented in a future paper.

4. Are There Other Bright Miras Out There?

DHK 1 = LD 103 seems very suitable for inclusion in the AAVSO program. The star is extremely red, so the usual precautions must be taken in order to make consistent visual estimates. Good light curves of several more cycles are needed to improve the period and preliminary light elements. Charles Scovil has prepared AAVSO preliminary charts for 015457 DHK-1 (Cas) at "d" and "e" scales, which can be ordered from Clinton Ford, chairman of the Preliminary Chart Committee.

It may seem surprising that a large-amplitude Mira variable with maxima as bright as 10.0 **V** was not discovered many decades ago. However, most variable star discoveries have been made by searching blue photographic plates. In the case of DHK 1 with a **B-V** index of +3.8, most maxima are invisible on blue plates reaching to 14th magnitude. We wonder how many of the known Mira variables with maxima of 14th or 15th photographic magnitude may in fact have maxima within reach of visual observers using small telescopes, and how many faint red Miras await discovery by searchers using yellow- or red-sensitive photographic emulsions.

5. **Acknowledgements**

We wish to thank Martin Burkhead of the Indiana University Astronomy Department for providing a copy of the NGC 957 reference. David B. Williams helped to prepare the chart and offered useful suggestions regarding the method used to determine the visual comparison star magnitudes. AAVSO Director Janet Mattei assisted in establishing the identity between DHK 1 and LD 103.

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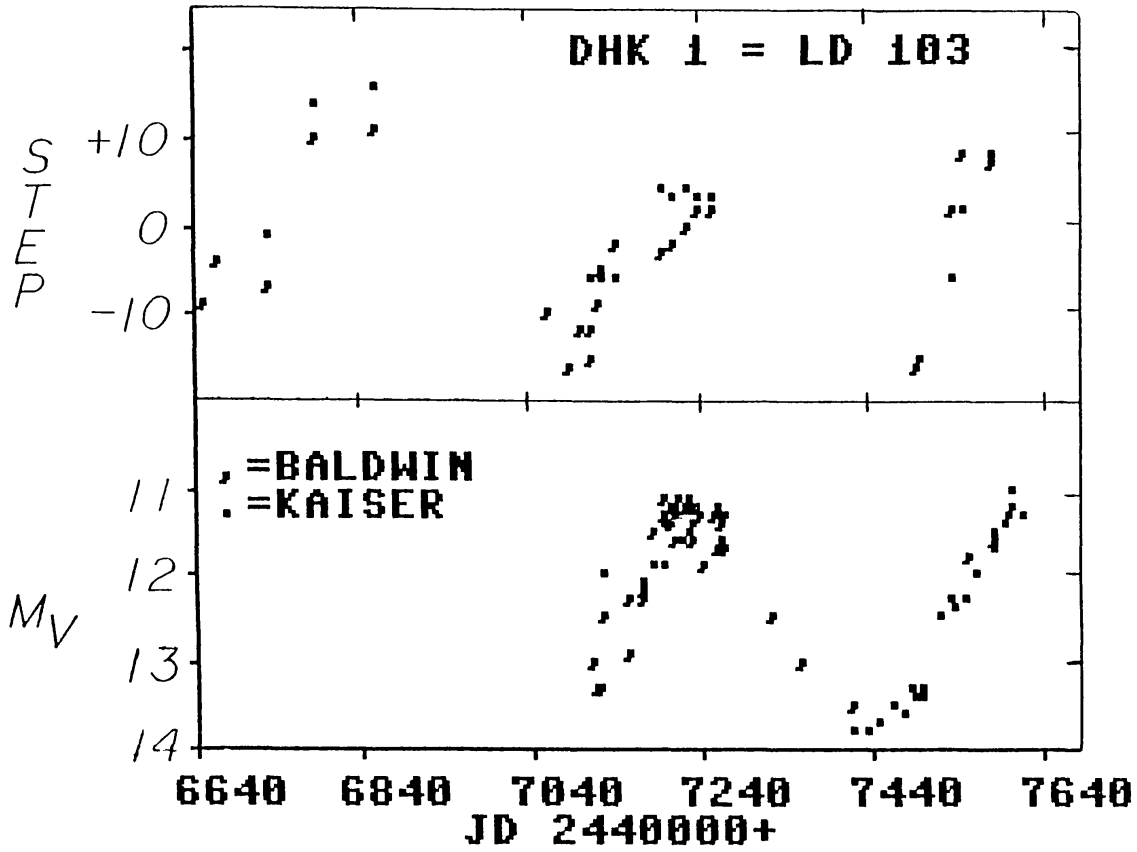

Figure 1. Light curve of DHK 1 = LD 103. The range, period, and shape of the light curve indicate Mira type. Estimates from Kodak Ektachrome 400 color-slide film are brighter than the visual estimates and are plotted on a step scale in which each unit is about 0.1 magnitude.

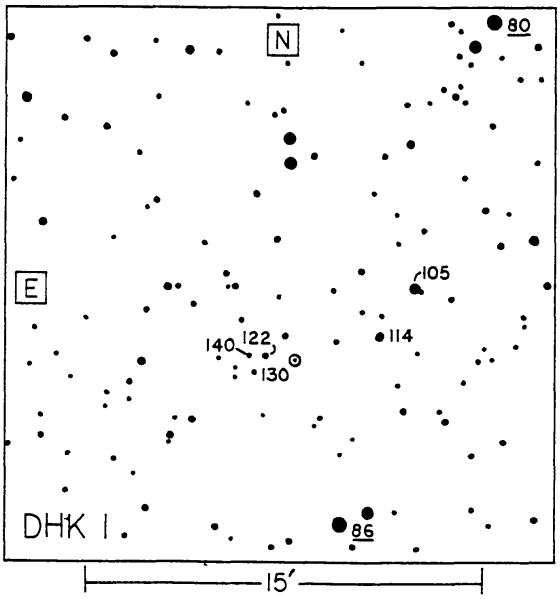

Figure 2. Finding chart and visual comparison star sequence for DHK 1 = LD 103. The faintest stars are 14th magnitude. Comparison star magnitudes were determined by the method described in the text. Photoelectric **V** magnitudes for two stars in the field are underlined.