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USNO-A2.0 0825-15411768: A NEW MIRA IN AQUILA

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The University of Illinois at Urbana-Champaigne's *Stardial* instrument is an autonomous drift-scan CCD camera mounted on the roof of that institution's Astronomy building (McCullough and Thakkar 1997). Consisting of a Kodak KAF400 CCD with a Nikon $f/1.4$ 50-mm focal length 35-mm format camera lens stopped to $f/2.0$, the instrument records nightly 8×5 degree images of a band of sky centered on -4 degrees declination. A broadband red-infrared filter (RG-1, passband 600 nm and longer) is employed between the lens and the CCD. A polynomial fit to the background light of each image is subtracted, and the images are immediately made available on the *Stardial* WWW site (http://www.astro.uiuc.edu/stardial/) in both FITS and JPEG format.

While blinking *Stardial* images of an area in Aquila, a star near R.A. $19^{\rm h}20^{\rm m}35^{\rm s}$, Dec. $-03^\circ57'50''$ (J2000) was observed to vary in brightness. A check of the GCVS (Kholopov et al. 1998) revealed no known variable star at or near that position, however the TASS tenxcat (Richmond et al. 2000) contained a series of Johnson V-band observations associated with the star GSC 5138-0446 (USNO magnitudes $m_B = 13.1$, $m_R = 11.6$, position R.A. $19^{\rm h}20^{\rm m}36\overset{\rm s}{.}51$, Decl. $-03^\circ58'18\overset{''}{.}9$, J2000 from GSC-ACT via Visier) that showed variability between magnitude 11.4 and 12.0. Viewing the area using the *Aladin* interactive sky atlas revealed another TASS detection (TASS J192035.3-035756) quite near the first – and the two sources appeared to vary in phase with each other. The second source was apparently associated with another red star, USNO-A2.0 0825-15411768 (USNO2 magnitudes $m_B = 14.9$, $m_R = 11.9$, J2000 position R.A. $19^{\rm h}20^{\rm m}35\overset{\rm s}{.}029$, Dec. $-03^\circ57'50\overset{''}{.}85$). Which star was the variable?

The TASS Mark III cameras have 13.4 arcseconds/pixel resolution, and the FWHM of stellar images range from 2.5 to 4.0 pixels. The GSC star and the USNO star are separated by 36 arcseconds. Therefore, the two stars were frequently merged.

The necessary confirmation was found on Digitized Sky Survey (http://archive.stsci.edu/dss/) images of the area. First and second generation red images of the area are presented in Figure 1. Comparing the two images, taken nearly 4 years apart, USNO-A2.0 0825-15411768 (indicated by tick marks in the left-hand, first generation image) is clearly the variable. For field identification, three prominent stars are identified on the right-hand, second generation image.

With the variable identified, all available *Stardial* images of the region were analyzed. 293 images covering portions of six observing seasons 1996–2001 were found suitable for differential photometry. A comparison star, SAO 143290, and a check star, SAO 143252, were chosen, and differential magnitudes were extracted from each image. As the *Stardial*

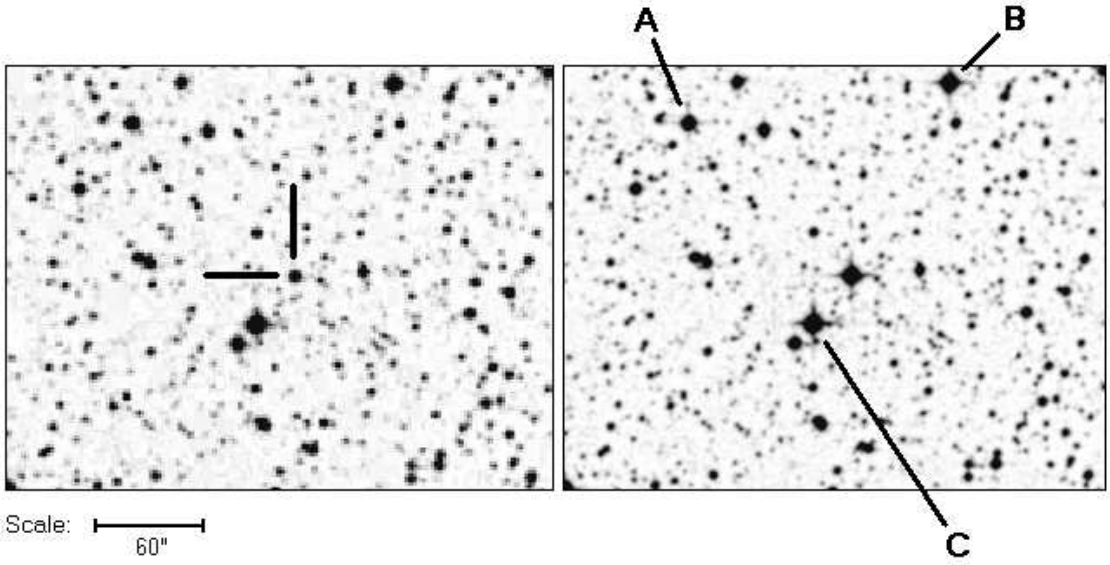

Figure 1. Comparison of Digital Sky Survey red plates of USNO-A2.0 0825-15411768. Tick marks on the left image indicate the variable. Three field stars are identified on the right image: A = GSC 5138-0815, B = GSC 5138-0058, C = GSC 5138-0446

images have a scale of approximately 35 arcseconds per pixel, over double that of the TASS Mark III cameras, the variable and GSC 5138-0446 are certainly merged in *Stardial* images. The contribution of GSC 5138-0446 to the total light of the pair, calculated from its red plate magnitude of 11.6, was subtracted from each observation. The results, along with 26 TASS I-band observations (converted to differential magnitudes) that are unambiguously associated with USNO-A2.0 0825-15411768 are plotted in Figure 2 and given in the electronic table 5164-t1.txt.

Regular variations of about 2.2 magnitudes in amplitude are seen. At first glance, the low amplitude would seem to be cause to classify this star as SRa; however the combination of the KAF400 CCD and RG-1 filter minimizes the effect of "amplitude excess" caused by TiO absorption bands (Celis 1978). Though we lack unambiguous V-band data, the visual amplitude is probably at least 3 magnitudes. TASS data show that $V - I$ near maximum light is 3.6 magnitudes, indicating a spectral type of M4-5 and an effective temperature of 3000 K (Zombeck 1990). The star is therefore classified as a Mira-type variable.

Infrared data from the IRAS Point Source Catalog support a conclusion that this star is likely a mass-losing AGB variable. USNO-A2.0 0825-15411768 is located within the uncertainty ellipse of IRAS 19179-0403. The star's average I-band flux, calculated from TASS data, when compared to the IRAS 12 and 25 micron infrared fluxes (Table 1) demonstrate an infrared excess consistent with a circumstellar dust shell as observed in other stars of this type (Little-Marenin and Little 1997).

Three maxima, at JD 2,450,325; 2,450,970 and 2,451,412 are well observed. A simple graphical solution (Richter et al. 1985, p. 16) yielded a best-fit period of 217.2 days. With only three maxima to work from, this period must be regarded as preliminary in nature. Initial elements for USNO-A2.0 0825-15411768 are thus:

$$\mathrm{JD}_{\max} = 2450323.4 + 217.2 \times E.$$

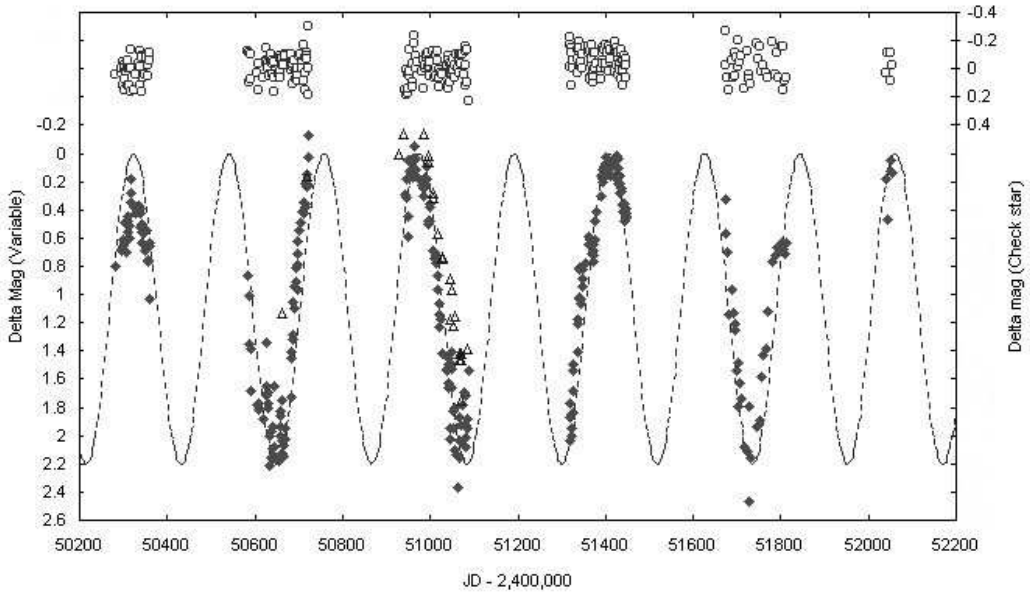

Figure 2. Light Curve of USNO-A2.0 0825-15411768. Filled diamonds represent the variable, open triangles are TASS Mark III *I*-band data, open circles represent the check star, and the dashed curve is computed from elements given in the text

Table 1: Infrared fluxes for USNO-A2.0 0825-15411768

λ (microns)	Flux (Jy)
0.79	1.71
12	1.63 $\pm$0.1
25	0.698 $\pm$0.01

The above elements may be affected slightly by infrared phase lag due to the combination of filter and CCD used. Maximum light of Miras in the infrared typically occurs near visual phase 0.1 to 0.2 (Pettit and Nicholson 1933; Lockwood and Wing 1971).

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