COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5384

Konkoly Observatory
Budapest
26 February 2003

HU ISSN 0374 – 0676

DISCOVERY OF ANOTHER MIRA VARIABLE IN THE FIELD OF V4641 Sgr

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This Note is the fourth in a series of Notes (e.g. Gieles et al., 2002a,b,c) where we report new variable stars discovered during our extensive CCD monitoring program of the black hole binary V4641 Sgr (SAX J1819.3-2525, Orosz et al., 2001). The field of V4641 Sgr has been monitored with the YALO 1m telescope (Bailyn et al., 1999) at Cerro Tololo using the ANDICAM optical/IR camera and the V and I filters during much of the 2001 and 2002 seasons. In this Note we report discovery of another Mira variable in the field of V4641 Sgr. We also give additional observations of two other Mira variables in the field (Gieles et al., 2001c).

As a result of our monitoring campaign, we have the light curves of about 15 000 stars in a $9' \times 9'$ field containing V4641 Sgr. We searched for variables by comparing the standard deviation σ of the light curves and by computing the maximum power in a Lomb-Scargle periodogram (Lomb, 1976; Scargle, 1982) for each star. These two techniques are well suited for finding either large amplitude variables (these have large values of σ) or smaller amplitude periodic variables (these have large L-S power).

Previously, by using the data complete through the end of the 2001 observing season, we easily identified two high-amplitude long-period variable stars that we classified as Mira variables. One of these stars was identified with GM Sgr, while the other one was previously unknown (Gieles et al., 2002c). We had also found a star that showed relatively large brightness variations, but we were unsure of its classification. By including the data from the 2002 season, it became clear that this unidentified variable star was another Mira variable. Table 1 gives an overview of the photometric information of the newly identified variable. For comparison, we also give updated information on the other two Mira variables in the field (Gieles et al., 2002c). Figures 1, 2, and 3 show the light curves folded on the best-fitting periods found using the "pdm" task in IRAF. Figure 4 shows a finding chart for the newly identified Mira variable. As in our previous Note, the name of the new variable is based on its coordinates in equinox 2000 and is given the prefix YALO.

The new Mira has a period of about 408 days, and is extremely red, with $V - I \approx 4.7$ at maximum light and $V - I \approx 6.1$ at minimum light (the reddening in the direction of V4641 Sgr is relatively low with $E(B - V) \approx 0.25$, Orosz et al., 2001). Mira variables

with periods less than about 400 days are thought to pulsate in an overtone, whereas Mira variables with periods more than about 400 days are thought to pulsate in the fundamental mode (e.g. van Leeuwen et al., 1997). The folded light curve of the new variable YALO J181910.5 − 252742 (Figure 1) has somewhat of a saw-tooth character, whereas the folded light curves of YALO J181936.7 − 252553 (P = 200 days, Figure 2) and YALO J181921.5 − 252538 = GM Sgr (P = 216 days, Figure 3) are more sinusoidal. Hence the new variable YALO J181910.5 − 252742 may be a fundamental pulsator.

The light curves of the two shorter-period variables (Figures 2 and 3) do not repeat precisely from cycle to cycle, a feature that is fairly common for the Mira variables (e.g. Whitelock, 1996). Also, many Mira variables do not have stable periods (Whitelock, 1996), which seems to be the case here for the two shorter-period variables. The updated period of 200 days we find for YALO J181936.7 − 252553 is shorter than the 208 days we found earlier, while the revised period of 216 days we find for GM Sgr is a bit longer than the 212 days found by us earlier (Gieles et al., 2002c) and also by Kato et al., (2001). Continued monitoring of these sources will be needed to better establish the mean pulsational periods and the modes of pulsation.

Table 1. Photometric data.

Coordinates (J2000)		V	$V-I$	period	$T_0^\dagger$	ID*
RA	DEC	range	range	(days)	(HJD 2 450 000+)	
18:19:10.9	−25:27:42.0	15.6 – 20.0	4.7 – 6.1	408	2050	1
18:19:36.7	−25:25:53.1	12.0 – 16.8	2.3 – 4.9	200	2114	2
18:19:21.5	−25:25:37.6	13.1 – 18.2	2.9 – 5.5	216	2104	GM Sgr

†Time of maximum brightness.
* 1: YALO J181910.5 − 252742
2: YALO J181936.7 − 252553

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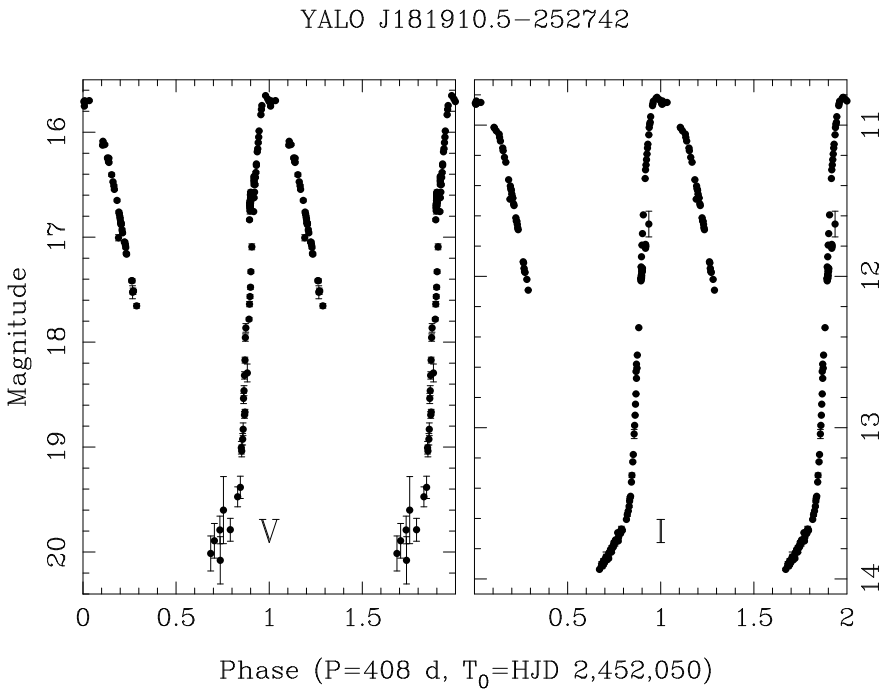

Figure 1. Folded V (left) and I (right) light curves of YALO J181910.5 − 252742.

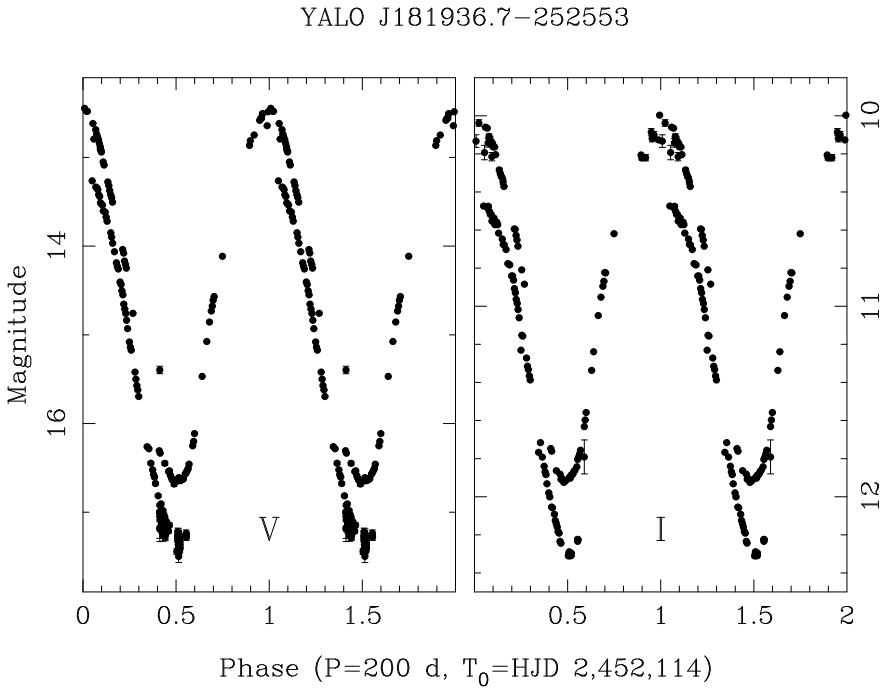

Figure 2. Folded V (left) and I (right) light curves of YALO J181936.7 − 252553.

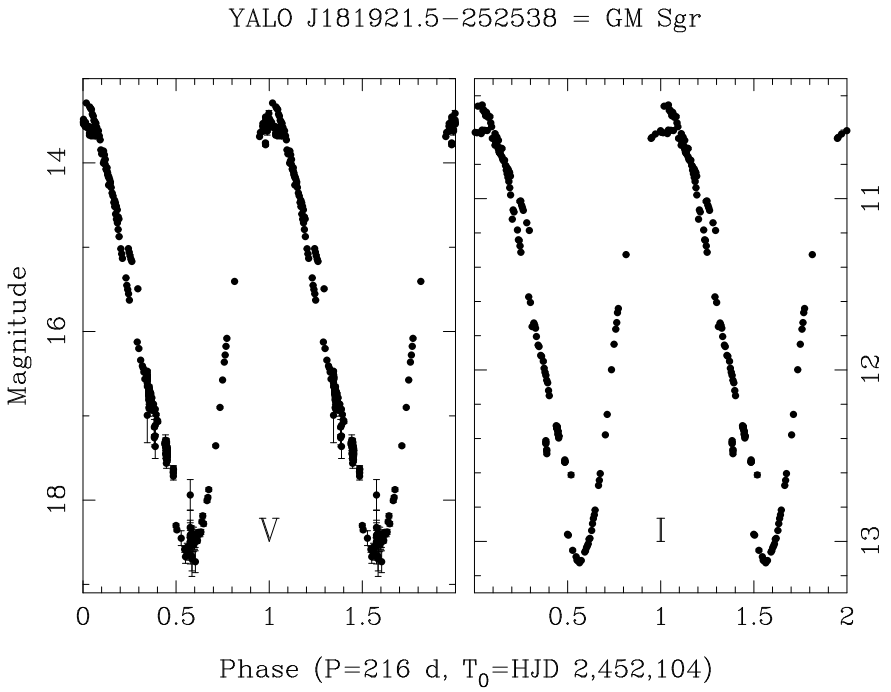

Figure 3. Folded V (left) and I (right) light curves of YALO J181921.5 − 252538 = GM Sgr.

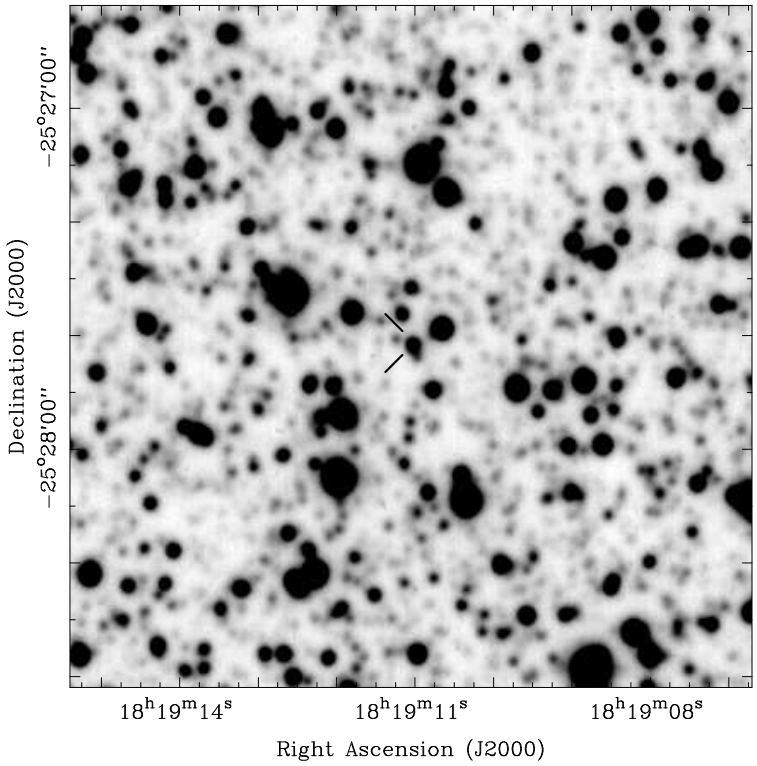

Figure 4. V-band finding chart of YALO J181910.5 − 252742. The bright star immediately to the northwest is the variable star YALO J181910.6 − 252739 (Gieles et al., 2002a).