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REVISED COORDINATES OF VARIABLE STARS IN CASSIOPEIA

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Abstract

The identification of the variable stars published on IBVS #3573 has ben revised on the basis of the original (unpublished) finding charts. Cross check with the 2MASS catalog has been made to get more accurate coordinates and to confirm their nature from their $J-H$, $H-K$ colors. The Mira stars, given their known periods, could be used with the astrometric parallaxes of the forthcoming Gaia catalog to improve the Period-Luminosity relation.

1 Introduction

Mira stars are among the brightest star in a stellar population, and their absolute luminosity is fairly related to their pulsation period, so that are useful as standard candles to derive the distances of nearby galaxies.

A list of red variables, including a number of Miras, in a field centered on IC 1805, was published by Gasperoni, Maffei and Tosti (1991, IBVS #3573), giving a measure of their periods on the basis of 7 years of observations using infrared (I-N + RG5) and blue (103aO) Schmidt plates of the Asiago Observatory.

This variable stars sample is statistically well defined, being magnitude limited and followed with 75 plates along 7 years. Gasperoni et al. (1991) did not publish finding charts but only coordinates at B1950, with arcmin approximation, rather poor for a safe identification near the galactic plane. Based on that paper, the stars were imported in the General Catalog of Variable Stars (Samus et al. 2017) by Samus et al. (2003). The individual stars can be searched in SIMBAD by their original provisional name (SV* Mxxx) or by coordinates. They can also be searched in the VSX database, but only with the variable name or the coordinates, and the historic link to Gasperoni et al. (1991) is generally not present.

In the course of a larger on-going research on the Mira stars in Cassiopeia, I found for some of these stars strong inconsistencies between the optical and near infrared (JHK) magnitudes available from cross correlation of the GCVS and 2MASS (Cutri et al. 2003) catalogs, suggesting that some misidentifications have occurred. As a matter of fact, most of these stars are not referred by any paper (besides the discovery one) in the SIMBAD or ADS databases.

2 Identification

In the family archive of the late prof. Paolo Maffei (`http://www.archiviomaffei.org`) I was able to recover the original paper enlargements of the Asiago plates, with pencil annotations by Maffei of the detected variables and comparison sequences, so it was possible to check for all the stars their actual positions. I also found the two original thesis works (unpublished) of the two Maffei's students V. Gasperoni and G. Tosti on the stars of this field. Comparison of the finding charts with the Digitized Sky Survey infrared plates, available on-line from the Space Telescope Science Institute (`http://archive.stsci.edu/cgi-bin/dss_plate_finder`), and with the 2MASS catalog and images, available from SIMBAD (`http://simbad.u-strasbg.fr/simbad/`), and IRSA database (`http://irsa.ipac.caltech.edu/`) allowed to perform a satisfactory identification for all the variables listed in Gasperoni et al. (1991) with a 2MASS counterpart.

In some cases the coordinates differences between Gasperoni et al. (1991) (precession corrected) and the actual coordinates were small, compatible with the quoted accuracy, but often they were rather large, several arcmin! Two stars have outstanding errors: M279 (presently identified in the GCVS as V0687 Cas) and M289 (identified in the GCVS as V0685 Cas).

In the case of the SR variable M279 the published coordinates are 187 arcmin (3 degrees !) off from the position in the finding chart: the finding chart says that it must be associated to IRAS 02205+6014, a bright and very red star. At the coordinates of M279 published in Gasperoni et al. (1991) the CGVS reports V0676 Cas, but nothing similar to a red star is nearby. In Maffei's finding charts no variable star is reported near the published coordinates.

Similarly dramatic is the situation of the SR variable M289, which is 169 arcmin (again about 3 degrees) off from the published position: at the finding chart position there is a bright and red source in 2MASS, as should be for a SR variable. At this position the VSX catalog reports a low amplitude variable, NSVS 1890163. On his thesis, G. Tosti reports large irregularities in the light curve of this star, which prevented to define a time scale for its variability: the variability amplitude, 0.8 mag, is similar to that reported in the NSVS. The associated name in GCVS is V0685 Cas, but its position corresponds to a rather bright and blue star ($B = 13.188$, $V = 12.697$, $B - V = 0.49$ in the UCAC4 catalog) clearly inconsistent with the Maffei's variable because it is reported to be always below the detection limit ($B \sim 18$ mag) in the Asiago blue plates. Clearly NSVS 1890163 is the actual identification of M289.

I tried to understand from the documents in Maffei's archive how such large errors for these two stars could arise. In Tosti's thesis no coordinates are given, while in Gasperoni's one the coordinates are given as published in Gasperoni et al. (1991): the most likely explanation is therefore that the misprints in the thesis were carried on in the article.

3 Results

Table 1 lists for each star the Maffei's provisional name and the B1950 coordinates as reported in Gasperoni et al. (1991), the J2000 coordinates of the actual 2MASS counterpart as derived from Maffei's original finding charts, the present designation in SIMBAD, the distance between the old (precessed to J2000) and the new position in arcmin. Only in 9 cases the coordinates difference is less than 1 arcmin, that is their formal accuracy:

Table 1: Revised coordinates and identifications of variable stars in the field of IC 1805.

Maffei name	RA1950 orig.	DEC1950 orig.	RAJ2000 corrected	DECJ2000 corrected	GCVS name	offset arcmin	VSX ident.
M278	02:41:51	+62:53:00	02:45:31.33	+63:02:19.6	V0690 Cas	4.07	–
M279	02:37:26	+62:31:00	02:24:16.45	+60:27:56.8	V0687 Cas*	186.83	–
M280	02:31:29	+59:45:00	02:35:09.68	+59:55:28.6	V0678 Cas	2.67	–
M281	02:47:50	+59:14:00	02:51:40.21	+59:26:40.8	V0696 Cas*	0.36	Dauban V268
M282	02:43:40	+57:56:00	02:47:29.08	+58:07:32.3	V0692 Cas	1.14	–
M283	02:25:25	+60:17:00	02:28:55.44	+60:23:26.6	V0675 Cas*	7.13	Dauban V264
M284	02:46:57	+58:16:00	02:50:45.86	+58:37:59.4	V0694 Cas*	9.62	Dauban V258
M285	02:17:54	+60:20:00	02:21:12.48	+60:20:11.8	V0725 Cas*	13.78	NSVS 1837975
M286	02:19:42	+59:24:00	02:23:22.56	+59:38:00.9	V0671 Cas	0.42	V0671 Cas
M287	02:27:11	+62:32:00	02:30:27.53	+62:31:45.6	V0647 Cas	14.23	V0647 Cas
M288	02:32:42	+59:10:00	02:36:24.47	+59:21:34.6	V0679 Cas*	1.48	–
M289	02:36:33	+63:14:00	02:56:00.73	+61:24:04.5	V0685 Cas*	169.00	NSVS 1890163
M290	02:24:19	+61:56:00	02:27:34.59	+61:55:57.1	V0674 Cas*	14.08	–
M291	02:56:41	+61:25:00	03:00:39.86	+61:39:50.6	V0699 Cas	2.96	–
M292	02:22:15	+59:24:00	02:25:42.73	+59:31:14.8	V0673 Cas*	6.45	–
M293	02:56:54	+59:31:00	03:00:45.13	+59:43:05.6	V0700 Cas	0.41	V0700 Cas
M294	02:32:46	+63:24:00	02:36:06.77	+63:25:11.1	V0680 Cas*	12.70	–
M295	02:33:38	+61:48:00	02:37:09.94	+61:55:22.9	V0726 Cas*	6.16	NSVS 1846691
M296	02:47:05	+61:27:00	02:50:57.00	+61:40:41.9	V0695 Cas	1.46	V0695 Cas
M297	02:35:28	+61:51:00	02:39:04.08	+61:59:16.4	V0684 Cas*	5.11	–
M298	02:35:09	+58:50:00	02:38:55.63	+59:02:08.8	V0682 Cas	0.84	V0682 Cas
M299	02:20:50	+59:11:00	02:24:29.93	+59:24:31.3	V0672 Cas	0.08	V0672 Cas
M300	02:50:59	+60:16:00	02:55:02.21	+60:31:09.5	V0697 Cas	3.19	V0697 Cas
M301	02:24:01	+60:37:00	02:27:24.01	+60:40:47.7	V0703 Cas*	9.99	NSV 824
M302	02:37:21	+62:22:00	02:40:51.84	+62:29:41.3	V0686 Cas*	6.01	–
M303	02:35:17	+59:31:00	02:39:00.88	+59:42:55.0	V0683 Cas	1.05	NSVS 1925038
M304	02:43:51	+62:30:00	02:47:31.09	+62:41:02.7	V0693 Cas*	2.79	–
M305	02:55:16	+61:02:00	02:59:20.49	+61:18:01.1	V0698 Cas*	4.14	–
M306	02:31:27	+62:59:00	02:34:40.22	+63:00:03.8	V0677 Cas*	13.15	V0943 Cas
M307	02:41:00	+61:52:00	02:44:38.87	+62:02:59.8	V0688 Cas	2.66	NSVS J0244383+620258
M308	02:42:07	+58:10:00	02:45:58.48	+58:22:14.9	V0691 Cas*	0.89	V0691 Cas
M309	02:41:50	+60:26:00	02:45:44.75	+60:39:28.7	V0689 Cas*	0.96	V0689 Cas
M310	02:29:22	+58:12:00	02:33:01.12	+58:25:37.3	V0508 Per	0.44	V0508 Per
M311	02:18:29	+60:57:00	02:21:40.87	+60:54:41.6	V0670 Cas*	16.45	DE Cas
M312	02:34:51	+58:37:00	02:38:31.49	+58:50:19.1	V0681 Cas*	0.50	V0681 Cas

the median difference for the whole set is 3 arcmin and for 14 stars it is larger than 6 arcmin, 2 of them being about 3 degrees off as discussed above.

After having found the actual positions of the Maffei's variables, I looked if they were present in the VSX catalog with another name, adopting a coordinates tolerance of 1 arcmin: these names are reported in column 8 of Table 1.

For 11 stars the name in VSX is the same as in SIMBAD: generally this happens because the old coordinates were near to the actual ones. For 11 cases a different variable name is listed in VSX, meaning that the variable was 'rediscovered' and not recognized as already known because the old coordinates were significantly different from the actual ones: for these stars the two names should be merged in a single identification in variable star catalogues like VSX or GCVS. For 13 stars no counterpart is present in VSX, indicating that they have not been 'rediscovered': for these stars the GCVS variable name can be retained.

To help the reader, and the keepers of variable stars catalogs, I have marked with an asterisk the GCVS star names which, in the last version of the GCVS (Samus et al. 2017),

Table 2: Table 2. NIR colors, periods and distances for Mira stars.

Maffei ID	name GCVS	Period days	$I-$mean mag	K mag	$I-K$ mag	$J-H$ mag	$H-K$ mag	Dist kpc
M278	V0690 Cas	311	13.85	7.47	6.39	1.12	0.59	8.6
M281	V0696 Cas	189.5	13.85	6.95	6.90	1.33	0.73	4.7
M282	V0692 Cas	420	14.05	4.86	9.19	1.37	0.80	3.3
M283	V0675 Cas	273	12.95	5.93	7.02	1.38	0.75	3.9
M284	V0694 Cas	359	14.5	6.90	7.60	1.30	0.83	7.4
M285	V0725 Cas	228	14.1	6.57	7.53	1.34	0.69	4.5
M287	V0647 Cas	552	8.9	3.60	5.30	1.06	0.55	2.2
M296	V0695 Cas	166.5	11.1	6.35	4.75	1.03	0.49	3.3

have coordinates different by more than 1 arcsec from my determination and therefore must be updated.

I remark that the alignment of VSX and CGVS is not always updated to the last version: this is a source of confusion.

In Table 2, I report for each Mira star the period in days and the apparent average I magnitude from Gasperoni et al. 1991, the K magnitude, the $I-K$, $J-H$ and $H-K$ colors form 2MASS, and a distance estimate. The distances were computed assuming the absolute K magnitude from the Period-Magnitude relation by Whitelock 2012 ($M_K = -3.69(\log P - 2.38) - 7.3$), and a common foreground K absorption of 0.3 mag. These distances are rather indicative because the K magnitude in the 2MASS catalog is taken at an unknown phase in the light curve so may be off up to half magnitude from the average value: a likely error is 0.2 dex in $\log 10$(Dist). Apparently these Mira stars belong to two broad groups, the main one (6 stars) clustered around 3.5 kpc, likely associated to the Perseus arm, while two stars are much farther, around 8 kpc, likely associated to the Outer arm.

There is no clear correlation between the estimated distance of each Mira star and its $J-H$ (or $H-K$) color, so it is unlikely that a different reddening is the main reason for the spread in distances found.

The $J-H$,$H-K$ color-color plot in Fig. 1 shows the positions of all the Maffei variables with respect to the regions defined by Bessell and Brett (1988). Three groups of stars can be identified in this plot: the first group comprises rather hot stars located on or near the Main Sequence and are generally irregular or eclipse variables; the second group has the Mira and Semiregular variables, with colors typical for this class of stars; the third group has the 4 reddest stars located in the typical area of the carbon stars with dusty envelopes, all classified in Gasperoni et al. (1991) as Semiregular or Irregular: one of them (M280) is already known as carbon star (CGCS 6035, Alksnis et al. 2001), the others (M 279, M286, M294) are most likely carbon stars too. Also M307 (V688 Cas, CGCS 0396) classified as SR, is a carbon stars, but its colors are not extreme so it is located among the Mira stars in this diagram.

4 Conclusions

Given that modern catalogs give coordinates more accurate than one arcsec, and that cross-identifications are now based on automatic coordinates matches rather than on

visual comparison of finding charts, an update of the coordinates of these variables in the GCVS and VSX catalogs is necessary to allow recovering the variability history of these stars and to allow cross-identifications with present and future galactic plane surveys.

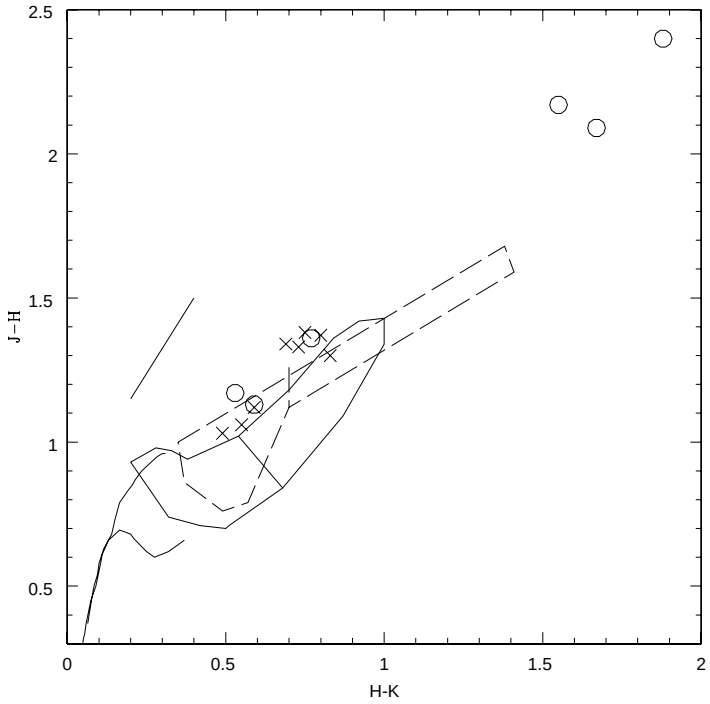

Figure 1. The $J-H, H-K$ diagram with the different areas according to Bessel and Brett (1988). Continuous lines are the Main Sequence and the Giant Branch. The star positions are indicatd by letters: M=Miras, S=Semiregulars, I=Irregulars, E=eclipsing stars. The reddening vector is indicated for E$(B-V)$=1 mag ($A_K \sim 0.3$ mag). All the stars in our sample fall nicely in this diagram, indicating a small absorption; the carbon stars with dusty envelopes are located in the upper right corner .

Thanks to the new more accurate coordinates all these Mira stars can be safely recognized in the forthcoming Gaia catalog of astrometric parallaxes and used to increase the database for studies of the Mira Period-Luminosity relation.

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