Study of a New CPM Pair 2Mass 05373833+2659169

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Abstract: This paper presents the results of a study of 2MASS 05373833+2659169 as components of a common proper motion pair. The proper motion of the secondary star is deduced indepently, because the PPMXL catalog does not provide any proper motion data about secondary star.

Halbwalchs' criterion indicates that this is a CPM system. The criterion of Francisco Rica indicates that this pair has a probability of 98% of being a physical pair (Rica, 2007).

Distance moduli 7.22 and 6.96 were obtained, which put the components of the system at a distance of 278.0 and 246.6 parsecs. Taking into account errors in determining the magnitudes, this means that the probability that both components are situated at the same distance is 97%.

It is proposed that this pair be included in the WDS catalog .

Introduction

The main purpose of this project is to determine some important astrophysical features of 2Mass 05373833+2659169 (Figure 1), including distance, spectral type of the components, etc. This was achieved by an astrophysical evaluation using kinematic, photometric spectral and astrometrical data and obtaining enough information to determine if there is a gravitational tie between both components and its nature.

In this study, Francisco Rica Romero's spreadsheets (Astrophysics, SDSS-2MASS-Johnson conversions) were used to make many astrophysics calculations.

Proper Motion

The proper motions for the pair given in the PPMXL catalog (a catalog that provides positions and proper motions) are given in Table 1.

Unfortunately, information about the secondary star could not be found, so an independent study about the proper motions of this system was made. Component's positions (grades) were calculated from different dates plates obtained using Aladin Sky Atlas with a timeline difference (Besselian date) of 44.869 years. See Figure 2. The measurements were made using Astrometrica software; the stars were not saturated on any plate, so obtaining measurements was easy. The results are shown in Tables 2 and 3.

Table 1: Proper motion of the A component from the PPMXL catalog.

Component	Proper Motion RA	Proper Motion DEC
A	-26.2 +-6.5	-46.3 +-6.5
B	?	?

The results show that the proper motions are similar and suggest that this system could be a CPM

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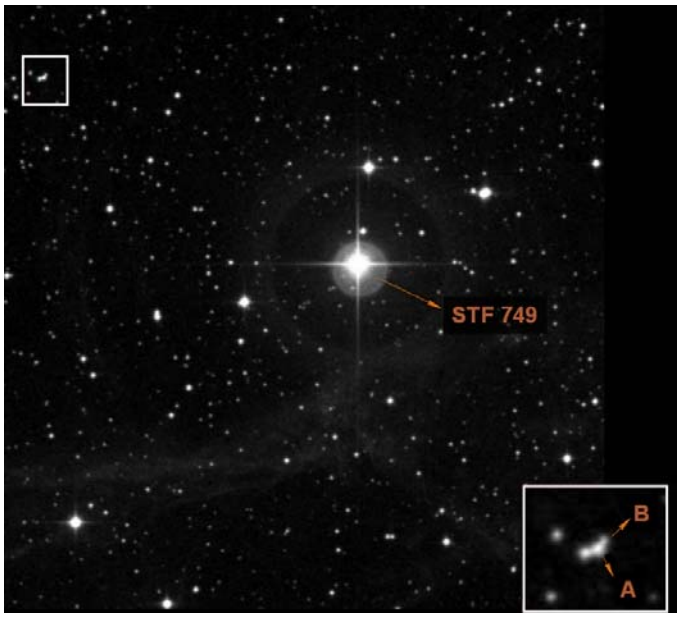

Figure 1: Picture from a POSS plate that shows the system under study (upper left hand box). Components are identified in the inset.

Table 2: Coordinates vs Besselian date used for calculating proper movements for each component.

Besselian Date	Primary RA (°)	Primary DEC (°)	Secondary RA (°)	Secondary DEC (°)
1951.8494	84.409167	26.988611	84.408500	26.989472
1990.7881	84.409625	26.988139	84.409000	26.988972
1996.7184	84.409583	26.988028	84.409000	26.988861
1996.7840	84.409833	26.988056	84.408875	26.988889

Table 3: Proper motions deduced using coordinates from Besselian dates.

	Primary RA	Primary DEC	Secondary RA	Secondary DEC
Proper motion (mas/yr)	+43.2 ± 8.6	-45.36 ± 9.9	+37.08 ± 8.9	-47.52 ± 9.9

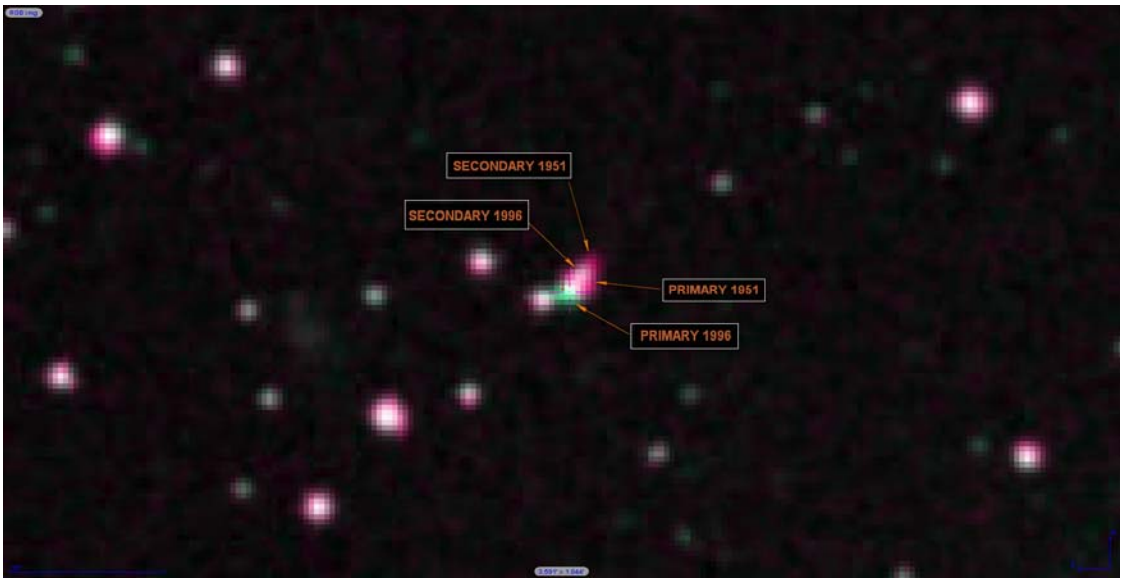

Figure 2: Picture based on a Red - Green color superposition, where each channel represents 2 POSS plates with different Besselian date (Red: 1951.8494 / Green: 1996.7840). The superposition shows the proper motion of the stars in 44.9346 years, revealing the system's common proper motion.

pair and warranted further study.

The resulting tangential velocities, calculated from the proper motions, are shown in Table 4.

Relative Astrometry

Relative astrometry measurements were based on plates from different dates with resolution: 1.1", obtained from Aladin software, I used Astrometrica software for obtaining angle deviation and applying that value on Reduc software calibration parameters for each plate. Reduc also let me obtain Theta and Rho values for each plate (see Table 5)

Photometry / Spectral type of the components

All plates with plate resolution around 1 arcsecond/pixel and catalog data of the image field were retrieved from 2MASS. Table 6 shows the photometric magnitudes.

Using Francisco Rica Romero's astrophysics spreadsheet, "SDSS-2MASS-Johnson conversions", I obtained the results shown in Table 7.

The spectral type of each component can be determined from photometric data. With this set of photometry in bands J,H,K, the deduced B,V,I and using the Francisco Rica Romero's "Astrophysics" spreadsheet, spectral types K5V and K7V were obtained for the primary and secondary respectively.

Reduced proper motions for the companions were determined using the same spreadsheet and are presented in Table 8. The Reduced Proper Motion Diagram (Figure 3) shows that both components are situated in the dwarf/subdwarf region.

The results suggest that the primary component as well its companion are main sequence stars.

The absolute visual magnitude of both components enable the calculation of the distance moduli. Francisco Rica Romero's spreadsheet "Astrophysics" was used for this task and the results are shown in Table 9. Distance moduli obtained for each component were similar, which means that, taking into account the errors in determining the magnitudes, the probability that components are at the same distance is 97%.

Conclusions

If the spectroscopy obtained above is reliable, then sum of the masses is estimated to be 1.19 solar masses at a distance calculated based on the data mentioned above. Then, the Wilson and Close criteria indicate a physical system.

The distance moduli calculated above, put both

Table 4: Tangential velocity calculation based on PPMXL and deduced proper motions.

Tangential Velocity Calculation	A	B
Mu (alpha) =	0.043	0.037
Mu (delta) =	-0.045	-0.048
Pi (") =	0.0036	0.0041
Ta (km/s)	57	43
Td (km/s)	-60	-56
Vt (Km/s)	83	70

Table 5:Theta / Rho measurements obtained with Reduc Software.

Besselian Date	Theta º	Rho "
1951.8494	323.47	3.556
1990.7881	328.48	3.555
1996.7184	328.89	3.709
1997.7840	328.83	3.764

Table 6: Photometric magnitudes pulled from 2MASS (infrared) catalog.

	J	H	K
A	12.633	12.013	11.886
B	13.688	13.009	12.840

Table 7: Based at JHK (2MASS) photometric magnitudes and using Francisco Rica Romero's "SDSS-2MASS-Johnson conversions" I obtained color index (B-V), (V-I), Magnitude V and later with "Astrophysics" spreadsheet, Bolometric correction.

	Color B-V	Color V-I	Magnitude V	Bolometric correction
A	1.17	1.21	14.72	-0.552
B	1.31	1.36	16.04	-0.752

Table 8: Reduced Proper Motion.

BAND	Mag (A)	H(A)	Mag (B)	H(B)
V	14.72	13.7	16.04	14.9
K	11.886	10.9	12.84	11.7

Table 9: Distance moduli and distance in parsec values obtained using Francisco Rica Romero's spreadsheet "Astrophysics"

Component	Distance modulus	Distance (parsec)
A	7.22	278.0
B	6.96	246.6

components at the same distance 278.0 (primary) and 246.6 (secondary) parsecs. Thus, the probability that both components are at the same distance is 97%, that value is a good indicator about the possible physical relation between the components

The latest image available from Aladin software (1996.7840) gives astrometry values Θ = 328.83º and ρ = 3.764". According to these data and using the Francisco Rica Romero's spreadsheet, the parameter (p/μ), representing the time it takes the star to travel a distance equal to their angular separation with its motion μ, is 60 years. This indicates that the stars are likely to be gravitationally bound. Halbwachs' criterion also indicates that this is a CPM system. .

In summary, it is probable that his pair is a binary system and it is suggested that the pair be included in the WDS catalog.

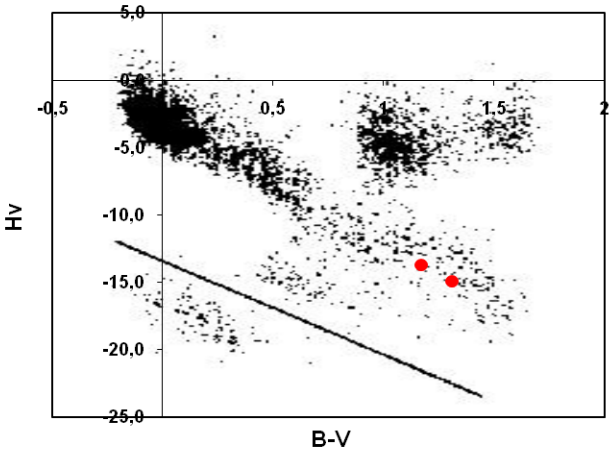

Figure 3: Reduced-Proper diagrams after II. Luyten's White Dwarf Catalog (Jones, E. M., Astrophysical Journal, vol. 177, p. 245. This diagram shows that both components are situated in the dwarf/ subdwarf region.

Acknowledgements

This study made use of Florent Losse's "Reduc" software for relative astrometry and Herbert Raab's "Astrometrica" software to calculate plate's angle deviation.

This study used Francisco Rica Romero's "Astrophysics" and "SDSS-2MASS-Johnson conversions" spreadsheets with many useful formulas and astrophysical concepts.

The data analysis for this paper used the Vizier astronomical catalog service maintained and operated by the Center de Donnès Astronomiques de Strasbourg (http://cdsweb.ustrasbg.fr)

Reference

Rica F., 2007, JDSO, 3, 21.