Study of a New CPM Pair 2Mass 14515781-1619034

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Abstract: In this paper I present the results of a study of 2Mass 14515781-1619034 as components of a common proper motion pair. Because PPMXL catalog's proper motion data not provide any information about secondary star, I deduced it independently, obtaining similar proper motions for both components. Halbwalchs' criteria indicates that this is a CPM system. The criterion of Francisco Rica, which is based on the compatibility of the kinematic function of the equatorial coordinates, indicates that this pair has a 99% probability of being a physical one (Rica, 2007). Also other important criteria (Dommanget, 1956, Peter Van De Kamp, 1961, Sinachopoulus, 1992, Close, 2003), indicate a physical system.

With the absolute visual magnitude of both components, I obtained distance modulus 7.29 and 7.59, which put the components of the system at a distance of 287.1 and 329.6 parsecs. Taking into account errors in determining the magnitudes, this means that the probability that both components are situated at the same distance is 96%.

I suggest that this pair be included in the WDS catalog .

Introduction

The main purpose is to study the pair, 2Mass 14515781-1619034, shown in Figure 1, to determine some important astrophysical features such as distance, spectral type of the components, etc. This was done by an astrophysical evaluation using kinematics, photometric spectral and astrometric data, obtaining enough information to determine if there is a gravitational tie between both components.

In this study, I used Francisco Rica Romero's spreadsheet (Astrophysics, SDSS-2MASS-Johnson conversions) that makes many astrophysics calculations

Proper motion

I started by obtaining the proper motions for the pair given in the PPMXL catalog (a catalog that provides positions and proper motions) and shown in Table 1.

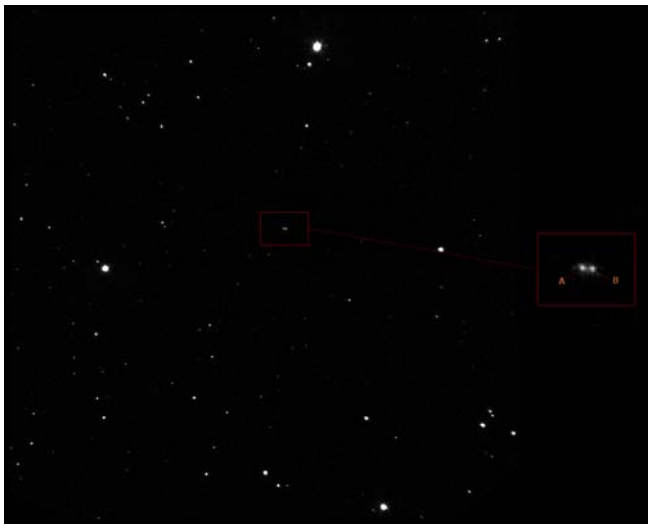

Figure 1: Picture based on DENIS plate that shows the system under study with components clearly identified.

Table 1: Proper motion of the pair described in this study from the PPMXL catalog.

Component	Proper Motion RA (mas/yr)	Proper Motion DEC (mas/yr)
A	-21.0 ± 4.0	-15.9 ± 4.0
B	?	?

Unfortunately, I couldn't find any information about the secondary star, so I made an independent study about the proper motions of this system, where I calculated components' positions from different dates plates that I obtained using Aladin Sky Atlas with a short timeline difference of 9.1595 years and showed large and similar proper motions. I made the measurements using Astrometrica software, the stars were not saturated in any plate, so that the measurements were easily made. The results are shown in Tables 2 and 3.

The proper motions being quite similar suggest that this system could be a CPM pair and that was the reason I decided to study this system.

With those results, I obtained the tangential velocities given in Table 4.

Relative Astrometry

Relative astrometry measurements were based on plates from different dates with resolution of 1.1 a.s., all plates were obtained from Aladdin 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

I retrieved all plates with plate resolution around 1 arcsecond/pixel and catalog data of the image field from 2MASS (Table 6).

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

With this set of photometry in bands J,H,K, the deduced B,V,I and using the Francisco Rica Romero's "Astrophysics" spreadsheet, I can evaluate and calculate the spectral type of each component from photometric data. I obtained M0V and M0.5V for the primary and secondary respectively.

Using the same spreadsheet I obtained the reduced proper motions for the companions presented in Table 8. Reduced Proper Motions Diagram (Figure 2)

Table 2: Coordinates vs Besselian date information used to calculate proper motion for each component

Besselian date	Primary RA (°)	Primary DEC (°)	Secondary RA (°)	Secondary DEC (°)
1992.2425	222.990750	-16.317722	222.989875	-16.317722
1993.2529	222.990792	-16.317611	222.989917	-16.317611
1999.2995	222.990708	-16.317750	222.989833	-16.317750
2001.4020	222.990917	-16.317722	222.990042	-16.317722

Table 3: Proper motions deduced using coordinates from Besselian date plates (Besselian date vs coordinates)

	Primary RA	Primary DEC	Secondary RA	Secondary DEC
Proper motion (mas/year) (± error)	+61.92 ± 3.97	-26.28 ± 2.8	+61.92 ± 3.97	-26.28 ± 2.8

Table 4: Tangential velocity calculation based on deduced proper motions given in Table 3.

Tangential Velocity Calculation	A	B
Mu (alpha) =	0.062	0.062
Mu (delta) =	-0.026	-0.026
Pi (") =	0.0035	0.0035
Ta (km/s)	84	97
Td (km/s)	-36	-41
Vt (Km/s)	92	105

Table 5: Theta / Rho measurements obtained with Reduc software

Besselian Date	Theta (deg)	Rho (as)
1992.2425	266.38	3.832
1993.2529	266.85	3.886
1999.2995	262.18	4.119
2001.4020	266.55	4.161

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

	J	H	K
A	13.583	12.986	12.614
B	14.043	13.362	13.046

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shows that both components are situated in the swarf/subdwarf region.

With this set of photometry in bands J,H,K, the deduced B,V,I and using the Francisco Rica Romero's "Astrophysics" spreadsheet, I calculated the spectral type of each component from photometric data. I obtained M0V and M0.5V for the primary and secondary respectively.

Using the same spreadsheet, I obtained the reduced proper motions for the companions presented in Table 8. In that table, H is the apparent magnitude the star would have at a distance for which its proper motion is 0.1 as/yr. The Reduced Proper Motion Diagram (Figure 2) 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 modulus, I used Francisco Rica Romero's spreadsheet "Astrophysics" 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 96%.

Conclusions

If we consider the spectroscopy obtained above to be reliable, we can estimate the sum of the masses to be 0.64 solar masses at a distance calculated above. Wilson and Close criteria indicate a physical system as do the Jean Dommanget, Peter Van de Kamp and Dimistris Sinachopoulos criteria.

The distance moduli put both components at the same distance 287.1 (primary) and 329.6 (secondary) parsecs, which means that the probability that both components are at the same distance is 96%, and is a good indicator of the possible physical relation between the components

Respect to the kinematics, I intended to verify the plate kinematics through digitized plates from different dates being the difference (besselian date): 9.1595 years, It's a short period of time but in that study the proper motions are high. I made this study because I couldn't find any information about secondary's proper motion, obtaining good and similar results on RA and DEC, that results suggest that system as CPM.

The latest image available from Aladin software (2001.4020) gives astrometry values $\Theta = 266.55^{o}$ and $\rho = 4.161$". Using these numbers in Francisco Rica

Table 7: Color indices (B-V), (V-I), and V magnitude from JHK (2MASS) photometric magnitudes and using Francisco Rica Romero's "SDSS-2MASS-Johnson conversions". Bolometric correction calculated using Rica Romero's "Astrophysics" spreadsheet.

	Color B-V	Color V-I	Magnitude V	Bolometric correction
A	1.42	1.58	16.29	- 0.939
B	1.49	1.63	16.84	- 1.024

Table 8: Reduced Proper Motion

BAND	Mag (A)	H(A)	Mag (B)	H(B)
V	16.29	15.4	16.84	16.0
K	12,614	11.8	13.046	12.2

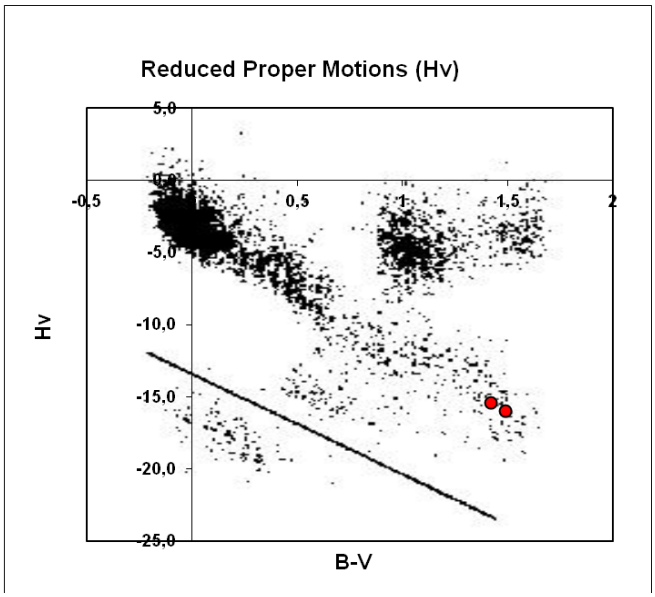

Figure 3: Reduced-Proper diagrams after II. Luyten's White Dwarf Catalog (Jones, 1972). This diagram shows that both components are situated in the swarf/subdwarf region.

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

Component	Distance modulus	Distance (parsec)
A	7.29	287.1
B	7.59	329.6

Romero's spreadsheet calculates the parameter (p/μ) representing the time it takes the star to travel a distance equal to their angular separation and gives T = 59 years. This result is consistent with the system being a bound system. Halbwachs' criteria tell us that this is a CPM system and Rica criterion (Rica, 2007), indicates that this pair has a probability of 96% to be a physical one.

In summary, with the present information we can consider this pair as a binary and I suggest that this pair be included in the WDS catalog.

Acknowledgements

I used Florent Losse's "Reduc" software for relative astrometry and Herbert Raab's "Astrometrica" software to calculate plate's angle deviation.

I 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 has been made possible with the use of Vizier astronomical catalogs service maintained and operated by the Center de Donnès Astronomiques de Strasbourg (http://cdsweb.ustrasbg.fr)

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