

Two New Common Proper Motion Binaries in Aquarius

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Abstract: In this paper two new double stars are reported in Aquarius which are currently not listed in the WDS catalog, the components of which share common proper motions. Separated by a mere 278.9" angular distance in the sky, notwithstanding some uncertainties in the underlying data, they are shown to be two distinct physical systems in 3D space.

Introduction

The pairs were initially identified in DSS images on June 3, 2014 in a region of the sky near the western edge of constellation Aquarius (Figure 1). Images were later obtained on June 7, 2014 with a 61 centimeter Cassegrain telescope operated by the Sierra Stars Observatory Network in California [2] in the V band, with an exposure time of 25 seconds, which confirmed both

pairs. The primary of the brighter pair has the designation BD-04 5244 and the primary of the fainter pair TYC 5182-1922-1. ICRS positions for 2000.0, astrophysical data and measurements taken on high resolution J-band imagery obtained from the 2MASS database [1] are summarized in Table 1.

The spectral types and distances shown in Table 1 were fitted to the observed parameters as follows. For the brighter pair (20452-0331), the primary has 2MASS

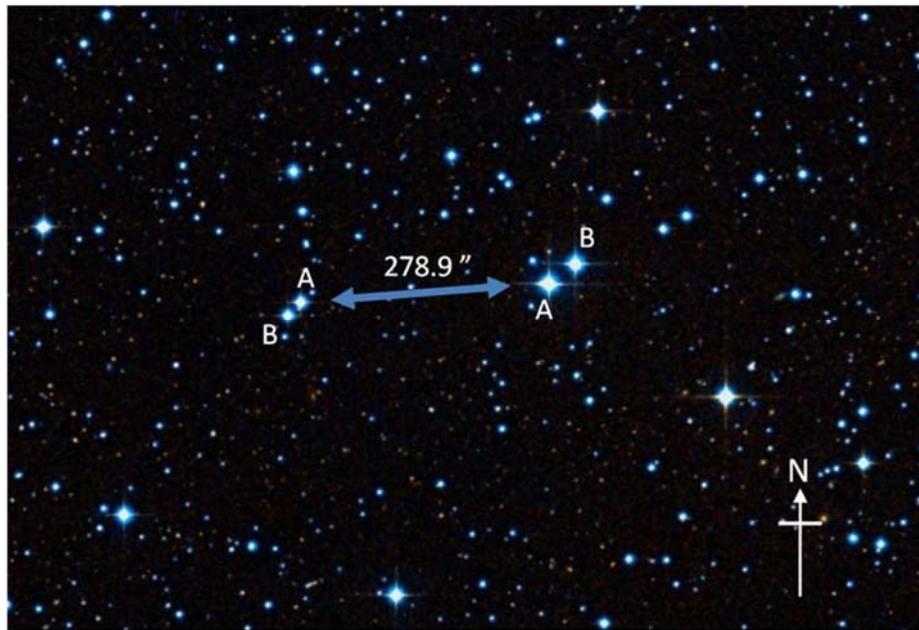


Figure 1: Field image of the two new pairs in Aquarius. The rectangle covers an area (17.2 x 11.6) arcminutes [Source: SDSS]

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Table 1: Identification, measurements, and results

Pair		RA	Dec	μ_{α} mas/yr	μ_{δ} mas/yr	V mag	θ (deg)	ρ (as)	Epoch	Spec Type	Distance (ly)
20452-0331	A	20 45 10.6	-03 31 22	+26.1	-22.6	10.16	307.3	37.1	1998.715	F9V	~442
	B			+26.5	-21.3	10.64				G2V	
20455-0332	A	20 45 29.1	-03 31 43	+1.4	-43.6	11.99	136.0	20.9	1998.715	K6V	~225
	B			+0.1	-44.0	12.20				K7V	

(J-K) color indices of +0.31 and (B-V) of +0.55 in SIMBAD, which both independently point to a spectral type of about F9V. The secondary has 2MASS (J-K) color indices of +0.30 and (B-V) of +0.62 in SIMBAD, indicating spectral types of between ~F9V and ~G2V. This discrepancy was resolved and a final spectral type of G2V was recorded based on a magnitude difference Δm of 0.48 and that the two stars share virtually identical PPMXL [3] proper motions and are taken to be at the same distance.

The primary component of the second pair (20455-0332) was inferred to be a star of spectral class K6V. With the benefit of a (B-V) color index of +1.16 as an additional guide and not relying exclusively on its (J-K) color index of +0.54, both point to a spectral classification of about K6V. Inferring a spectral type of K7V for the secondary component in this pair was not so straightforward, however. It is based on a Δm of 0.21 and on the high probability that it is at the same physical distance as the primary, given that the proper motions of both stars lie within 99.6% of their mean value of 43.8 mas/yr. Finally, the distances from Earth of 442 and 225 light years for the two pairs were estimated using the distance modulus on apparent magnitudes of 10.16 and 11.99 for the primaries of each pair, and on absolute magnitudes of the primaries of roughly ~ 4.5 for an F9V star and ~ 7.8 for a K6V star. With uncertainties inherent in the underlying assumptions about spectral types and absolute magnitudes, these distances should of course be treated as probabilistic peaks as opposed to absolute facts.

Positions and Velocities in 3D Space

When two stellar systems are positioned next to each other in the sky, as is the case here, and when distances to each have been projected with some confidence it is tempting to ponder how far apart they are likely to be from one another in 3D space, and at what rate they might be moving in relation to each other.

The 2014 edition of the WDS catalog [4] showed the nearest other catalogued pairs in the immediate sky vicinity were LDS 724 (0.64° away in distance), RST

4678 (0.69° away), and OCC9021 (0.92° away).

As was illustrated earlier in Figure 1, the primary components of these two new binaries in Aquarius are separated by an angular distance of just 278.9 arcseconds in the sky (0.08°). They have total proper motions of 34.3 mas/yr and 43.8 mas/yr, respectively. The PM vectors indicate that the two systems are distinctly separate from each other, their components following totally different paths in the sky. To obtain the true space velocity of an object in 3D space, it is necessary to know the three quantities of radial velocity, transverse velocity, and distance. Since radial velocities are not available for any of the components in these pairs, it has not been possible to derive their true space motions in 3D. By summing the (μ_{α} , μ_{δ}) vector components of PM shown in Table 1, it was nevertheless possible to project the direction of movements for both pairs in the 2D plane of the sky. The fainter pair, made up of two K dwarves, is heading south, whereas the brighter pair is moving roughly in a south easterly direction in the sky. Such motions are of course unlikely to become perceptible to the human eye except over vast aeons of time going into the far distant future. Taking the faster moving pair (20455-0332, made up of K dwarves) travelling at a rate of 43.8 mas/yr, they will take approximately 40,000 years to cover a distance equivalent to the width of the Full Moon.

On the calibrated distance projections of each system, the three dimensional configuration of their relative positions in space would be roughly as shown in Figure 2.

The physical distance separation, D , in Figure 2 between the two pairs given their distances from Earth, and their angular separation in the sky can be determined using the cosine rule of plane trigonometry:

$$D^2 = a^2 + b^2 - 2ab \cos A$$

Where a and b are the distances of each pair from Earth and A is the angular separation in the sky, so we have:

$$D^2 = 225^2 + 442^2 - 2 \times 225 \times 442 \times \cos(278.9'')$$

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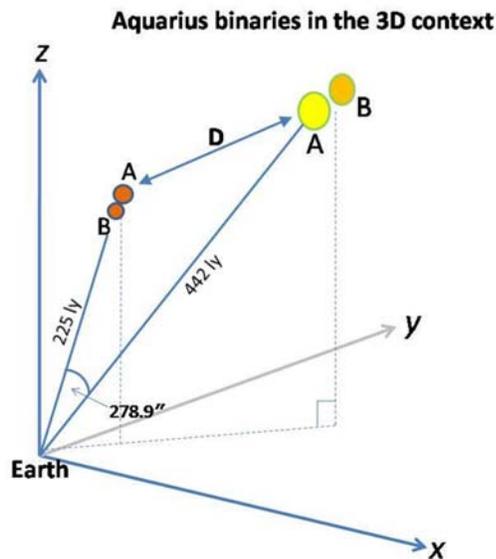


Figure 2: The two new Aquarius binaries shown in 3D perspective

This gives $D = 217$ light years (66.5 parsecs).

On the assumption that these distances are in fact precisely correct, if one were physically located in the vicinity of the fainter system (20455-0332), the stars of the brighter binary would shine at magnitudes 8.6 and 8.9 in the local night sky (determined from the equations in reference [5]). A further thought provoking insight about the brighter pair (20452-0331) arose from this study. Since the B component of this pair has been inferred to be a possible G2V star much like our own Sun (a *solar analog*), if one were to look in the direction of our Solar System from a hypothetical vantage point within this binary, our Sun would be seen to be shining as a single point of light of about the same brilliance - as only a 10th magnitude star in the night sky!

Conclusions

In the various methods of fitting the observed data to physical properties, distances and motions of these pairs discussed in this paper, it seems highly likely that they might be true binaries. Considering their proximity to each other and that they appear in the same field of view in amateur-sized telescopes, it is recommended that these pairs be added to the WDS catalog as exciting new double stars.

Acknowledgments

This research has made use of the Washington Double Star Catalog maintained at the US Naval Observatory. The study has also made extensive use of various digitized sky survey images and the stellar catalogs fed through SIMBAD and VizieR databases operated at the Centre de Données astronomiques, Strasbourg, France.

References

- 1 The Two Micron All Sky Catalog of Point Sources, Cutri, et al., 2003.
- 2 Sierra Stars Observatory Network (SSON) <http://www.sierrastars.com>.
- 3 PPMXL Catalog (Roeser, et al., 2010)
- 4 Brian D. Mason, Gary L. Wycoff, William I. Hartkopf, 2014, The Washington Double Star Catalog. <http://ad.usno.navy.mil/wds/>
- 5 Ahad, A., *Webb Society Double Star Section Circular*, **18**, 49, 2010