Kruger 60

Wilfried R.A. Knapp
Vienna, Austria
wilfried.knapp@gmail.com

John Nanson
Star Splitters Double Star Blog
Manzanita, Oregon
jnanson@nehalemtel.net

Abstract: As announced in our report "Measurements of WDS Objects found in images taken for detecting CPM pairs in the LSPM catalog" we present here a report on Kruger 60. This multiple is listed in WDS with such a large number of components that we thought it deserves a separate report.

1. Introduction and Historical Research

Kruger 60 AB is certainly one of the most interesting WDS objects – only about 13 light years distance from our sun, very high proper motion speed of nearly 1 arc second per year, fast orbit of ~45 years, and the secondary is a variable star with a very short period of 8 minutes. As the fast orbit suggests there is a strong gravitational relationship between the two components with an average distance of only about 10 AU.

A bit unclear to us is the large number of additional components obviously not sharing the proper motion of the AB pair. While this might be explained for the "older" components listed by simply not being aware of this fact, it cannot be assumed for the more recently "discovered" components – one gets the impression these were added because they were found in images in the same field of view as KR 60 AB. With this logic we could easily double the number of components by adding the many stars around KR 60 not yet identified as companions (see Figure 1). We chose not to do that, but instead simply measured all components listed so far even though we are aware that KR 60 AB's high rate of proper motion will make all measurement results "obsolete" at the moment of addition to the WDS catalog due to the time lag of publication.

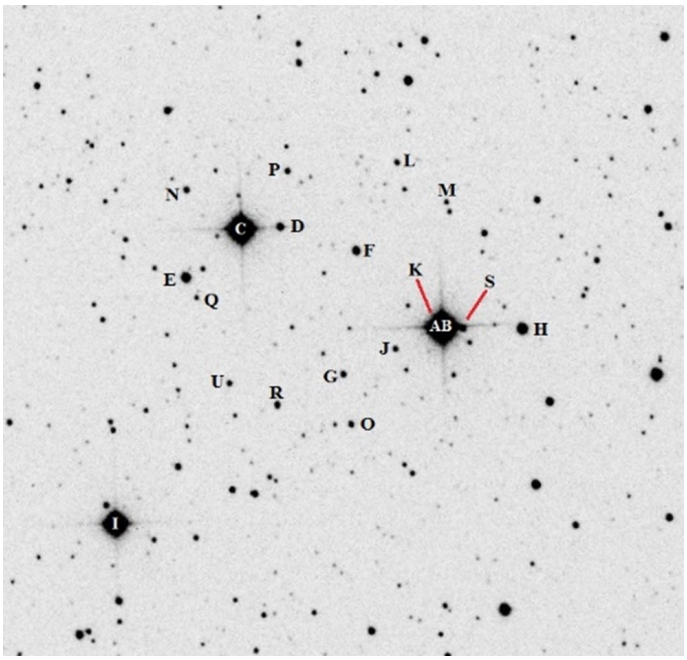

Figure 1: KR60 field of view near the center of an iT24 1x60s I-filter image of Bessel epoch 2016.658. North is at the top, east at the left

Historical Information and Details of KR 60

KR 60 is an intriguing multiple star with a few characteristics not commonly seen in a single star. The AAVSO web site designates it as DO Cep, a UV type variable star, with a magnitude range of 10.3 to 11.4. In 1988 it was also classified as a flare star. In addition, KR 60 AB is an orbital pair with a period of 44.67 years specified in the WDS. The separation of the AB

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148 *PUBLICATIONS OF THE LICK OBSERVATORY.*

K	Star Catalogue.	α 1875.	δ 1875.	Magnitudes.	Notes.
60	13,170	22 23 32	57 4.3	. . . 9.1	Dupl. 12″ pr. Com. 9.3.
61	13,262	22 29 37	57 33.8	. . . 9.4	Dupl.
62	13,727	23 0 12	62 43.3	9.1 . . . 9.1	Dupl. 5″.
63	13,901	23 11 5	61 16.9	. . . 6.8	Dupl.?
64	13,912	23 12 1	55 1.2	. . . 9.3	Dupl. 2″ seq.
65	14,171	23 28 14	59 5.4	. . . 9.1	Dupl. pr. Com. 9.4.
66	14,208	23 31 56	60 0.8	. . . 9.2	Dupl.?
67	14,673	23 59 33	60 10.3	. . . 9.0	Dupl. 3″ bor. Com. 9.4.

from
Measures of Stars Noted as Double in Krueger's Catalog of the Astronomische Gesellschaft, Zones 55° to 65°
by S.W. Burnham in Publications of Lick Observatory, Vol. II (1894), p. 148

Figure 2. Krueger's notes on double stars from his A.G. survey. The numbers were assigned by Burnham.

pair is currently increasing, having reached its closest point in 2015, 1.396". The AB pair also has a rather high rate of proper motion, which is a reflection of its 13.05 light year proximity to us. Also intriguing are the number of components associated with KR 60. The WDS currently lists it with a total of twenty, which aroused our curiosity as to what prompted their addition and is the primary motivation for our research. As with any star associated with a large number of components, the devil is in the details, some of which frequently required considerable effort to untangle.

A cursory look at the many components of KR 60 and the dates of their first measures listed in the WDS leads to the initial impression the A and B components are the original pair. A closer look reveals the first observation date of the I component precedes the B component by seventeen years, 1873 versus 1890, leading to the conclusion the I component was the original secondary of KR 60. However, further research revealed that wasn't the case.

The KR prefix refers to Adalbert Krueger (1832-1896), who in 1873 was conducting observations for the Astronomische Gesellschaft Catalog. The first step on the path back to Krueger's 1873 observation of the star that became the I component began with looking at S.W. Burnham's *General Catalogue of Double Stars* (Burnham, 1906). On page 987 of Part II (the second volume) of that catalog, Burnham includes this cryptic note on KR 60: "Noted by Krueger in A.G. Hels., *'dupl. 12" pr. Com 9.3'* in 1873.73." Stumped by the reference to A.G. Hels., the next step was to look up Burnham's notes on the KR prefix, which were found on p. vii of Part II. His note there was more enlightening: "Stars noted as double by Krueger in *A.G. Helsingsfors-Gotha*. The first measures of these pairs are found in *Publications of Lick Observatory*, Vol. II."

A Google book search produced the Lick publication referenced above by Burnham (Burnham, 1894). The first table shown by Burnham (pp. 147-148) consists of stars which were designated as double by Krueger (Figure 2: KR 60 is on the top line). For the pair Burnham has designated as KR 60, Krueger shows magnitudes of 9.1 and 9.3. There are no measures of position angles or separations listed in this table, but estimated separations are found in the Notes column, where Krueger includes the note referring to a 12" pair mentioned above by Burnham. In his introductory material to the table Burnham states Krueger's notes were "appended concerning such of the stars as appeared double in the meridian instrument" (p. 147). There's a second table (pp. 149-150) which consists of Burnham's measurements of each of Krueger's stars listed in the first table. That table lists Burnham's 1890 measures for the AB and AC pairs, but no mention is made of the 1873 component which is designated as I by the WDS.

Given that the 1873 Obs1 data in the WDS for the AI pair lists a separation of 195.35", it is clear the comment in Krueger's Notes does not refer to what is now the I component. In fact, at this point in our research it was not at all clear which component Krueger was referring to with the 12" separation. That led to a search for the publication in which he listed his 1873 observation, which fortunately turned up in Google books despite it's formidable title: *Catalog von 14680 Sternen zwischen 54° 55' und 65° 10' Nördlicher Declination 1855 für das Aequinoctium 1875 nach Beobachtungen am Achtfüssigen Reichenbach'schen Passagen-Instrument der Helsingsforser Sternwarte auf der Sternewarte der Universität Helsingfors in den Jahren 1869 bis 1876 und auf der Herzoglichen Sternwarte zu Gotha in den Jahren 1877 bis 1800 von A. Krueger*. (Krueger's publication is actually the fourth volume of the 1890 Astronomische Gesellschaft Catalog, covering declinations between 55 and 65 degrees).

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Zone 55° bis 65°. Helsingfors-Gotha. 265

Nr.	Gr.	A.R. 1875	Praec.	Var. saec.	Decl. 1875	Praec.	Var.saec.	Ep.	Zonen	B. D.
13166	7.0	22 23 11.32	+1.9816	+0.0132	+ 63 19 4.6	+18.292	+0.111	77.7	512 515	63 1850
13167	9.2	23 17.27	2.0553	0.0146	61 42 1.1	18.295	0.115	75.9	463 467	61 2291
13168	8.2	23 19.26	2.0149	0.0139	62 37 46.0	18.296	0.113	77.0	488 509	62 2084
13169	9.1	23 25.04	2.0539	0.0146	61 45 48.7	18.300	0.115	75.9	463 467	61 2300
13170	9.1[3]	23 32.35	2.2288	0.0164	57 4 16.3	18.304	0.125	73.7	307 310	56 2783
13171	9.4	22 23 33.62	+1.9062	+0.0116	+ 64 54 11.8	+18.305	+0.106	82.0	528 R	64 1667
13172	8.6	23 35.06	2.2761	0.0165	55 33 7.4	18.305	0.128	74.1 73.7	14 173[a] 657	55 2753
13173	9.2	23 37.15	2.0298	0.0142	62 21 52.5	18.307	0.113	77.0	487 514	62 2086
13174	9.0	23 40.25	2.1889	0.0162	58 18 3.3	18.309	0.122	73.9	336 337	58 2438
13175	9.1	23 41.13	1.9135	0.0118	64 47 32.3	18.309	0.106	82.0	526 R	[64 1668]
13176	8.9	22 23 42.14	+2.2062	+0.0163	+ 57 48 3.2	+18.310	+0.124	78.9	175 R	57 2542
13177	8.3	23 43.63	2.2319	0.0165	57 1 24.0	18.311	0.125	72.8	202 307	56 2784
13178	7.9	23 45.25	1.9878	0.0135	63 18 52.4	18.312	0.110	78.7	512 515 683	63 1851
13179	9.3	23 47.78	2.2178	0.0164	57 28 31.5	18.313	0.124	73.0 72.7	181[a] 315	57 2541
13180	7.8	23 52.00	2.2564	0.0166	56 16 55.5	18.316	0.126	71.8	30 310	56 2785

from
Catalog von 14680 Sternen zwischen 54° 55' und 65° 10' Nordlicher Declination 1855 fur das Aequinoctium 1875, Adalbert Krueger, 1890, Lepizig, p. 265

Figure 3. Krueger's 1873 A.G. observations. Nr. 13170 is KR 60 A; Nr. 13177 is KR 60 I.

Krueger's volume is a list of individual stars in order of right ascension. Each listing includes his catalog number for each star, its coordinates, and the star's BD number (Bonner Durchmusterung). There is no attempt made in the catalog to locate double stars, thus there is no separation or position angle, and additionally there is no column for notes (Figure 3). Burnham included Krueger's catalog number for the A component of KR 60 in the Lick publication referred to above, so it was a simple matter to locate it in Krueger's catalog. Also, since both KR 60 A and KR 60 I have BD numbers assigned, locating the star in Krueger's catalog that is now the I component was also easy to do. (Kruegers catalog numbers for the two BD stars are 13170 and 13177, respectively, and the BD numbers are +56 2783 and +56 2784, respectively).

With Krueger's 1873 coordinates now located for both the A and the I components, all that was necessary was to plug the RA and declination numbers into a spreadsheet in order to compute the 1873 separation and position angles. That resulted in a separation of 195.311" and a PA of 151.906 degrees. The WDS Obs1 data for 1873 is 195.35" and 151.9 degrees, so it's safe to say those numbers are based on Krueger's 1873 coordinates. In fact, the WDS numbers correspond to the data listed by Burnham on the second page of his entry on KR 60 in his 1906 catalog (p. 988), which is referred to there as "A and DM (56°) 2784", the latter number, as already mentioned, being the BD number for what is now the I component of KR 60. Since Burnham didn't add that star to the KR 60 system in his 1906 catalog, it was apparent the addition was made some time after several of the other components were added in 1900 and 1912. However, at that point in our research it wasn't clear what would prompt the decision to add a star at that distance which is also 1.6 magnitudes brighter than the primary and has no gravitational relation to it.

That still left a question regarding identity of the 9.3 magnitude component at a distance of 12.3" referred to above in Krueger's notes by Burnham. That mystery was resolved by pulling up an Aladin image of KR 60, loading Simbad into it, and then using the epoch slider to return the stars in the image to their 1873 positions. That resulted in KR 60 A being located 11" from what is now the C component of KR 60, which has a WDS magnitude of 10.53. That's not quite the 9.3 magnitude referred to by Krueger, but his estimated separation of 12" would indicate this is the star he was referring to in his notes. KR 60 C was never assigned a BD number, so it isn't possible to use Krueger's 1873 catalog positions to compute the 1873 separation of the two stars (Krueger didn't include a position angle). During our research we found that Eric Doolittle had arrived at the same conclusion in 1900. Based on the known motions of A and C, he computed an 1873 position angle of 41.0 degrees and a separation of 11.76" for the two stars (Doolittle, 1900). So as it turns out, the reference to a star at an estimated distance of 12" in Krueger's notes refers to what is now the C component of KR 60, not the star which is now the I component. In effect, the C component of KR 60 was historically the original secondary of KR 60.

With regard to the many other components of KR 60, S. W. Burnham was the first to provide measures of the AB and AC pairs, which he did in 1890. His 1906 catalog lists the initial AB and AC measures on p. 987. That same page also contains Burnham's diagram of the orbital motion of the B component between 1890 and 1906, as well as the direction of the proper motion of the primary (Figure 4.) Using the C component as a reference point, Burnham estimated a rate of motion of .0942" per year in the direction of 245.2 degrees.

The rapid proper motion of KR 60 AB soon cap-

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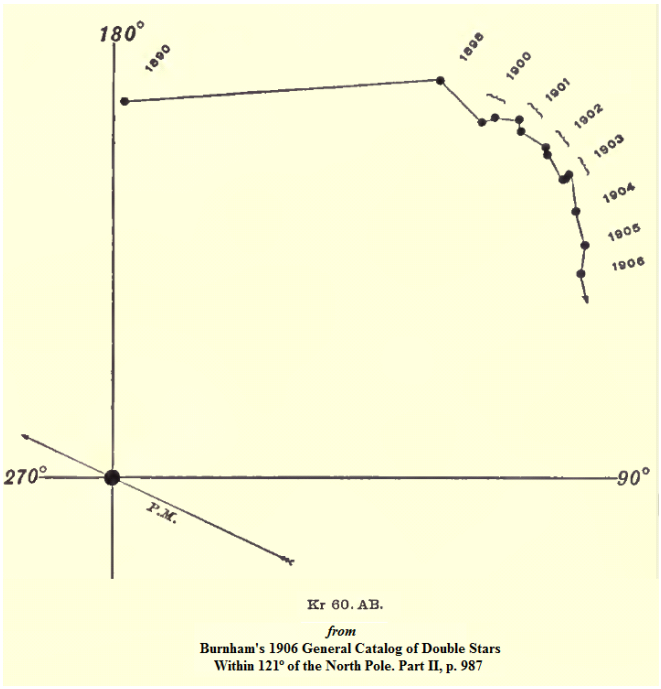

Figure 4. Burnham's diagram of orbital motion of AB. The direction of proper motion is shown at the lower left.

tured the attention of both Eric Doolittle and E.E. Barnard. In 1900, in a short piece in issue number 486 of the Astronomical Journal, Doolittle combined his own 1898 and 1900 measures of AB with Burnham's 1890 measures to arrive at proper motion rate of .093" per year in the direction of 247.9 degrees. One of the stars used by Doolittle for a reference point in determining the proper motion of A was the star which is now the I component of KR 60, which he referred to by Krueger's 1890 catalog number, 13177 (Doolittle, 1900, p. 47).

Doolittle's work caught the attention of E. E. Barnard, who responded quickly in issue 488 of the Astronomical Journal (Barnard, 1900) with measures for the D and E components of KR 60. Referring to KR 60 AB, Barnard, who at that time was at Yerkes Observatory, wrote, "This star is likely to be of considerable interest, and I have therefore made a series of measures with the 40-inch, introducing two other smaller stars to more thoroughly explain hereafter the character of the motion." (p. 64). Because the AB pair was actually a discovery by Burnham, not Krueger, Barnard also suggested the pair be designated as β 1291, a suggestion which wasn't accepted because Burnham had already used that designation for another star (Barnard, 1903, p. 172).

In 1903 Barnard returned to the pages of the Astronomical Journal (Barnard, 1903) with 1901 and 1903 measures of an additional star which he designated as F. In that paper he was primarily concerned with using the known measures of AB at that date to establish the motion of B was not rectilinear, but due to orbital motion. He also used the star which became the I component, which he also referred to as Helsingfors-Gotha A.G.C. 13177, to continue to establish the large proper motion of the AB pair.

In 1916 Barnard published a lengthy paper in the Monthly Notices of the Royal Astronomical Society which included the first measures of the G and H components, which he had made in 1912. Barnard was very specific as to why he chose to add the two stars to the KR 60 system: "Two additional stars have been observed, to be used in future observations of A when it has receded too far from C." (Barnard, 1916, p. 602). In addition, he provided measures for several other stars in the vicinity of A for which he omitted letter designations. Barnard also stated (p. 592) that he had determined a parallax for A of .249", which was a result of a study he had published previously in a 1908 MNRAS paper (Barnard, 1908). That parallax is remarkably close to the current figure in Simbad of .24994". Also, while reading through Barnard's 1908 MNRAS paper, we found he had refined his measure of the direction of proper motion for AB from 247 degrees to 238 degrees, which is notably close to the 240.57 degrees we found when comparing URAT1 coordinates to 2MASS coordinates. Barnard's plots of the orbital motion of the AB pair and the proper motion of the pair are included elsewhere in this paper as Figures 5 and 6. Also included here as Figure 7 are Barnard's 1908 and 1915 images showing the orbital motion of B around A, as well as the proper motion of the AB pair relative to C.

Given that Barnard's designations for the components of KR 60 had reached the letter H as of 1916, it seemed likely the I component would show up in R.G. Aitkens 1932 *General Catalogue of Double Stars*. A search through the second volume for KR 60 did in fact show the addition of the I component (Aitkens, 1932, p. 1386), although the first measures listed are Burnham's 1906 and 1910 measures. No mention or reference is made to the measures derived by Burnham from Krueger's 1873 coordinates.

Turning to J, which was the next component added, AJ and BJ (HEL 4 in the WDS) were first measured as part of a 2009 speckle survey conducted with the 200 inch and 10 meter Keck II telescopes (Helminiak, et.al, 2009). The star labeled in Table 6 on p. 415 of the paper as GJ 860 1-3 is the AJ pair, and the star labeled GJ 860 2-3 is the BJ pair. The first measures listed in the WDS, which are dated 1999, are from 2MASS

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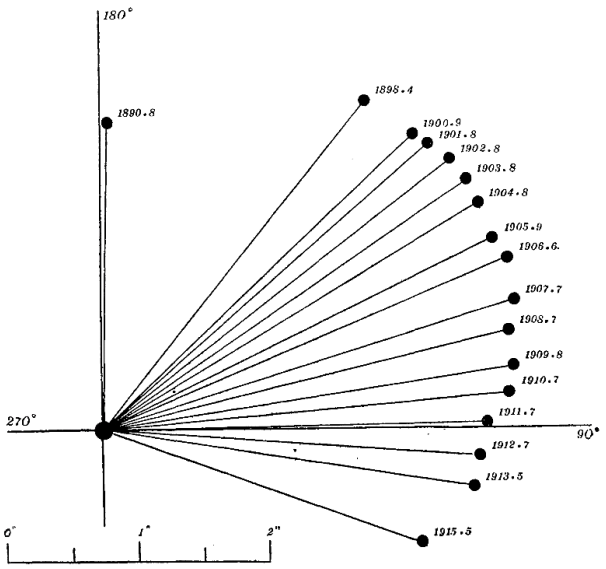

Fig. 3—Krueger 60, AB, from 1890 to 1915.

from
Stars, Double and Multiple, Observations of the Double Star Krueger 60 (Burnham Gen. Catalog 11761)
by E. E. Barnard, MNRAS, Vol. 76, p. 593

Figure 5. Barnard's plot of orbital motion based on first twenty-five years of data.

measures.

The K component, HZE 5 AK, was actually discovered before the J component. It was added during a 2006 survey for exo-planets around sun-like stars (Heinze, et. al., 2010). The measures for the AK pair can be found in Table 10 (p. 1565) of the resulting paper, where the pair is identified as GJ 860 A. The Heinze measure is the only measure listed in the WDS for the pair (we attempted to measure it, but were unable to resolve it). As we identified the various components of KR 60, the K component initially eluded us. It was finally located after loading Simbad into Aladin and moving the epoch slider to the date of its single observation, 2006, which placed KR 60 AB at a distance and position angle which matched the 2006 measures of Heinze, 7.24" and 0.25 degrees. In the Aladin image, K appears immediately off the west edge of AB at a distance of 11.8" and a position angle of 270 degrees. The rapid proper motion of the AB pair combined with the close proximity of K is responsible for the amazing change between the 2000 epoch of the Aladin image and the 2006 Heinze observation.

In 1999 another nine components were added as FYM 118, all of them in the 15th magnitude range. Those measures were initially made in 2012 by Marcel Fay (Fay, 2013), but earlier measures were added to the WDS by using data from the 2MASS and UCAC4 catalogs, as well as the AAVSO's APASS survey. Curious as to why the additional nine components were added to the KR 60 system in the absence of any proper motion relation to AB, we contacted Marcel Fay, who replied it was an interest in the possibility of common motion in clustered stars that prompted the additions. While this is an intriguing area for additional research, it remains unclear to us as to whether it warrants the addition of nine gravitationally unrelated components to the KR 60 system.

So with regard to the C through I components of KR 60, based on statements made by Burnham, Doolittle, and Barnard, the primary reason for the addition of the non-physical components was for use as reference points to measure the rapid proper motion of the KR 60 primary. Proper motion played no role in the addition of the J and K components, but the possibility of common motion among the L through U component led to their addition. The possibility of shared motion occurred to us as well as we were working through the details of this paper. That topic suggests an interesting area for inquiry which hopefully will soon benefit from the availability of GAIA parallaxes.

2. Results of Our Research

In Table 1 below we present the WDS catalog data as of the beginning of 2017 in the header line, the URAT1 and/or GAIA DR1 data in the second and/or third line, and in the two following lines our own measurements based on images taken with remote telescope iT24. The image processing followed our usual procedure: stacking with VPhot, plate solving and measuring positions and Vmags with Astrometrica using URAT1 as reference catalog, and calculating Sep and PA with the formulas provided by Buchheim 2008. The I-filter images were first plate solved with URAT1 as reference catalog for the astrometry results and then again plate solved with USNO B1 as reference catalog for Icmags for the I-band photometry results. Given below is a description of the Table 1 content per column:

- Name gives the discoverer ID of the selected object in the header line.
- RA and Dec give the recent precise coordinates of the A component from the WDS catalog in the header line in the traditional HH:MM:SS DD:MM:SS format and in the data lines from the sources referred to in the Notes column in decimal degrees format as these values are directly usable for calculating Sep and PA.
- Sep gives separation in arcseconds in the data lines calculated as

$$Sep = \sqrt{\left[\left(RA_2 - RA_1\right)\cos\left(Dec_1\right)\right]^2 + \left(Dec_2 - Dec_1\right)^2}$$

in radians.

(text continues on page 9)

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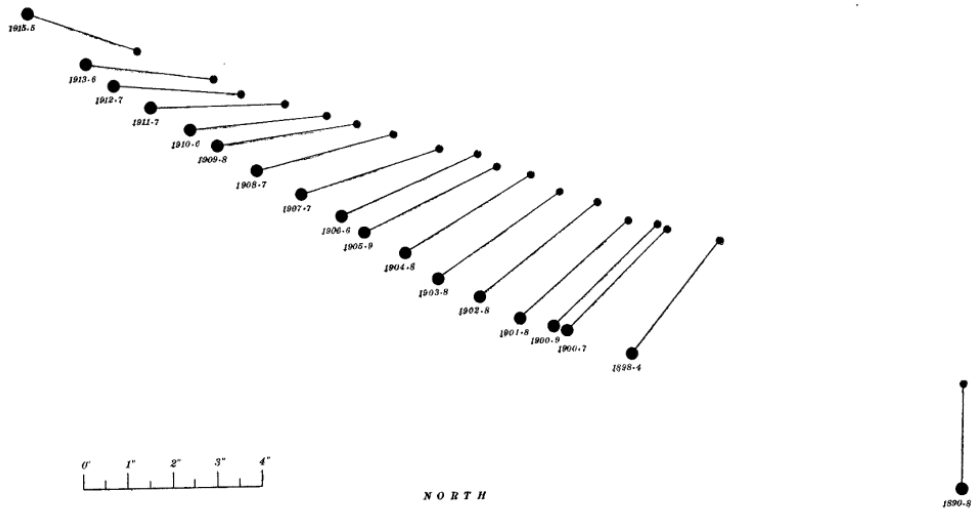
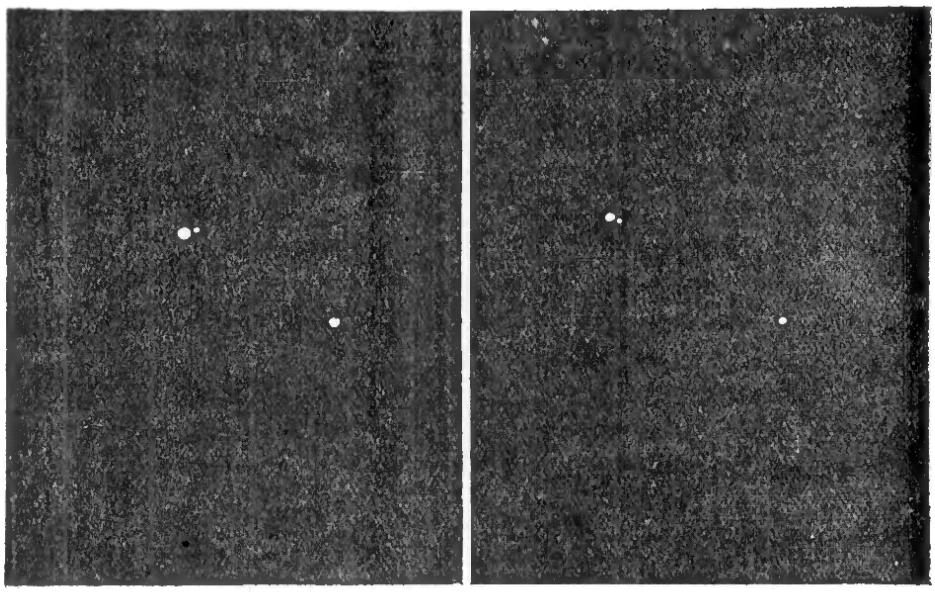


FIG. 2.—KRUEGER 60. THE RELATIVE POSITIONS OF AB WITH RESPECT TO C FROM 1890 TO 1915. (C IS OMITTED.)

from
Stars, Double and Multiple, Observations of the Double Star Krueger 60 (Burnham Gen. Catalog 11761)
by E. E. Barnard, MNRAS, Vol. 76, p. 594

Figure 6. Barnard's plot of proper motion of AB relative to C.



1908 July. 1915 September.

Photographs of Krueger 60, AB and C.
(Both photographs are on the same scale).

Yerkes Observatory, Williams Bay, Wisconsin:
1916 *March* 6.

from
Stars, Double and Multiple, Observations of the Double Star Krueger 60 (Burnham Gen. Catalog 11761)
by E. E. Barnard, MNRAS, Vol. 76, p. 606

Figure 7. Images taken by E.E. Barnard showing the orbital motion of B around A and the proper motion of the AB pair relative to C.

(Continued from page 7)

- PA gives position angle in degrees in the data lines calculated as

$$PA = \arctan\left[\frac{(RA_2 - RA_1)\cos(Dec_1)}{Dec_2 - Dec_1}\right]$$

  in radians depending on quadrant.
- M1 and M2 give WDS Vmags in the header line for A and B, URAT1 Vmags in the URAT1 data line, and GAIA Gmags in the GAIA DR1 line, and the next two lines give the measured V- and Imags from our own images.
- pmRA1 and pmDE1 with e_pm1 give the WDS proper motion data for A and pmRA2, pmDE2 and e_pm2 for B in the header line and in the URAT1 and GAIA DR1 lines the values calculated by comparison with 2MASS positions.
- Spc1 and Spc2 give in the header line the WDS spectral class range for A and B if given in the WDS catalog and in the iT24 I-filter image lines the spectral class range based on the V-I color index taking into consideration also the error range of the measured Imags using the table provided by the Space Telescope Science Institute (http://www.stsci.edu/~inr/intrins.html).
- Ap indicates in the data lines the aperture used for the observation listed and Me indicates the WDS code for the used observation method (for GAIA calculated equivalent circular surface diameter).
- Date is the Bessel epoch of the (averaged) observation date given in the data lines.
- CPM Rat gives the rating of the CPM assessment based on comparison of positions between 2MASS and URAT1 and/or between 2MASS and GAIA DR1 (see Appendix A).
- And last, Source/Notes indicates the source used (images and catalogs) and additional explanations if considered necessary.

3. CPM pair nearby Kruger 60

By chance we found near Kruger 60 a faint wide pair with common proper motion characteristics, although the 2MASS to GAIA DR1 position comparison is slightly questionable due to the rather large 2MASS position error. See Table 2.

We hoped in vain for PM data with higher reliability from the new UCAC5 catalog for a counter-check, but both components are not UCAC5 objects.

4. Summary

Historical research suggests that KR 60 AB should rather be listed with a BU discoverer designation but Burnham himself obviously decided otherwise. Due to the high speed proper motion of AB the rest of the currently WDS catalog listed components represent a data mess of obsolete separations and position angles which would be much easier to control with coordinates given not only for the primary but also for the other components with little to no proper motion as for example in Table 3 (Appendix B). We can only hope that there will be no more attempts to measure additional "pairs" with KR60 A or B as "primary" – as image 1 demonstrates there exist enough potential candidates to double the current number of KR 60 components. The idea that a good part of the stars in this field with exception of KR 60 AB might be members of an open cluster has some appeal but the currently existing data does not give any serious hint in this direction – proper motion of most stars is according to UCAC5 very small with rather different PM vector direction and GAIA Plx data is currently not available.

5. Acknowledgements:

The following tools and resources have been used for this research:

- Washington Double Star catalog
- 2MASS All Sky catalog
- iTelescope: Images were taken with iT24: 610mm CDK with 3962mm focal length. CCD: FLI-PL09000. Resolution 0.62 arcsec/pixel. V-filter. Located in Auberry. California. Elevation 1405m
- GAIA DR1 catalog
- URAT1 catalog
- UCAC5 catalog
- Aladin Sky Atlas v9.0
- SIMBAD, VizieR
- AstroPlanner V2.2
- NASA/ IPAC Infrared Science Archive
- Astrometrica 4.10.1.432
- AAVSO Web Page: https://www.aavso.org/
- AAVSO Search Page: https://www.aavso.org/vsx/index.php?view=search.top

Thanks also to Marcel Fay for his reply to our inquiry regarding the L through U components of KR 60

6. References

Aitkens, R.G., 1932, *New General Catalogue of Double Stars Within 120° of the North Pole, Part 2*, Carnegie, Washington, D.C., pp. 1385–1386.

Barnard, E.E., 1900, "Observations of the Stars Krueger 60 and Beta 1291", *Astronomical Journal*, **21**, 64.

(References continue on page 16)

Table 1: Measurements for KR 60 components found in the existing CPM LSPM II image. Headline data from the WDS catalog per beginning of 2017

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
KR 60 AB	22 27 59.20	+57 41 43.8	1.4	298	9.93	11.41	-806	-399		-713	-321		M3.5	M4.5			2015		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284			9.63		-749.40	-422.72	9.70				>M4		0.20	Eu	2013.754		URAT1. PM data calculated for A is from position comparison with 2MASS. M1 is URAT1 Vmag. Spc1 is from URAT1 B-V data (1.66). The B component is not identified in URAT1 or 2MASS; GAIA DR1 does not identify either A or B.
	336.991800	57.694089	1.540	268.511	9.67	10.76									0.61	C	2016.658		iT24 stack 5x10s V-filter. Heavily overlapping star disks but obvious elongation - measurements thus questionable? But counter-check with 6th Orbit catalog for this fast moving object rather confirming. Also B (variable) might be in a bright phase
	336.991679	57.694036			6.61								>M4		0.61	C	2016.658		iT24 stack 5x10s I-filter. No resolution of B. Spc range from V-I color index
KR 60 AC	22 27 59.20	+57 41 43.8	136.8	62	9.93	10.53	-806	-399		3	-1		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	137.741	61.977	9.63	10.42	-749.40	-422.72	9.70	-13.11	-4.04	10.94	>M4	>M4	0.20	Eu	2013.605	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (2.01).
	336.991800	57.694089	139.786	62.119	9.67	10.34									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	140.050	62.069	6.61	6.90							>M4	>M4	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AD	22 27 59.20	+57 41 43.8	115.6	56	9.93	14.30	-806	-399		-8	-9		M3.5				2011		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284			9.63	13.73	-749.40	-422.72	9.70				>M4		0.20	Eu	2013.578		URAT1. PM data for A is calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag shown). Spc1 is from URAT1 B-V data (1.66). D companion not identified by 2MASS.
	336.991800	57.694089	119.087	56.274	9.67	14.65									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	119.321	56.279	6.61	12.61							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AE	22 27 59.20	+57 41 43.8	160.1	78	9.93	13.33	-806	-399		2	-2		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	161.103	77.255	9.63	13.31	-749.40	-422.72	9.70	-7.64	11.55	6.74	>M4	M2-M3	0.20	Eu	2013.590	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.48).
	336.991800	57.694089	162.987	77.200	9.67	13.34									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	163.383	77.123	6.61	11.29							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index

Table 1 continues on next page.

Table 1 (continued). Measurements for KR 60 components found in the existing CPM LSPM II image. Headline data from the WDS catalog per beginning of 2017

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
KR 60 AE	22 27 59.20	+57 41 43.8	160.1	78	9.93	13.33	-806	-399		2	-2		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	161.103	77.255	9.63	13.31	-749.40	-422.72	9.70	-7.64	11.55	6.74	>M4	M2-M3	0.20	Eu	2013.590	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.48).
	336.991800	57.694089	162.987	77.200	9.67	13.34									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	163.383	77.123	6.61	11.29							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AF	22 27 59.20	+57 41 43.8	69.3	46	9.93	14.43	-806	-399		0	-2		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	70.018	45.717	9.63	14.43	-749.40	-422.72	9.70	-21.42	-9.78	9.95	>M4	>M4	0.20	Eu	2013.578	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.90).
	336.991800	57.694089	71.939	46.478	9.67	14.49									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	72.174	46.403	6.61	12.09							>M4	M3->M4	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AG	22 27 59.20	+57 41 43.8	65.5	117	9.93	15.14	-806	-399		-9	-20		M3.5				2009		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	66.919	114.805	9.63	14.42	-749.40	-422.72	9.70	-31.59	-31.27	9.39	>M4		0.20	Eu	2013.562	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66).
	336.991800	57.694089	68.410	113.529	9.67	14.97									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	68.518	113.435	6.61	13.39							>M4	K7-M1	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AH	22 27 59.20	+57 41 43.8	53.8	266	9.93	13.02	-806	-399		4	3		M3.5				2011		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	52.348	266.106	9.63	13.02	-749.40	-422.72	9.70	-10.93	-13.47	9.92	>M4	M0-M1	0.20	Eu	2013.602	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.46).
	336.991800	57.694089	50.182	266.801	9.67	13.00									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	50.152	266.925	6.61	10.95							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 AI	22 27 59.20	+57 41 43.8	237.6	120	9.93	8.31	-806	-399		-7	-7		M3.5				2009		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	236.916	119.574	9.63	8.29	-749.40	-422.72	9.70	3.80	1.73	6.70	>M4	F5-F8	0.20	Eu	2013.631	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (.52).
	336.991800	57.694089	238.229	119.183	9.67	8.28									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	238.318	119.138	6.61	7.48							>M4	G8-K4	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index

Table 1 continues on next page.

Table 1 (continued). Measurements for KR 60 components found in the existing CPM LSPM II image. Headline data from the WDS catalog per beginning of 2017

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
KR 60 CE	22 28 13.44	+57 42 44.1	46.1	130	10.53	13.33	3	-1		2	-2		M3				2012		WDS 22280+5742, WDS data as of beginning of 2017
	337.056003	57.712261	45.968	129.394	10.42	13.31	-13.11	-4.04	10.94	-7.64	11.55	6.74	>M4	M2-M3	0.20	Eu	2013.441	CAC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (2.01); Spc2 is also from same data (1.48)
	337.055997	57.712258	45.960	129.391	8.61	12.59	-12.49	-4.22	9.83	-7.86	10.16	6.04			0.96	Hg	2015.000	CAC	GAIA DR1. PM data calculated from position comparison with 2MASS. M1 and M2 are GAIA Gmag data.
	337.056021	57.712247	45.896	129.608	10.34	13.34									0.61	C	2016.658		iT24 stack 5x10s V-filter
	337.055992	57.712258	45.975	129.413	6.90	11.29							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
HEL 4 AJ	22 27 59.20	+57 41 43.8	29.8	118	9.93	15.70	-806	-399		-1	1		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	30.753	115.844	9.63	14.90	-749.40	-422.72	9.70	-22.03	-16.83	9.40	>M4		0.20	Eu	2013.558	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag, M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66)
	336.991800	57.694089	32.475	113.251	9.67	15.98									0.61	C	2016.658		iT24 stack 5x10s V-filter. SNR for J <20
	336.991679	57.694036	32.299	112.807	6.61	13.69							>M4	M2->M4	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
HZE 5 AK	22 27 59.20	+57 41 43.8	7.2	0	4.78	16.00	-806	-399					M3.5				2006		WDS 22280+5742, WDS data as of beginning of 2017; only one WDS observation of AK. M1 is clearly in error
	336.992804	57.694284			9.63		-749.40	-422.72	9.70				>M4		0.20	Eu			URAT1. PM data calculated for A is from position comparison with 2MASS.No obvious match for K at the location shown in the WDS. Spc1 is from URAT1 B-V data (1.66)
	336.995585	57.697010				10.40									0.96	Hg	2015.000		GAIA DR 1. A is not recognized by GAIA DR1; K is not recognized by 2MASS. M2 is GAIA Gmag data.
	336.991800	57.694089			9.67										0.61	C	2016.658		iT24 stack 5x10s V-filter. No resolution of K
	336.991679	57.694036			6.61								>M4		0.61	C	2016.658		iT24 stack 5x10s I-filter. No resolution of K. Spc range from V-I color index
FYM 118 AL	22 27 59.20	+57 41 43.8	105.4	12	9.93	15.44	-806	-399		2	-3		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	105.691	12.433	9.63	14.78	-749.40	-422.72	9.70	-17.56	-12.09	9.97	>M4		0.20	Eu	2013.567	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66)
	336.991800	57.694089	106.629	13.345	9.67	15.36									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	106.980	13.441	6.61	13.74							>M4	K7-M1	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 AM	22 27 59.20	+57 41 43.8	77.5	354	9.93	15.60	-806	-399		-2	5		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017. Note: There are two stars of identical magnitude lined up north-south and separated by 6.44" in the Aladin image - the northernmost of the pair most closely matches the WDS data
	336.992804	57.694284	77.806	354.578	9.63	15.20	-749.40	-422.72	9.70	-20.49	-14.40	9.95	>M4		0.20	Eu	2013.583	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66)
	336.991800	57.694089	78.042	355.877	9.67	15.93									0.61	C	2016.658		iT24 stack 5x10s V-filter. SNR for M <20
	336.991679	57.694036	78.369	356.123	6.61	14.15							>M4	M0-M2	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index

Table 1 continues on next page.

Table 1 (continued). Measurements for KR 60 components found in the existing CPM LSPM II image. Headline data from the WDS catalog per beginning of 2017

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
FYM 118 CD	22 28 13.44	+57 42 44.1	24.0	274	10.53	14.30	3	-1		-8	-9		M3				2012		WDS 22280+5742, WDS data as of beginning of 2017
	337.056003	57.712261			10.42	13.73	-13.11	-4.04	10.94				>M4		0.20	EU	2013.455		URAT1. PM data for C is calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag. Spc1 is from URAT1 B-V data (2.01). The D component is not identified by 2MASS
	337.055997	57.712258			8.61	13.94	-12.49	-4.22	9.83						0.96	Hg	2015.000		GAIA DR1. PM data for C is calculated from position comparison with 2MASS. M1 and M2 are GAIA Gmag data. The D component is not identified by 2MASS
	337.056021	57.712247	24.514	271.753	10.34	14.65									0.61	C	2016.658		iT24 stack 5x10s V-filter
	337.055992	57.712258	24.487	271.498	6.90	12.61							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 CN	22 28 13.44	+57 42 44.1	43.0	56	10.53	14.92	3	-1		-4	-2		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	337.056003	57.712261	42.128	52.550	10.42	14.91	-13.11	-4.04	10.94	-7.01	9.32	6.75	>M4	K0-K1	0.20	Eu	2013.430	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (2.01); Spc2 is also from same data (.82)
	337.055997	57.712258	42.120	52.545	8.61	14.45	-12.49	-4.22	9.83	-7.52	7.61	6.04			0.96	Hg	2015.000	CCC	GAIA DR1. PM data calculated from position comparison with 2MASS. M1 and M2 are GAIA Gmag data
	337.056021	57.712247	42.196	52.341	10.34	14.83									0.61	C	2016.658		iT24 stack 5x10s V-filter
	337.055992	57.712258	42.104	52.485	6.90	13.38							>M4	K5-M0	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 AO	22 27 59.20	+57 41 43.8	82.0	137	9.93	15.17	-806	-399		-20	-45		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	82.228	136.203	9.63	15.73	-749.40	-422.72	9.70	-41.06	-52.89	9.38	>M4	K4-K5	0.20	Eu	2013.570	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.13)
	336.991800	57.694089	83.031	134.959	9.67	15.32									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	83.162	134.830	6.61	13.50							>M4	M0-M2	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 CP	22 28 13.44	+57 42 44.1	46.0	319	10.53	14.79	3	-1		-7	-3		M3				2012		WDS 22280+5742, WDS data as of beginning of 2017
	337.056003	57.712261	46.498	319.575	10.42	14.79	-13.11	-4.04	10.94	-18.40	-2.61	9.96	>M4	G8-K0	0.20	Eu	2013.425	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (2.01); Spc2 is also from same data (.76)
	337.055997	57.712258	46.502	319.569	8.61	14.52	-12.49	-4.22	9.83	-17.59	-2.93	8.91			0.96	Hg	2015.000	CCC	GAIA DR1. PM data calculated from position comparison with 2MASS. M1 and M2 are GAIA Gmag data
	337.056021	57.712247	46.527	319.502	10.34	14.93									0.61	C	2016.658		iT24 stack 5x10s V-filter
	337.055992	57.712258	46.508	319.586	6.90	13.46							>M4	K5-M0	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 EQ	22 28 17.87	+57 42 15.0	13.6	206	13.33	15.70	2	-2		-11	-11						2012		WDS 22280+5742, WDS data as of beginning of 2017
	337.074476	57.704157	14.216	205.602	13.31	15.26	-7.64	11.55	6.74	-9.75	8.13	6.76	M1-M3		0.20	Eu	2013.400	CBC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag, M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.48)
	337.074468	57.704156	14.223	205.592	12.59	15.40	-7.86	10.16	6.04	-9.78	6.55	6.04			0.96	Hg	2015.000	CBC	GAIA DR1. PM data calculated from position comparison with 2MASS. M1 and M2 are GAIA Gmag data
	337.074408	57.704119	14.195	205.518	13.34	15.92									0.61	C	2016.658		iT24 stack 5x10s V-filter. SNR for Q <20
	337.074463	57.704150	14.193	205.594	11.29	14.35							M1-M3	K7-M1	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index

Table 1 concludes on next page.

Table 1 (conclutions). Measurements for KR 60 components found in the existing CPM LSPM II image. Headline data from the WDS catalog per beginning of 2017

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
FYM 118 AR	22 27 59.20	+57 41 43.8	111.6	115	9.93	15.20	-806	-399		-2	15		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	112.322	113.960	9.63	14.51	-749.40	-422.72	9.70	-15.97	-25.16	9.41	>M4		0.20	Eu	2013.551	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66)
	336.991800	57.694089	113.726	113.375	9.67	15.60									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	113.396	113.110	6.61	13.47							>M4	M1-M3	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
FYM 118 AS	22 27 59.20	+57 41 43.8	16.4	262	9.93	15.70	-806	-399		-3	2		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	15.548	261.450	9.63	15.00	-749.40	-422.72	9.70	-18.91	-13.97	9.92	>M4		0.20	Eu	2013.602	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 is URAT1 Vmag; M2 is URAT1 f.mag (no Vmag listed). Spc1 is from URAT1 B-V data (1.66)
	336.991800	57.694089	13.394	262.622	9.67	15.82									0.61	C	2016.658		iT24 stack 5x10s V-filter. SNR for S <20
	336.991679	57.694036	13.243	264.019	6.61	14.26							>M4	K7-M1	0.61	C	2016.658		iT24 stack 5x10s I-filter. SNR for S <20. Spc range from V-I color index
FYM 118 AU	22 27 59.20	+57 41 43.8	135.3	104	9.93	15.20	-806	-399		-6	-10		M3.5				2012		WDS 22280+5742, WDS data as of beginning of 2017
	336.992804	57.694284	135.778	103.363	9.63	15.16	-749.40	-422.72	9.70	-6.87	-6.81	6.76	>M4	K5-K7	0.20	Eu	2013.565	CCC	URAT1. PM data calculated from position comparison with 2MASS. M1 and M2 are URAT1 Vmags. Spc1 is from URAT1 B-V data (1.66); Spc2 is also from same data (1.32)
	336.991800	57.694089	137.627	102.847	9.67	15.16									0.61	C	2016.658		iT24 stack 5x10s V-filter
	336.991679	57.694036	137.676	102.816	6.61	13.60							>M4	K7-M1	0.61	C	2016.658		iT24 stack 5x10s I-filter. Spc range from V-I color index
KR 60 BC	22 27 59.97	+57 41 44.4	136.0	62	11.41	10.53	-713	-321		3	-1		M4				2012		WDS 22280+5742, WDS data as of beginning of 2017
						10.42				-13.11	-4.04	10.94		>M4	0.20	Eu	2013.455		URAT1 PM data for C is calculated from position comparison with 2MASS. M2 is URAT1 Vmag. Spc2 is from URAT1 B-V data (2.01). The B component is not identified in URAT1 or 2MASS; GAIA DR1 does not identify either A or B
	336.991000	57.694078	141.167	62.396	10.76	10.34									0.61	C	2016.658		iT24 stack 5x10s V-filter. B heavily overlapped with A
						6.90								>M4	0.61	C	2016.658		iT24 stack 5x10s I-filter. No resolution of B. Spc range from V-I color index
HEL 4 BJ	22 27 59.97	+57 41 44.4	25.1	137	11.41	15.70	-713	-321		-1	1		M4.5				2002		WDS 22280+5742, WDS data as of beginning of 2017
						14.90				-22.03	-16.83	9.40			0.20	Eu	2013		URAT1 PM data for J is calculated from position comparison with 2MASS. M2 is URAT1 f.mag. The B component is not identified in URAT1 or 2MASS; GAIA DR1 does not identify either A or B
	336.991000	57.694078	33.880	112.161	10.76	15.98									0.61	C	2016.658		iT24 stack 5x10s V-filter. B heavily overlapped with A. SNR for J <20
						13.69								M2->M4	0.61	C	2016.658		iT24 stack 5x10s I-filter. No resolution of B. Spc range from V-I color index

Table 1 concludes on next page.

Table 2: Catalog data and measurement results for the CPM candidate 2MASS 22280738+5742326/22280593+5741502

2MASS ID	RA	Dec	Sep "	PA °	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
22280738 +5742326 22280593 +5741502	337.030778	57.709061	43.956	195.39	16.44	17.46									1.30	E2	1999.738		2MASS. M1 and M2 estimated from J- and K-band
	337.030580	57.709008	44.002	195.411			-28.20	-14.10	6.00	-30.10	-17.10	6.00			0.20	Eu	2013.233		URAT1. Given PM error neglects the larger than average 2MASS position error
	337.030574	57.709008	43.983	195.397	17.33	17.45	-25.67	-12.52	9.83	-26.41	-14.16	10.75			0.96	Hg	2015.000	AACC	GAIA DR1. M1 and M2 are G-band. PM data calculated from position comparison with 2MASS. 2MASS position error rather large - but looks like a solid CPM candidate
	337.030463	57.709075	44.236	194.434	17.92	18.04									0.61	C	2016.658		iT24 1x180s V-filter
	337.030538	57.709028	44.381	195.092	16.11	16.25							M0-M2	M0-M2	0.61	C	2016.658		iT24 1x60s I-filter. SNR A and B <20. Spc range from V-I color index

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Appendix A

Explanation of the CPM rating scheme according to Knapp and Nanson 2017:

- Three rating factors are used: Proper motion vector direction, proper motion vector length and size of position error in relation to proper motion vector length
- Proper motion vector direction ratings: “A” for within the error range of identical direction, “B” for similar direction within the double error range, and “C” for outside
- Proper motion vector length ratings: “A” for within the error range of identical length, “B” for similar length within the double error range, and “C” for outside
- Error size ratings: “A” for error size of less than 5% of the proper motion vector length, “B” for less than 10%, and “C” for a larger error size

To compensate for excessively large position errors resulting in an “A” rating despite rather high deviations an absolute upper limit is applied regardless of calculated error size:

- Proper motion vector direction: Max. 2.86° difference for an “A” and 5.72° for a “B”
- Proper motion vector length: Max. 5% difference for an “A” and 10% for a “B”

Appendix B

The following table gives the plate solving errors for the used iT24 images and error information derived therefrom for the measurements provided in Table 1 as well as the measured positions for both components:

Table 3. Error Estimations for the Measurements in Table 1.

- *dRA and dDec = average RA and Dec plate solving errors in arcseconds*
- *Err_Sep = separation error estimation in arcseconds calculated as SQRT(dRA^2+dDec^2)*
- *Err_PA = position angle error estimation in degrees calculated as arctan (Err_Sep/Sep) assuming the worst case that Err_Sep points perpendicular to the separation vector*
- *dmag as average mag plate solving error (Vmag for images with made V-filter and Imag for images made with I-filter)*
- *Err_Mag = magnitude error estimation calculated as SQRT(dVmag^2+(2.5*LOG10(1+1/SNR))^2)*
- *SNR as signal to noise ratio for the given object*

Name		RA	Dec	dRA	dDec	Err Sep	Err PA	Err Mag	SNR	dmag	Filter
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	4.203	0.070	313.16	0.07	V
	B	22 27 57.840	57 41 38.68					0.071	110.82		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	-	0.130	332.32	0.13	I
	B							-			
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.046	0.070	313.16	0.07	V
	C	22 28 13.445	57 42 44.09					0.070	214.72		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.040	0.130	332.32	0.13	I
	C	22 28 13.438	57 42 44.13					0.130	378.30		
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.054	0.070	313.16	0.07	V
	D	22 28 10.387	57 42 44.84					0.076	37.23		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.048	0.130	332.32	0.13	I
	D	22 28 10.383	57 42 44.77					0.132	54.20		
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.040	0.070	313.16	0.07	V
	E	22 28 17.858	57 42 14.83					0.072	67.41		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.035	0.130	332.32	0.13	I
	E	22 28 17.871	57 42 14.94					0.130	99.88		
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.090	0.070	313.16	0.07	V
	F	22 28 04.539	57 42 28.26					0.075	39.43		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.079	0.130	332.32	0.13	I
	F	22 28 04.523	57 42 28.30					0.131	68.26		

Table 3 continues on next page.

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Table 3 (continued). Error Estimations for the Measurements in Table 1.

Name		RA	Dec	dRA	dDec	Err Sep	Err PA	Err Mag	SNR	dmag	Filter
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.095	0.070	313.16	0.07	V
	G	22 28 05.856	57 41 11.41					0.079	29.85		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.083	0.130	332.32	0.13	I
	G	22 28 05.845	57 41 11.28					0.133	37.76		
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.129	0.070	313.16	0.07	V
	H	22 27 51.782	57 41 35.92					0.071	80.40		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.113	0.130	332.32	0.13	I
	H	22 27 51.756	57 41 35.84					0.130	116.14		
KR 60	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.027	0.070	313.16	0.07	V
	I	22 28 23.977	57 39 42.56					0.070	325.88		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.024	0.130	332.32	0.13	I
	I	22 28 23.969	57 39 42.49					0.130	361.13		
KR 60	C	22 28 13.445	57 42 44.09	0.08	0.08	0.113	0.141	0.070	214.72	0.07	V
	E	22 28 17.858	57 42 14.83					0.072	67.41		
KR 60	C	22 28 13.438	57 42 44.13	0.07	0.07	0.099	0.123	0.003	378.30	0.13	I
	E	22 28 17.871	57 42 14.94					0.130	99.88		
HEL 4	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.200	0.070	313.16	0.07	V
	J	22 28 01.754	57 41 25.90					0.094	17.01		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.176	0.130	332.32	0.13	I
	J	22 28 01.717	57 41 26.01					0.134	32.14		
HZE 5	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	-	0.070	313.16	0.07	V
	K							-			
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	-	0.130	332.32	0.13	I
	K							-			
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.061	0.070	313.16	0.07	V
	L	22 28 01.102	57 43 22.47					0.083	23.48		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.053	0.130	332.32	0.13	I
	L	22 28 01.105	57 43 22.58					0.135	29.87		
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.083	0.070	313.16	0.07	V
	M	22 27 57.332	57 42 56.56					0.092	17.47		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.072	0.130	332.32	0.13	I
	M	22 27 57.342	57 42 56.72					0.138	23.53		

Table 3 continues on next page.

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Table 3 (continued). Error Estimations for the Measurements in Table 1.

Name		RA	Dec	dRA	dDec	Err Sep	Err PA	Err Mag	SNR	dmag	Filter
FYM 118	C	22 28 13.445	57 42 44.09	0.08	0.08	0.113	0.264	0.070	214.72	0.07	V
	D	22 28 10.387	57 42 44.84					0.076	37.23		
	C	22 28 13.438	57 42 44.13	0.07	0.07	0.099	0.232	0.003	378.30	0.13	I
	D	22 28 10.383	57 42 44.77					0.132	54.20		
FYM 118	C	22 28 13.445	57 42 44.09	0.08	0.08	0.113	0.154	0.070	214.72	0.07	V
	N	22 28 17.614	57 43 09.87					0.077	32.93		
	C	22 28 13.438	57 42 44.13	0.07	0.07	0.099	0.135	0.003	378.30	0.13	I
	N	22 28 17.606	57 43 09.77					0.133	36.66		
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.078	0.070	313.16I	0.07	V
	O	22 28 05.361	57 40 40.05					0.082	25.47		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.068	0.130	332.32	0.13	I
	O	22 28 05.360	57 40 39.90					0.134	34.53		
FYM 118	C	22 28 13.445	57 42 44.09	0.08	0.08	0.113	0.139	0.070	214.72	0.07	V
	P	22 28 09.674	57 43 19.47					0.078	30.45		
	C	22 28 13.438	57 42 44.13	0.07	0.07	0.099	0.122	0.003	378.30	0.13	I
	P	22 28 09.675	57 43 19.54					0.133	35.29		
FYM 118	E	22 28 17.858	57 42 14.83	0.08	0.08	0.113	0.457	0.072	67.41	0.07	V
	Q	22 28 17.095	57 42 02.02					0.094	16.81		
	E	22 28 17.871	57 42 14.94	0.07	0.07	0.099	0.400	0.011	99.88	0.13	I
	Q	22 28 17.106	57 42 02.14					0.139	21.55		
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.057	0.070	313.16	0.07	V
	R	22 28 11.054	57 40 53.60					0.088	19.60		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.050	0.130	332.32	0.13	I
	R	22 28 11.075	57 40 53.81					0.134	33.73		
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.484	0.070	313.16	0.07	V
	S	22 27 56.375	57 41 37.00					0.094	16.92		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.428	0.130	332.32	0.13	I
	S	22 27 56.360	57 41 37.15					0.141	19.01		
FYM 118	A	22 27 58.032	57 41 38.72	0.08	0.08	0.113	0.047	0.070	313.16	0.07	V
	U	22 28 14.770	57 41 08.12					0.080	27.53		
	A	22 27 58.003	57 41 38.53	0.07	0.07	0.099	0.041	0.130	332.32	0.13	I
	U	22 28 14.749	57 41 07.99					0.134	32.16		

Table 3 concludess on next page.

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Table 3 (conclusion). Error Estimations for the Measurements in Table 1.

Name		RA	Dec	dRA	dDec	Err Sep	Err PA	Err Mag	SNR	dmag	Filter
KR 60	B	22 27 57.840	57 41 38.68	0.08	0.08	0.113	0.046	0.010	110.82	0.07	V
	C	22 28 13.445	57 42 44.09					0.070	214.72		
	B			0.07	0.07	0.099	-	-		0.13	I
	C	22 28 13.438	57 42 44.13					0.130	378.30		
HEL 4	B	22 27 57.840	57 41 38.68	0.08	0.08	0.113	0.191	0.010	110.82	0.07	V
	J	22 28 01.754	57 41 25.90					0.094	17.01		
	B			0.07	0.07	0.099	-	-		0.13	I
	J	22 28 01.717	57 41 26.01					0.134	32.14		
22280738+5742326 2228059 3+574150 2	A	22 28 07.311	57 42 32.67	0.11	0.08	0.136	0.176	0.046	23.04	0.08	V
	B	22 28 05.935	57 41 49.83					0.090	26.03		
	A	22 28 07.329	57 42 32.50	0.07	0.07	0.099	0.128	0.146	16.10	0.13	I
	B	22 28 05.887	57 41 49.65					0.152	13.20		