The Relative Proper Motion of G 167-29 in the Constellation Boötes

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Abstract: G 167-29 is a high proper motion star in the constellation Bootes. The study of the relative proper motion is pictured over an epoch of 97 years. Different sources will be used for recalculation the proper motion. The result of recalculation shows an improvement of proper motion which is given by μx = 0.100" / year for right ascension and μy = 0.337" / year for declination.

The high proper motion star G 167-29 (coordinates: 15 15 07.06 +33 18 03.3**)** can be found at a distance of about 300 arc seconds from δ Bootis. The star was found by the Lowell Proper Motion study in 1964 by comparison of star fields from different epochs. G 167-29 is the 29th proper motion star of plate 167, which was centered on STT192 in Corona Borealis. The study gives a brightness of 15.0 magnitudes and a proper motion of 0.40 arc seconds with direction of 193 degree [H.L. Giclas, R. Burnham, Jr., N.G. Thomas, 1964].

G 167-29 is also listed in the LSPM catalog. The LSPM study gives a brightness of 12.73 magnitudes and a proper motion of -0.046 arc seconds in R.A. and -0.356 arc seconds in declination (φ = 187.4 degree). The distance is 26.6 pc = 86.8 light years [Lepine S., Shara M., 2005].

The following figures show the proper motion of G 167-29 for the last 97 years. All figures are aligned to the angle conventions of double star observations. Figure 1 was made by F. Kaiser in 1914 on observatory Landessternwarte Heidelberg-Königstuhl with the Bruce astrograph (Figure 5). The Bruce astrograph is a double telescope and has an aperture of 2 x 0.4 m and a focal length of 2 m. To recognize plate errors in this early stage of astrophotography two

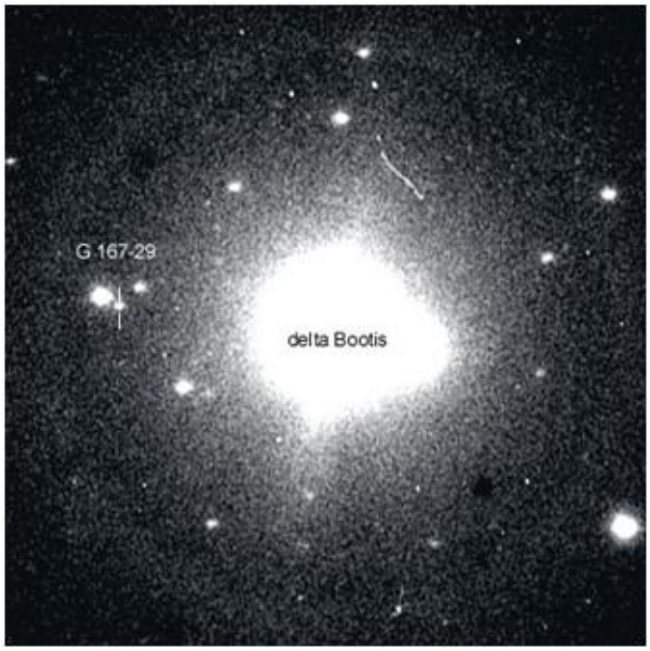

Figure 1: Detail of photo from Bruce astrograph of 1914, observatory Landessternwarte Heidelberg-Königstuhl, G 167-29 is marked with lines, image was taken from HDAP, notes were added by the author

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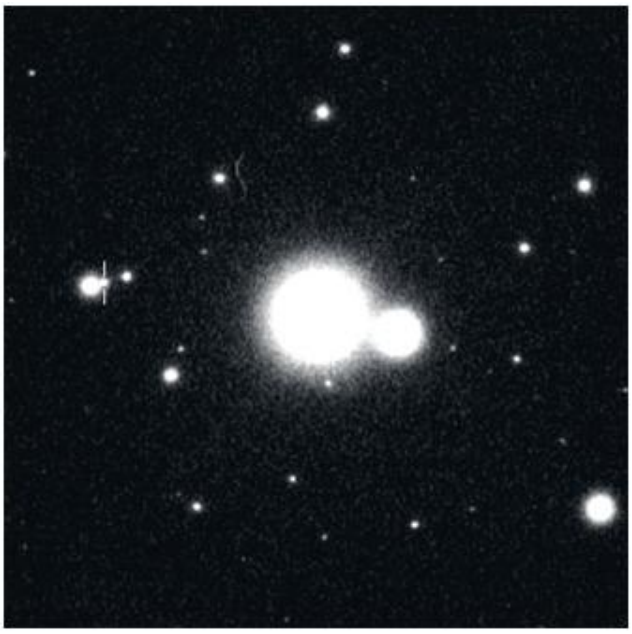

Figure 2: Detail of photo from Bruce astrograph of 1961, observatory Landessternwarte Heidelberg-Königstuhl, G 167-29 is marked with lines, image was taken from HDAP

Figure 3: Detail of POSS2 image of 1994, Oschin Schmidt telescope, Mount Palomar observatory, taken from The Digitized Sky

images were recorded. Therefore two independent images can now be analyzed for each record. A third telescope with a focal length of 4 m was used for tracking control. The quality of the scanned Bruce plates is about 1 arc second per pixel. In Figure 1, G 167-29 is below the neighborhood stars. Figure 2 is also from observatory Landessternwarte Heidelberg-Königstuhl. It was made in 1961 by G. Klare. The Bruce astrograph was also used. This time all stars were in line. It is also near the time of closest approach to one of the neighborhood stars. Figure 3 was made by the POSS 2 survey in 1994 with the Oschin Schmidt telescope and G 167-29 has moved straight through the neighborhood stars. The scale of the scanned POSS2 images is also 1.0 arc second per pixel. Figure 4 was made by the author in 2011. An 8 inch Newtonian telescope with a webcam was used. The webcam was placed in the primary focus with a focal length of 800 mm. The figure shows the result of 100 stacked frames. For scale calibration the distance of both neighborhood stars was used. These stars (labeled as B and C) show no variations in distance or position angle over the epoch. The image scale is about 1.2 arc seconds per pixel.

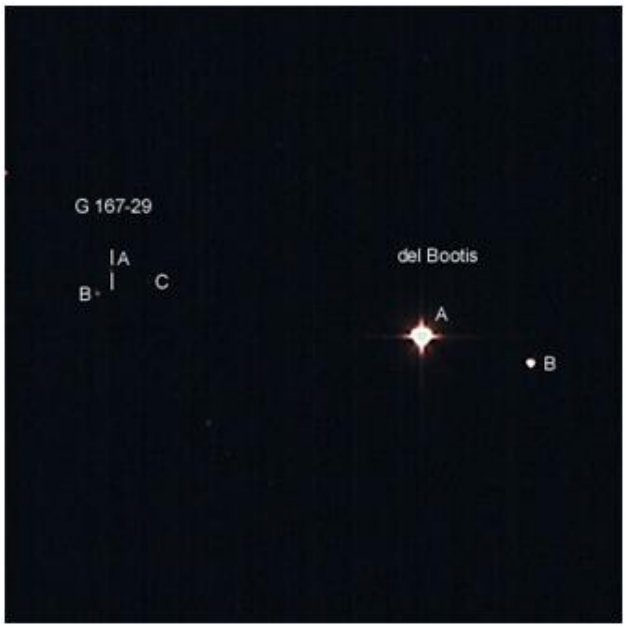

Figure 4: Detail of webcam image, made by the author in 2011 with 8-inch Newtonian telescope

For plotting the relative proper motion, first the position angle of the measurements is procession cor-

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Figure 5: Photo of the Bruce astrograph made by the author in 2009, left astrograph with plate B, right telescope is for tracking control, behind it is the second astrograph with plate A

rected to J2000. The maximum correction is about 0.15 degree. Then, the data are transformed from polar to Cartesian coordinates. A linear fit is calculated with the Gaussian method of least squares. The value of proper motion was calculated from measurements of 1914 (averaged over the values from both images) and 2011.

Table 1 gives the position measurements used in this study for G 167-29 AB, Table 2 gives the position measurements used for the AC components, Table 3 gives the position measurements for the BC components. In all cases the position angle is not precession corrected.

The proper motion values of this study are given by the averaged values of AB and AC (see Figures 6 and 7). The result of recalculation of the proper motion from these data sets is different to the current values in literature (see Table 4). In comparison with the Lowell study the recalculation shows an increased angle but a degreased value for proper motion. Compared with the LSPM values, the value for proper motion is similar but the direction shows a difference of about 10 degree.

Table 1: G167-29 AB (Position angle is not yet precession corrected

Source	PA	SEP	DATE
B3473a 1914-04-29	242.99	24.392	1914.324
B3474b 1914-04-29	245.44	24.596	1914.324
B9000a 1961-02-15	284.88	17.153	1961.126
B9001b 1961-02-15	283.31	17.471	1961.126
POSS2/UKS TU red image	319.34	20.942	1994.337
Author 8-inch Newtonian	330.22	24.834	2011.410

Table 2: G167-29 AC (Position angle is not yet precession corrected

Source	PA	SEP	DATE
B3473a 1914-04-29	131.86	34.267	1914.324
B3474b 1914-04-29	132.62	33.963	1914.324
B9000a 1961-02-15	104.09	30.518	1961.126
B9001b 1961-02-15	104.94	31.017	1961.126
POSS2/UKS TU red image	84.15	32.531	1994.337
Author 8-inch Newtonian	73.53	36.327	2011.410

Table 3: G167-29 BC (Position angle is not yet precession corrected

Source	PA	SEP	DATE
B3473a 1914-04-29	104.48	47.768	1914.324
B3474b 1914-04-29	104.07	49.617	1914.324
B9000a 1961-02-15	104.28	47.703	1961.126
B9001b 1961-02-15	105.77	47.774	1961.126
POSS2/UKS TU red image	105.28	47.695	1994.337
Author 8-inch Newtonian	103.42	calibr. 2011.410	

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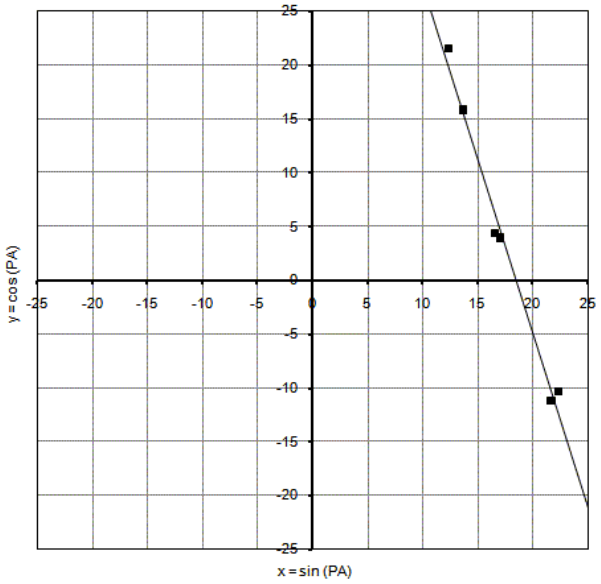

Figure 6: Proper motion of G 167-29 AB.

Polar coordinates for closest approach:
s = 17.7 as; pa= 107.2 degree

Time of closest approach: T0 = 1962.3

Proper Motion:
μx = -0.103 as/yr; μy = -0.332 as/yr; φ = 197.2 degree

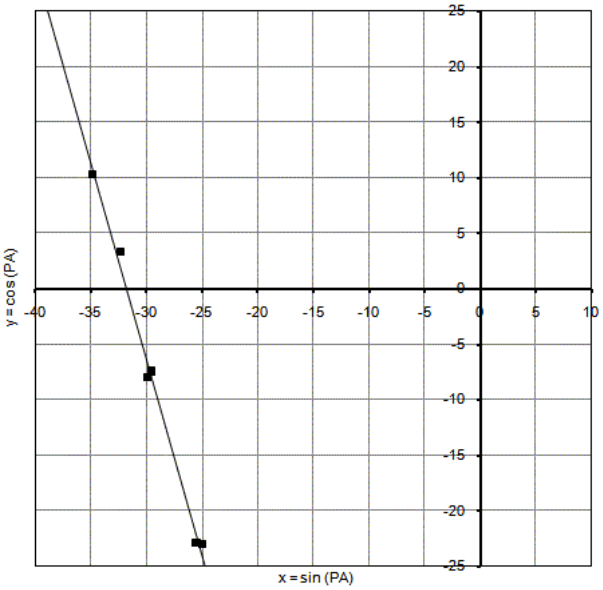

Figure 7: Proper motion of G 167-29 AC.

Polar coordinates for closest approach:
s = 30.6 as; pa= 285.8 degree

Time of closest approach: T0 = 1956.9

Proper motion:
μx = -0.097 as/yr; μy = -0.341 as/yr; φ = 195.9 degree

Table 4: The relative Proper motion of G167-29

Source	date	μx	μy	μ	φ
H.L.Giclas	1964			0.4	193
LPSM catalog	2005	-0.046	-0.356	0.359	187.4
This study	2011	-0.100	-0.337	0.352	196.6

Acknowledgements

This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France

This work made use of the HDAP which was produced at Landessternwarte Heidelberg-Königstuhl under grant No. 00.071.2005 of the Klaus-Tschira-Foundation

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Centre de Données Astronomiques de Strasbourg, SIMBAD Astronomical Database, http://simbad.u-strasbg.fr/simbad/

The POSS2 image was taken from The Digitized Sky, Association of Universities for Research in Astronomy, http://stdatu.stsci.edu/cgi-bin/dss_form

HDAP, Heidelberg Digitized Astronomical Plates, http://dc.zah.uni-heidelberg.de/lswscans/res/positions/q/form