

# The Discovery of an Equal-Mass Twin Binary System by Online Sky Survey Images

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**Abstract:** A previously uncataloged double star (an equal-mass twin binary system) was discovered by the author while searching for planetary nebulae candidates in the online DECaLS images.

## Introduction

While hunting for planetary nebulae in the online DECaLS images, I found an interesting group of three stars that give the appearance of a visual triple star system (Figure 1).

The system is composed of UCAC4 613-046272 ( $G=13.9068$ ), UCAC4 613-046274 ( $G=13.7953$ ) and UCAC4 613-046273 ( $G=13.9697$ ), which I have labeled A, B, and C respectively throughout the rest of this paper.

Gaia DR2 reported the A component to have a proper motion of  $[3.391 -7.965]$  and a parallax of  $5.2283 (\pm 0.0317)$  milli-arcseconds (Gaia 2018b). For the B component Gaia DR2 reported a proper motion of  $[2.327 -7.856]$  and a parallax of  $5.1745 (\pm 0.0315)$  milli-arcseconds (Gaia 2018b). For the C component Gaia DR2 reported a proper motion of  $[-2.062 -2.755]$  and a parallax of  $0.0371 (\pm 0.0322)$  milliarcseconds (Gaia 2018b).

Gaia DR2 measurements were also used to calculate the apparent separation (Sep) and the Position angle (PA). The Gaia DR2 astrometry measurements for these stars are summarized in Table 1.

Interestingly, astrometric data from Gaia DR2 show that A-B and C are not correlated based on their parallax, but that A and B are likely related.

Using the APOP catalog (Qi+, 2015), I was able to deduce B-V color index of these stars. Using the J and K band from the 2MASS catalog (Cutri et al. 2003), I was able to deduce J-K color of these stars. Based on the absolute magnitude of the Gaia G filter (MG), Teff and Lum (Gaia Collaboration, 2018), and their radius

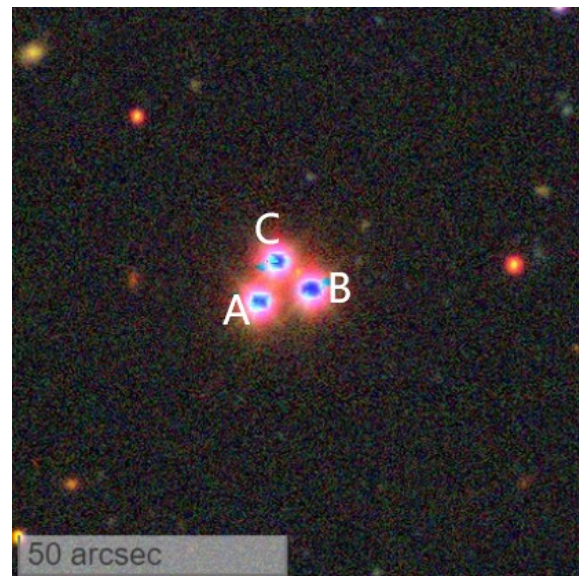


Figure 1. Discovery DECaLS DR5 image extract showing the group of three stars. Their visual appearance in this image is much like that of a triple star system. UCAC4 613-046272 (A), UCAC4 613-046274 (B) and UCAC4 613-046273 (C).

and mass (Stassun, Keivan G., et al. 2019) (see Table 2), A and B should be a pair of K-type dwarf stars, and their spectral type may be K5V.

## Conclusion

According to the parallax data of Gaia DR2, we exclude the correlation between A-B and C. According to Gaia parallax data, A lies at a distance of  $\sim 623$ ly and

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Star	RA+Dec	PM(RA)	PM(Dec)	Parallax	Plx_error	Sep	PA
A	08 51 11.53 +32 35 13.58	3.391	-7.965	5.2283	±0.0317	--	--
B	08 51 10.76 +32 35 15.83	2.327	-7.856	5.1745	±0.0315	9.989"	283.019°
C	08 51 11.26 +32 35 20.96	-2.062	-2.755	0.0371	±0.0.0322	8.131"	335.185°

Table 1. Gaia DR2 Astrometry

Star	B-V	J-K	MG	Teff	Rad	Mass	Lum
A	1.51	0.788	7.5	4211.36	0.695	0.64	0.11
B	1.528	0.779	7.36	4132.63	0.708	0.65	0.13

Table 2. Photometry (APOP, 2MASS, Gaia DR2 and TESS)

B at ~630ly. If the uncertainty of measurement is taken into account, assuming B is at the same distance as A, the physical distance would be ~1900 AU. So they are likely to be physical.

Because A and B have highly similar masses (Stassun, Keivan G., et al. 2019) and luminosity (Gaia Collaboration, 2018), A and B are likely to be an equal-mass twin binary system (Kareem El-Badry, et al. 2019).

### Acknowledgements

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

- DECaLS DR5 images
- GAIA DR2 catalog
- 2MASS Catalog
- TESS Catalog
- Washington Double Star Catalog
- CDS VizieR
- APOP catalog

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