A New Visual Binary System in Auriga

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Abstract: A new visual binary system is reported in Auriga, currently not listed in the WDS catalog. The components have been determined to be a pair of G-type main sequence stars that lie close to a least squares negative exponential curve, which places the pair at a distance of some 300 to 500 ly from Earth.

Introduction

I had first noticed this pair on the moonless night of September 24th 2014 whilst sweeping the star fields surrounding the red-tinted carbon star UU Aurigae. My initial reaction was how aesthetically beautiful this pair had seemed, all so neatly presented in the eyepiece with a small Δm and that the components were not too widely spaced apart. It wasn't until October 21st 2014 that I had determined the system was in fact a true CPM binary. That same night of October 21st, once the clouds had shifted, the skies turned out to be pristinely clear with steady seeing conditions and so I set about finding the pair again in my 120mm refractor. They were easy to spot about 2.9° to the lower left of UU Aurigae, as shown in Figure 1.

I then had the pleasure of making a drawing of the field, and this is shown in Figure 2.

The components of this binary have Tycho 2 designations: TYC 2443-146-1 and TYC 2443-337-1, located in the sky at 2000 ICRS: 06 38 48.17 +35 36 29.6 (J2000.0), and they are of UCAC4 apparent visual magnitudes 10.17 and 11.39, respectively.

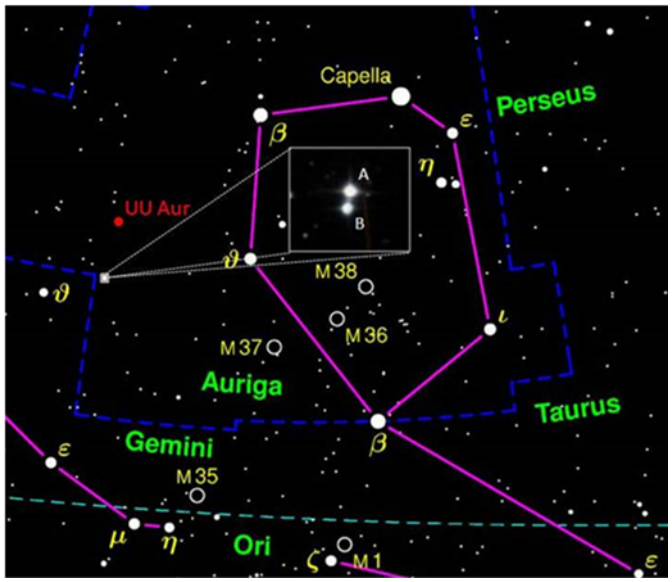

Figure 1: Location of the new binary south of UU Aurigae

Observations and Analysis

The system was later imaged using the 0.61 meter Cassegrain telescope of the Sierra Stars Observatory Network on November 3, 2014, from which the position angle and separation were deduced for epoch 2014.841:

PA: 172.6°
Sep: 15.61″

The UCAC4 catalog [1] revealed the two stars to be sharing virtually identical proper motions, shown in Table 1.

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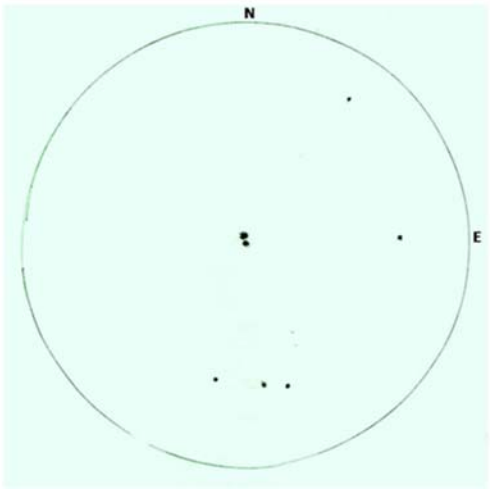

Figure 2: Pencil sketch made with a 120mm (4.75") refractor at a magnification of x159. The FOV is about 10 arcminutes in radius and the faintest stars are of magnitude 12.

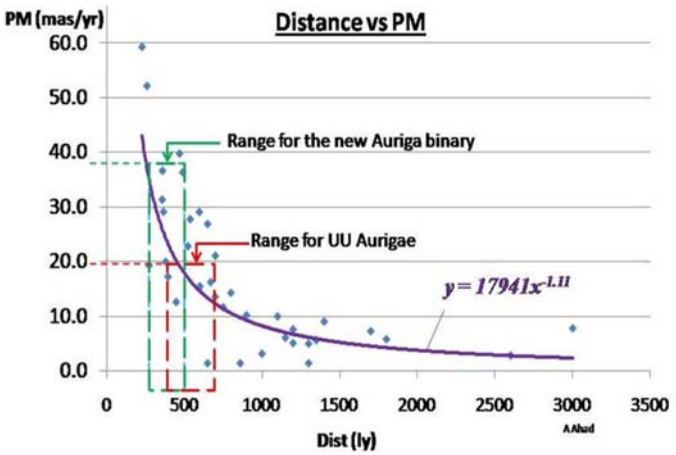

Figure 3: The negative exponential determined by the author to fit a least-squares regression curve, showing statistically significant distance ranges for both the new binary and UU Aurigae.

A total proper motion, $\mu = (\mu_\alpha^2 + \mu_\delta^2)^{1/2} = 37.8$ mas yr^{-1} was computed for the pair. Referring back to my earlier work, the use of the inverse correlation between distance and proper motion which I had first postulated in 2011 (Ahad 2011, Webb Society DSSC 19, page 48, Table 1) to be a predictive tool for gauging astrophysical characteristics of wide double stars, was further expanded over a larger sample of stars and then fine-tuned to both a tabular, as well as a graphical, form. The latter is shown in Figure 3.

Through successive iterations and some trial and error, I derived a least-squares negative exponential to fit the centreline:

$$y = 17941\ x^{-1.11}$$

where x is the distance in light-years and y the total annual proper motion in milliarcseconds. It will be seen from the chart that a total PM of 37.8 mas yr^{-1} places this new Auriga binary at a distance range of some 300 to 500 light-years (90 to 150 parsecs) from Earth. The curve in Figure 3 can, in fact, be used as a general reference tool to ascertain a more statistically rigorous distance estimate for both single and multiple stellar systems in cases where trigonometrical parallaxes have either not been determined at all, or have been poorly determined. Whereas trigonometrical parallaxes can be highly uncertain for stellar systems going into great distances exceeding of the order of 1000 light-years or more, it is the author's personal experience that the proper motion errors can often be much more manageable way beyond such distance thresholds. The carbon star UU Aurigae is a good candidate case to illustrate this point. UU Aurigae is in its own right a 'Washington Double Star' (WDS 06365+3827), though not a binary, attended by a wide unrelated companion of magnitude 11.77. Distance estimates for UU Aurigae A tend to be highly uncertain in the literature. Values typically range from 1600 to 1800 light-years, with a ±800 light-year error margin. The measured parallax of UU Aurigae is 1.80 mas, with a high uncertainty of ±0.81 mas (45% error), whereas the proper motion of this star is stated as 20 mas yr^{-1}, with an uncertainty of ±1.0 mas yr^{-1} (just 5% error). In these circumstances, it would make more sense to use the proper motion to estimate the distance of UU Aurigae rather than its unreliable parallax. Hence, a more reasonable estimate for the distance of UU Aurigae would perhaps be in the 400 to 700 light-year distance range, as shown by the red dotted line in Figure 3.

Table 1: Proper Motion of Components

	μ_α mas yr^{-1}	Error mas yr^{-1}	μ_δ mas yr^{-1}	Error mas yr^{-1}
Primary	+7.7	±1.0	-36.9	±0.9
Companion	+7.8	±0.8	-37.1	±1.1

From the 2MASS catalog [2] we find J and K magnitudes, color indices (J-K), and likely spectral types [3] for the components of this new CPM binary as shown in Table 2.

Fitting the apparent visual magnitudes of the components of 10.17 and 11.39 to average absolute magnitudes for a pair of G1V + G8V stars in the distance modulus equations, we project spectral distances of 405

Table 2: 2MASS photometry, color indices, and spectral types

	J-mag	K-mag	Color Index (J-K)	Spec Type
Primary	9.157	8.836	+0.32	G1V
Companion	10.229	9.859	+0.37	G8V

ly and 428 ly, respectively, for the A and B components of this Auriga binary. These distances are close enough to one another and fit well within the 300 to 500 ly distance range derived earlier from proper motions, hence the whole scenario proves this to be a visual binary system with gravitationally connected components.

References

[1] The Fourth US Naval Observatory CCD Astrograph Catalog (UCAC4), Zacharias, et al., 2012.

[2] The Two Micron All-Sky Catalog of Point Sources, Cutri, et al., 2003.

[3] Ahad, A., "A New Common Proper Motion Double Star in Cetus", *JDSO*, **8**, 332-334, 2012.