Measurements of Binary and Multiple Systems in Open Clusters NGC 2301 and NGC 2422

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Abstract: The angular distances and the angular position of all the stars that are included in these clusters, as they are referred to in the Washington Double Star Catalog, were measured. The telescope used was a Newtonian telescope on a go-to equatorial mount. For the recording of data, the planetary camera QHY 5 and the DSLR camera Canon 30 D were used.

Introduction

I used the useful search engine for double and multiple stars "Stelle Dopie". The basic criteria for finding multiple stars were the last date of their measurement and the apparent magnitude of the stars (not fainter than 14 mag). I selected the open cluster NGC 2301 and NGC 2422, known to all as Messier 47.

The cluster NGC 2301 (Figure 1) is found in the constellation Monoceros at a distance of 2,500 light years from the Earth, belongs to the type I3 m, has an apparent magnitude of 6, and occupies an area of 14 arc minutes. It has 20 measurable members, consisting of the stars: HJ 740, ABH 53, BAL 1046, and BAL 1049.

The cluster NGC 2422 (Figure 2) is located in Puppis at a distance of 1,600 light years from the Earth, belongs to the type I3 m, has an apparent magnitude of 5.2, and occupies 30 arc minutes. It has 26 measurable members and consist of the stars: STF 1121, SLE 769, JRN 39, SLV 4, and S 555.

For recognizing the members of the open clusters the open source software Cartes du Ciel was used. The observation began in the autumn of 2014 and was completed in the spring of 2015 on the island of Corfu, Greece.

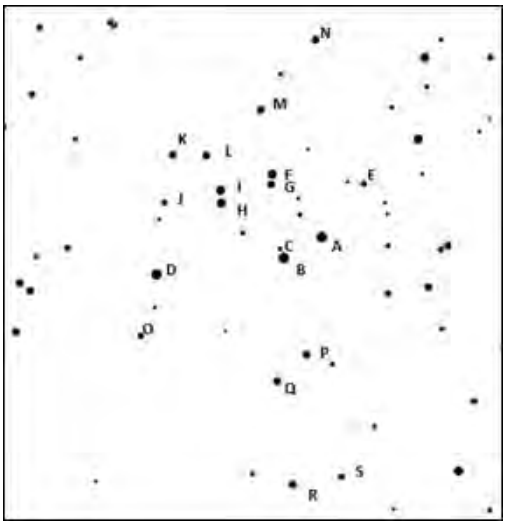

Figure 1. The components of NGC 2301.

Equipment

For the measurements, I used a planetary camera QHY 5 and the DSLR camera Canon 30 D, a Newtonian telescope Skywatcher 150/750 PDS and Celestron go to equatorial mount CG5, shown in Figure 3. The final data were determined by taking the average of the 3 measurements from both recording media. Data analysis was done with REDUC software.

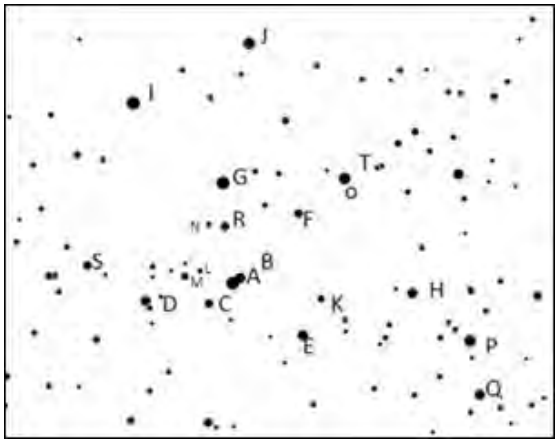

Figure 2. The components of NGC 2422.

Figure 3. The Equipment

Methodology

The measurements began the autumn of 2014 because during that time these star clusters went up above 30 degrees. Recordings were made mostly with the planetary camera QHY 5 which gives FOV 30.51'X 24.41' with resolution of 1.43''/pixel, and also with the DSLR with barlow, which gives FOV 51.56' X 34.37', with resolution of 0.88''/pixel . Exposure time with DSLR was 30 sec with ISO 800. Finally, dark frames were taken, which were stacked with the software Deep Sky Stacker to eliminate the thermal noise. Recording with QHY 5 included video format AVI, 6'' second duration, which were separated in 15 bmp frames with REDUC. The best frames were selected and used for measuring with REDUC.

Results

Results of the measurements of NGC 2301 are given in Table 1 and of NGC 2422 in Table 2. The component N wasn't measured, because it was too dim and beyond the capabilities of the telescope.

From these measurements I identified two possible errors in open cluster NGC 2422. The first error concerns the last value of the angular position of the component G in relation to the A. The variation observed in the values of the past with the current measurement. The first value for position angle and angular distance was θ = 0.80 - 1.2 degrees and ρ = 84 - 86 arcsec, the measurements of the period 1998 - 2002 was θ = 4 - 6 degrees and ρ = 80 - 82 arcsec. My measurements give θ= 2.76 and ρ = 84 arcsec. I consider that some observers may be confusing the component B with the reference star of cluster A, because they are located very close and have a minor difference in luminosity.

Another possible error in NGC 2422 was found when I tried to identify the stars of this cluster. The component O is probably the same star as the component T, because in this area two stars with the same values of magnitude don't exist. Specifically, the JRN 39 GO measurement shows that in this position angle only one star exists as bright as the component O which is mag 9.03. However, the measurement of position angle of SLE 796 AT shows that in the same area there is also another star of mag 12.01, something that is not true. Also all the neighboring stars are much fainter than mag 12.01 mag .

Acknowledgments

I wish to thank Florent Losse for his excellent software Reduc. I would like to thank the members of the Astronomical Society of Corfu for the use of the DSLR camera. I would also like to thank Gianluca Sordiglioni for providing a useful tool with lots of information about binaries on his website: http://stelledoppie.goaction.it

References

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Tanguay, Ronald, 1998, *The Double Star Observer's Handbook,* Saugus, MA: Double Star Observer.

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Table 1. Measurements of Open Cluster NGC 2301

STAR	COMP	R.A + DEC	MAG1	MAG2	P.A	SEP	DATE	STAGE	N
HJ 740	AB	06518+0028	8.16	9.18	9.15	21.20	2015.066	15	3
ABH 53	AD	06518+0028	8.16	9.07	353.30	82.15	2015.066	15	3
ABH 53	AE	06518+0028	8.16	12.94	212.97	33.09	2015.066	15	3
ABH 53	AF	06518+0028	8.16	10.84	290.00	38.72	2015.066	15	3
ABH 53	AG	06518+0028	8.16	12.91	292.70	36.23	2015.066	15	3
ABH 53	AH	06518+0028	8.16	10	321.80	51.92	2015.066	15	3
ABH 53	AI	06518+0028	8.16	12.49	316.61	53.92	2015.066	15	3
ABH 53	AJ	06518+0028	8.16	12.75	327.56	78.31	2015.066	15	3
ABH 53	AK	06518+0028	8.16	12.48	311.74	82.53	2015.066	15	3
ABH 53	AL	06518+0028	8.16	12.62	305.44	68.21	2015.066	15	3
ABH 53	AM	06518+0028	8.16	12.34	276.67	68.38	2015.066	15	3
ABH 53	AN	06518+0028	8.16	11.13	253.36	95.23	2015.066	15	3
ABH 53	A0	06518+0028	8.16	13.62	8.96	98.89	2015.066	15	3
ABH 53	AP	06518+0028	8.16	12.29	63.73	56.55	2015.066	15	3
ABH 53	AR	06518+0028	8.16	12.14	64.40	118.60	2015.066	15	3
ABH 53	AS	06518+0028	8.16	12.14	75.76	114.95	2015.066	15	3
ABH 53	AQ	06518+0028	8.16	12.67	53.56	72.39	2015.066	15	3
HJ 740	BC	06518+0028	9.13	11.80	285.99	9.07	2015.066	15	3
BAL1049	PQ	06518+0028	12.29	12.67	22.26	19.23	2015.066	15	3
BAL1049	FG	06518+0028	10.84	12.91	68.02	3.37	2015.066	15	3

Table 2. Measurements of Open Cluster NGC 2422

STAR	COMP	R.A + DEC	MAG1	MAG2	P.A	SEP	DATE	STAGE	N
STF1121	AB	07366-1429	6.92	7.30	306.14	7.334	2015.066	15	2
STF1121	AC	07366-1429	6.92	13.00	133.43	17.908	2015.066	15	2
STF1121	AD	07366-1429	6.92	9.55	100.19	64.430	2015.066	15	2
STF1121	AE	07366-1429	6.92	9.88	240.20	72.257	2015.066	15	2
STF1121	AF	07366-1429	6.92	11.34	316.81	83.547	2015.066	15	2
STF1121	AG	07366-1429	6.92	7.66	2.76	84.014	2015.066	15	2
STF1121	AH	07366-1429	6.92	9.44	269.94	149.534	2015.066	15	2
STF1121	AI	07366-1429	6.92	6.67	27.87	164.732	2015.066	15	2
STF1121	AJ	07366-1429	6.92	8.58	355.78	195.751	2015.066	15	2
STF1121	BE	07366-1429	7.30	9.88	234.00	69.434	2015.066	15	2
SLE 796	AR	07366-1429	6.92	12.19	1.61	49.089	2015.066	15	2
SLE 796	AS	07366-1429	6.92	11.73	81.88	113.035	2015.066	15	2
SLE 796	AT	07366-1429	6.92	12.01	313.98	130.117	2015.066	15	2
SLV 4	DE	07366-1429	9.55	9.88	258.85	128.368	2015.066	15	2
SLV 4	DH	07366-1429	9.55	9.44	272.19	213.467	2015.066	15	2
SLV 4	EH	07366-1429	9.88	9.44	291.81	94.219	2015.066	15	2
SLV 4	FC	07366-1429	11.34	13.00	135.63	101.209	2015.066	15	2
SLV 4	GJ	07366-1429	7.66	8.58	349.93	112.862	2015.066	15	2
JRN 39	CK	07366-1429	13.00	13.65	272.70	89.600	2015.066	15	2
JRN 39	CL	07366-1429	13.00	14.56	15.13	26.17	2015.066	15	2
JRN 39	CM	07366-1429	13.00	12.64	42.70	28.700	2015.066	15	2
JRN 39	GO	07366-1429	7.66	9.03	273.11	97.479	2015.066	15	2
JRN 39	HP	07366-1429	9.44	8.68	231.10	59.331	2015.066	15	2
JRN 39	HQ	07366-1429	9.44	10.49	214.29	97.391	2015.066	15	2
S 555	GI	07366-1429	7.66	6.67	49.29	95.686	2015.066	15	2