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THE SYSTEM OF EPSILON HYDRÆ

It has been known almost from the time of its discovery by Schiaparelli in 1888 that the close double star called AB of ϵ Hydræ is a binary system in rapid motion. Measures made by Burnham with the 36-inch telescope in the years 1888 to 1892 showed an increase in angle of 40° in the four years. Later observations at Greenwich, Pulkowa, Madison, and, since 1898, at the Lick Observatory, gave evidence that the rate of motion was increasing, the angular change in the twelve years from discovery to 1900 amounting to 150° . But this arc was not sufficient to warrant any conclusions as to the form of the orbit, or even as to the approximate period of revolution.

In 1901 I examined this star with the 36-inch on several nights, but could see no measurable elongation. But on November 15, 1902, I found no difficulty in measuring the pair. The disks of the two components were distinctly separated, and one was sensibly smaller than the other, so that there was no doubt about the quadrant. The smaller star was in the second quadrant, as it had been at the time of discovery in 1888, and had described an arc of 200° in the three years since my measures in 1900. This result was confirmed by two measures secured in February and March of this year.

The mean of Schiaparelli's measures in 1888, as given by Burnham,* is:

1888.28	142°0	0'21	6n
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and my recent observations are:

1901.299	Single.	Seeing 4.
1901.781	No measurable elongation.	Seeing 3.
1902.873	126°6	0'17
1903.139	132.8	0.21
.177	136.9	0.18
1903.06	132°1	0'19

Plotting these measures and those made in the

intervening years, I found it possible to represent them satisfactorily by an ellipse, from which, by graphical methods, I derived the following set of elements:

$T = 1901.1$	$\Omega = 109^\circ 5$
$P = 15.7$ years	$i = 35.5$
$e = 0.685$	$\lambda = 264.7$
$a = 0''.24$	$n = +22.293$

These results are considered as approximate only. When further observations have been secured, some of the elements will probably require considerable correction; but, as will be seen from the table below, the observations so far published, except those made at Greenwich in 1901, are represented satisfactorily. The two components of the system differ fully two magnitudes in brightness, and their maximum apparent separation is only $0''.25$. It is therefore a difficult pair to measure, even with the most powerful telescopes.

There is a third star about $3''$ distant with which the close pair forms the double star Σ 1273. The angular motion of C about the bright star has amounted to about 38° since 1830, without material change in the distance. It is thus evident that we have here a ternary system.

Still further interest attaches to this star from the fact that observations with the Mills Spectrograph show that its velocity in the line of sight is variable.*

Up to the present time seven spectrograms of the star have been taken. The plates have been measured by Dr. H. D. Curtis, with the following results:

	G.M.T.	Velocity.	Notes.
1899	November 28.02	+45.2	
	December 26.86	+45.0	
1900	December 4.96	+36.0	Rather poor plate.
	December 24.96	+36.8	" " "
1901	April 23.68	+31.1	
	November 7.06	+29.1	
1903	March 9.80	+33.4	

* Publications of the Lick Observatory, Vol. II, p. 68.

* See L. O. Bulletin No. 4, and Publ. A.S.P., Vol. XIII, p. 164.

At the first two dates the stars were approaching the line of nodes and were about 12° distant from it. By November, 1901, the system had described an arc of more than 180° and the stars were about 5° from the line of nodes. The plates taken at these epochs give, respectively, the maximum and minimum velocity of recession of the brighter star, strongly suggesting that the visual and spectroscopic binary systems are identical. If this is correct, spectrographic observations should show a slow increase in the velocity of recession for the next year or two and then a nearly uniform velocity until about the year 1912.

The following table contains all the published micrometric observations of this pair, and also the unpublished measures by Schiaparelli and Comstock, which have been communicated to me by letter. In

deriving the elements, since graphical methods were employed, only the complete observations were used. The measures secured by H. Struve and Comstock, both of whom recorded only estimated distances, and now the fine series by Schiaparelli, may therefore be used as a check upon the accuracy of the orbit. It should be said that Schiaparelli fears his measures for the last three or four years are not deserving of much confidence, as they were obtained under very unfavorable circumstances. As for the Greenwich measures in 1901, it is to be said that on any assumption that will satisfy the other measures, the distance between the two components at that time must have been less than $0''.10$. It therefore seems very possible that the elongation measured at Greenwich may have been simply optical.

Date.	θ_0	θ_c	ρ_0	ρ_c	$\Delta\theta$ (O-C)		$\Delta\rho$ (O-C)	Observer.	n
					Angle.	Arc.			
1888.29	141.7	145.7	0.22	0.23	— 4.0	— 0.016	— 0.01	Schiaparelli	7
88.98	154.4	153.3	0.26	0.24	+ 1.4	+ 0.007	+ 0.02	Burnham	2
89.27	152.8	155.4	0.24	0.24	— 2.6	— 0.011	± 0.00	Schiaparelli	12
89.31	149.6	155.7	(0.4 $\pm$)	0.24	— 6.1	— 0.026	(+ 0.16 $\pm$)	H. Struve	4,1
90.30	165.7	165.0	0.23	0.24	+ 0.7	+ 0.003	— 0.01	Schiaparelli	5
90.34	159.8	165.4	(0.35 $\pm$)	0.24	— 5.6	— 0.023	(+ 0.11 $\pm$)	H. Struve	2,1
90.92	170.0	170.8	0.19	0.24	— 0.8	— 0.003	— 0.05	Burnham	2
91.27	171.5	173.8	(0.4 $\pm$)	0.24	— 2.3	— 0.010	(+ 0.16 $\pm$)	H. Struve	3,1
91.32	173.3	174.3	0.22	0.24	— 1.0	— 0.004	— 0.02	Schiaparelli	5
92.18	179.6	182.3	0.21	0.24	— 2.7	— 0.011	— 0.03	Burnham	2
92.27	179.4	183.3	0.20	0.24	— 3.9	— 0.016	— 0.04	Schiaparelli	9
93.26	191.4	192.6	0.20	0.23	— 1.2	— 0.005	— 0.03	"	9
94.18	205.4	200.2	(0.45 $\pm$)	0.23	+ 3.2	+ 0.013	(+ 0.22 $\pm$)	H. Struve	3,2
94.27	201.2	201.1	0.24	0.23	+ 0.1	+ 0.001	+ 0.01	Schiaparelli	11
94.28	192.8	201.2	0.20	0.23	— 8.4	— 0.034	— 0.03	Comstock	3
95.26	207.6	213.0	0.20	0.23	— 5.4	— 0.022	— 0.03	Schiaparelli	10
95.30	210.5	213.4	(0.35 $\pm$)	0.23	— 2.9	— 0.012	(+ 0.12 $\pm$)	H. Struve	4,3
95.32	217.5	213.6	0.18	0.23	+ 3.9	+ 0.016	— 0.05	Comstock	2
96.21	212.0	223.3	0.22	0.22	— 11.3	— 0.043	± 0.00	Lewis	3
96.24	204.1	223.7	.....	0.22	— 19.6	— 0.075	.....	Dyson	1
96.26	226.0	223.9	0.15	0.22	+ 2.1	+ 0.008	— 0.07	Comstock	1
96.29	220.3	224.2	0.24	0.22	— 3.9	— 0.015	— 0.02	Schiaparelli	4
97.27	224.8	235.4	0.19	0.21	— 10.6	— 0.039	— 0.02	"	7
98.14	250.7	246.5	0.18	0.20	+ 4.2	+ 0.015	— 0.02	Aitken	1
98.28	259.7	248.4	0.20	0.20	+ 11.3	+ 0.039	± 0.00	Schiaparelli	5,2
99.15	261.3	261.3	0.22	0.18	± 0.0	± 0.000	+ 0.04	Aitken	3
99.23	263.5	262.6	0.21	0.18	+ 0.9	+ 0.003	+ 0.03	Lewis	4
99.28	257.8	263.5	0.20	0.18	— 5.7	— 0.018	+ 0.02	Comstock	2
1899.92	274.8	276.2	0.18	0.15	— 1.4	— 0.004	+ 0.03	Aitken	1
1900.18	293.4	283.1	0.13	0.13	+ 10.3	+ 0.023	± 0.00	"	3
00.24	267.2	284.9	0.20	0.13	— 17.7	— 0.040	+ 0.07	Lewis	1
01.28	(280.6)	55.8	(0.11)	0.05	.....	.....	.....	"	2
01.30	single	58.6	single	0.05	.....	.....	.....	Aitken	1
01.31	(272.3)	60.0	(0.18)	0.06	.....	.....	.....	Bryant	3
01.32	no elongation	.....	.....	.....	.....	.....	.....	Comstock	1
01.78	elongation uncertain	.....	.....	.....	.....	.....	.....	Aitken	1
02.30	not sure of elongation	.....	.....	.....	.....	.....	.....	Comstock	1
03.06	132.1	129.9	0.19	0.20	+ 2.2	+ 0.008	— 0.01	Aitken	3
1903.25	137.2	132.3	0.25	0.20	+ 4.9	+ 0.017	+ 0.05	Comstock	3

April, 1903.

R. G. AITKEN.