^{a} Centauri

Projection of its Orbit from its Apparent Curve

by

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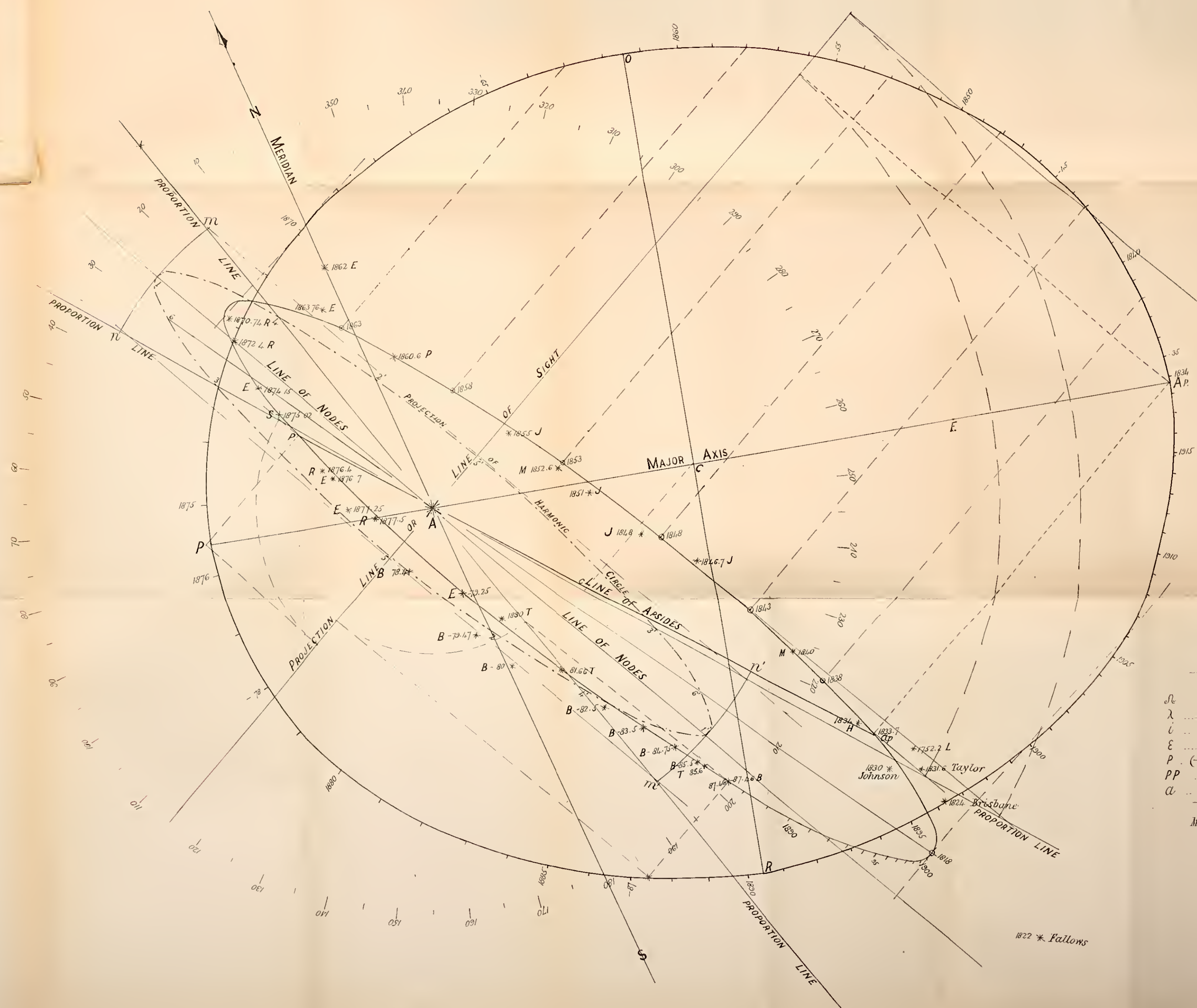
1887.

— Scale – One Second = 0·4 Inch —



— Symbols —

L	Lacaille
H	Herschell
M	Maclear
J	Jacobs
P	Powell
E	Ellery
S	Seliger
T	Tebbutt
B	Biggs

✳ Observed positions.
⊙ Calculated do

— Elements —

☊	25°
λ	50°
i	79°
ε	·513
P (–precession)	83·7 yrs.
PP	1875·6
a	18"·6

Max^{m} Elong^{n} 23"·25
t. 1818

α. CENTAURI, WITH A GRAPHIC PROJECTION OF ITS ORBIT FROM ITS APPARENT CURVE.

By A. B. Biggs.

Several circumstances invest the star Alpha Centauri, one of the brightest in our southern sky, with special interest. It was one of the earliest whose annual parallax (from which is deduced its distance) was approximately ascertained. It is, so far as at present known, by much the nearest of the fixed stars to our system. It is perhaps the most magnificent of double stars. And (what invests it with special interest to us) it is, from its great southern declination, invisible to the Observatories of the Northern Hemisphere. Science is therefore dependent entirely upon southern observations for all that can be known of the relative movements of its components. Its distance from the solar system is about 225,000 times that of the earth from the sun.

Various attempts have been made from time to time to determine its orbit and period, the latter varying from 75 years by Powell in 1854, to $88\frac{1}{2}$ years by Dr. Doberck in 1879. My own observations of the star extend from about the latter date to the present time. In venturing to attack the problem, I have therefore the advantage of combining my own more recent measures with the anterior ones of other observers.

A brief description of my method will furnish some criterion of the value of the result. I first drew up a table of every observation I could find recorded (including those in Crossley G. and W's work on double stars). These I laid off in a curve, on plotting paper (ruled decimally in millimetre squares) taking dates and position-angles for ordinates an co-ordinates. The distance measures were treated in the same way. After smoothing each curve into reasonable symmetry, I drew up a table for every 5th degree of position-angle, with date, as ascertained from the curve. The next process was to draw a circle, with radii to every 5th degree, the centre being the locus of the principal star A. On these radii I laid off by dots the distance answering thereto by date, of the star B. A figure was thus obtained approximating to that of a long ellipse, answering to the apparent curve of the star B round its primary. But it was *not* a true illipse, and it ought to have been. I wasted much time in trying to construct an ellipse that should fairly represent a mean of all the different positions, the early measures constituting the difficulty ; and at length came to the conclusion that I could only succeed by discarding them altogether. A glance at the diagram will show that those of 1822-24-30 and 31 are mutually inconsistent, and widely out of any rational curve, especially that by Fallows, in 1822, showing an elongation of 28″·75. The positions about the apparent periastron, 1876 to 1879, also are rather wide of the curve, but that is not to be wondered at, considering the difficulty of measurement of so small an interval (less than two seconds of arc), answering to one inch at nearly one and three-quarter miles. At that time, except to high telescopic power and fine definition, the pair appeared as a single star.

The apparent curve of course represents the real orbit *in perspective.* We have then to determine how much it is tilted, and in what direction? These questions are determined by the projection of the harmonic circles, in which the radii 1, 1′, 2, 2′, 3, 3′, etc., are in harmonic proportion to the corresponding radii of the apparent elliptic path of the star.

The projection of this circle being itself an ellipse, the direction of its major axis gives the line of nodes (the intersection of the plane of vision with that of the orbit), and the foreshortening is in the direction of its minor axis, and is in the proportion of its major and minor axes; that is as mm′, is to mn′. The lines nn′ and mm′ serve as proportion lines, on which are marked off the spaces above or below the line of nodes, which are set up at right angles to the nodal line. Setting off the points P′ A C′ and ap. in this way, we get P A C and Ap., the major axis of the real orbit, of which A C is the eccentricity, from which the length of the minor axis O R is deduced. A few more points sets off similarly from various parts of the curve should lie on the circumference of an ellipse, having P Ap. and O R for its major and minor axes. This came out fairly well.

I have laid off, about the apparent curve, a very few of the actual observations from which the curve was obtained, with dates, and the symbols of the observers My own observations extend from about 1878 to the present time. The earlier measures were made with a fine photographic reticle scale, in squares of 1-200th inch linear. The result proves such an instrument quite inadequate for such delicate measurements, the measures being manifestly wild. The later ones, from 1882·5 were taken with a new micrometer of my own, designed specially for such work. A description of this apparatus may serve for a future paper if acceptable. The measures by this instrument were very closely consistent, both with themselves and with the curve. The measures embrace an enormous number of observations, of which I have taken the means in convenient groups, with the means of the dates.

I estimated the period separately both from the apparent curve and the real orbit. First, from the apparent curve, I start from its greatest elongation, the date of which I make to be 1818. Kepler's 2nd law of planetary motion is:—that "the Radius Vector describes equal spaces in equal times," and this applies equally to the real and the apparent curve. The whole area of the apparent curve is 165·75 square seconds. Taking the maximum elongation in 1818 as a starting point, we have the sector between that and my last position (1887·46) to be described, in order to complete a revolution. The sector measures 29·9 square seconds. Deducting this from the whole ellipse, we have 135.8 square seconds traversed in 69·46 years. The proportion will give 15·3 years to complete the curve, making the whole period 69·46 + 15·3 = 84·76 years.

In the same way, from the real orbit, I deduce a period of 84·85 years.

I have not, so far, complicated the problem by allowing for *precession*, by which the meridian (the standard of reference) has a minute progressive shifting of its position. I reckon this would make a difference of about a year, shortening the period.

An analysis of the diagram yields the following results:—

Apparent Curve.

Position of Node	25°	
„ „ Apsides...	75°—255°	
Apse from Node	50°	
Semi axis major of apparent ellipse ...	17″	
„ „ minor „ „ ...	3″·1	
Maximum elongation	23″·25	*t.* 1818
Apparent periastron passage...	1″·7	*t.* 1878·2
Period	84·76 years.	

Real Orbit.

		Dr. Doberck's Elements, 1879.
Node (position)	25° ...	... ... 25·14
Apsides „ ...	...75°-255°	
Apse from Node	50° ...	... ... 45°·58
Semi axis major	18″·6 ...	... ... 18″·45
Eccentricity	·543 ...	... ... ·5332
Inclination of plane of Orbit from line of sight (= angle V A X)	79° ...	... ... 79°·24
Periastron passage... ...	1875·6 ...	... ... 1875·12
Period (diminished by precession)	83·7 ...	... ... 88·556 years.

(I have appended Dr. Doberck's elements for comparison.)

My measures (discarding the earlier ones), are as follows:—

Date.	*Position Angle.*	*Distance.*
1882·5	195°·7	10″·15
83·5	198 ·3	11 .63
85·47	200 ·15	14
86·8	201 ·1	14 ·83
87·46	201 ·72	15 ·2

I venture the following Ephemeris up to 1901 :—

Date.	*Position Angle.*	*Distance.*
1888	202°·2	15″·9
89	202 ·9	17
90	203 ·6	18
91	204 ·3	18 ·9
92	205	19 ·7
93	205 ·6	20 ·4
94	206 ·2	21
95	206 ·7	21 ·5
96	207 ·2	21 ·9
97	207 ·8	22 ·3
98	208 ·3	22 ·6
99	208 ·8	22 ·8
1900	209 ·3	23
01·7	210	23 ·25 Maximum elongation

The actual mean angular distance of A..B (=the semi-axis-major of the real orbit), is 18″·6. The accepted parallax of this star is 0·928″. The actual mean distance of the companion from its primary in terms of the earth's mean distance from the sun will be 18″·6 ÷ 0″·928 = 20·043,—a distance slightly greater than that of Uranus from the Sun, with a period almost identical. If B revolved round our Sun at the above distance, its period would be 89·732 of our years. Its actual period being only about 84 years it is evident that the gravitational force of A (and therefore its mass) is greater than that of our sun. How much? The calculation is:—89·732 years squared ÷ 83·7 years squared = 1·1493. That is, its mass is greater than that of our Sun in the proportion of 1 to $1\frac{1}{7}$ nearly. We cannot thus estimate the mass of the smaller star B, there being no visible object revolving round it.