President.—Would any member like to make any remarks on Mr. Raman's paper ?

President.—The next item is a paper by Revd. Mr. Ridsdale on "Some mathematical calculations of the dimensions, weight, etc., of the Earth, Moon and Sun," which Mr. Ridsdale has asked me to read for him in his absence. This is only the first part of the paper. (*Paper.*)

At another meeting Mr. Ridsdale will give us the second part of his paper and will explain the application of the formulæ that he has given you this evening.

There was no discussion on this paper.

An approximate method of computing precession in certain cases.

By A. B. Chatwood, B.Sc., F.R.A.S., A.M.I.C.E.

The present paper suggests that when rectangular co-ordinates are used instead of right ascension and declination, the computation of precession can in many cases be much simplified. The method suggested can only be used within certain limits which depend on the declination, on the interval between the two epochs, on the area considered, and on the accuracy required.

If we assume that the rate of change of precession is, within the limited area, under consideration—taken in this paper as a square of 130′ × 130′, corresponding to the plates of the astrographic catalogue—a linear function of the coordinates, we may then write as the annual precession in R.A. for any star.

$$Px + n\ (\propto \cos A \tan D + \delta \sin A \sec^2 D).$$

Where Px is the precession of the plate centre

A.D the R.A and decl. of the plate centre

$\propto \delta$ the angular distances in R.A, and decl. of any star from the plate centre expressed in circular measure.

Since $\propto \delta$ can be expressed in rectangular coordinates of x y, with the plate centre as origin and A.D are constant

for any one plate, this at once leads to a correction for the precession.

$$Qx + Ry.$$

Where $Q = \frac{1}{300} T\, n\, \mu \cos A \tan D.$

$$R = \frac{1}{300} T\, n\, \mu \sin A \sec^2 D.$$

Where T is the number of years from one epoch to the other.

n the precession constant.

μ the circular measure of the unit in which x and y are measured; in the present paper 5′ of arc or ·00145444 is used.

The factors cos A tan D; sin A sec² D being computed for each plate centre.

We might write for the precession in R.A of any star using the same notation.

$$T\,[m + n \sin (A - \alpha) \tan (D + \delta)].$$

The method of computation above suggested is equivalent to neglecting the second and higher order terms in the expansion of this expression which is only permissible of T.D, α δ do not exceed certain values depending on the accuracy required. These limiting values might be determined by the evaluation of the remainder of the series after the terms of the first order; but such evaluation cannot be carried out simply.

In Table I I give the computation of $[n \sin (A + \alpha) \tan (D + \delta)] - [n \sin A \tan D + Q x + Ry]$ for the limiting values $\pm$ 65′ of α and δ.

It may be pointed out that the error thus computed which must be multiplied by the number of years between the epochs is the maximum error which can occur. The computation is in practice carried out as follows :—

If A′ and D′ be the coordinates of the plate centre at the epoch desired

A.D the corresponding coordinates at the epoch of the catalogue.

A and D are computed in the usual way from $m + n \sin A'$ tan D′ and $n \cos A'$.

The values of x and y, the centre A.D being taken as origin, are taken from the catalogue and the factors Q.R applied. The resulting x′, y′ are then corrected for the projection in the usual manner.

Table II gives a number of examples and shows the errors [illegible] by the use of the method in working from an 1855

catalogue to the epoch 1900, the errors being given in units of 0″·03 of arc.

Similarly the precession in decl. is given by

$$S\,x$$

Where $S = -T\,n\,\mu \sin A$.

In Table II x″ has been computed by bringing up the stars to the epoch 1900 in the usual way and subsequently correcting to rectangular coordinates.

In the computation of x′ y′ Crelle's 3-figure multiplication tables have been used.

In conclusion I wish to express my thanks to my assistant, Mr. T. P. Bhaskara Sastri, B.A., who has assisted me in the preparation of the paper and has computed the tables.

Table I.

$$[\mu \sin (A+\alpha) \tan (D+\delta)] - [\mu \sin A \tan D + Qx + Ry]$$

Declination.

Right Ascension hours.	0°	15°	30°	45°	60°	75°
0	0·239	0·257	0·322	0·487	0·987	3 836
½	0·237	0·260	0·333	0·529	1·175	5·612
1	0·231	0·258	0·340	0·565	1·342	7·294
1½	0·220	0·251	0·342	0·589	1·487	8·854
2	0·206	0·241	0·337	0·604	1·605	10·250
2½	0·189	0·226	0·326	0·610	1·697	11·477
3	0·169	0·207	0·310	0·603	1·759	12·516
3½	0·145	0·186	0·288	0·603	1·792	13·345
4	0·118	0·160	0·261	0·559	1·801	13·935
4½	0·091	0·132	0·231	0·524	1·774	14·279
5	0·062	0·102	0·195	0·480	1·700	14·381
5½	0·030	0·069	0·157	0·426	1·619	14·243
6	0·001	0·035	0·117	0·367	1·503	13·870

Table II.

H. M. S.

Plate Centre. Epoch 1900 R.A. 0 0 0 Decl.—18°
Epoch 1855 ,, 23 57 41·65 ,, —18° 15′ 2″·4
Factors. Q—·00144 R + ·000039 S—·000035

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—12·7575	—12·7390	—12·7390	0	+ 2·4520	+ 2·4524	+ 2·4527	+3
— 4·9075	— 4·9001	— 4·9000	+1	+ 8·8520	+ 8·8522	+ 8·8520	—2
— 0·5325	— 0·5316	— 0·5315	+1	+ 8·8320	+ 8·8320	+ 8·8320	0
+10·2825	+10·2677	+10·2680	+3	+ 0·1320	+ 0·1316	+ 0·1320	+4
— 8·6925	— 8·6796	— 8·6790	+6	+ 9·4520	+ 9·4523	+ 9·4523	0
+ 4·4825	+ 4·4765	+ 4·4760	—5	+11·6520	+11·6518	+11·6520	+2

H. M. S.

Plate Centre. Epoch 1900 R.A. 3 4 0 Decl.—18°
,, 1855 ,, 3 1 55·82 ,, —18° 10′ 29″·8
Factors. Q—·00098 R—·00348 S+·00315

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—11·3160	—11·3030	—11·3025	+5	— 0·5593	— 0·5949	— 0·5947	+2
— 5·9310	— 5·9194	— 5·9195	—1	— 1·6593	— 1·6780	— 1·6778	+2
—10·7910	—10·8121	—10·8115	+6	+ 9·1207	+ 9·0867	+ 9·0870	+3
— 3·0160	— 3·0394	— 3·0390	+4	+ 7·5807	+ 7·5712	+ 7·5713	+1
+ 9·4840	+ 9·4709	+ 9·4705	—4	+ 1·1007	+ 1·1306	+ 1·1307	+1
+12·3240	+12·2875	+12·2870	—5	+ 7·0007	+ 7·0394	+ 7·0397	+3
—11·7710	—11·8008	—11·8000	+8	+11·9007	+11·8635	+11·8640	+5
+ 3·2590	+ 3·2210	+ 3·2205	—5	+10·0207	+10·0310	+10·0307	—3
+ 9·8490	+ 9·8010	+ 9·8005	—5	+11·0407	+11·0717	+11·0717	0

Plate centre. Epoch 1900 R.A. 6 0 0 Decl.—18°
,, 1855 ,, 5 58 01·3 ,, —18° 00′ 03·9″
Factors Q 0000. R—·00484 S+·00437.

Right Ascension.				*Declination.*			
x	x′	x″	Error. ·0001	y	y′	y″	Error. .0001
—10·7250	—10·7654	—10·7650	+4	+ 8·3470	+ 8·3002	+ 8·3000	—2
— 9·6050	— 9·6131	— 9·6125	+6	+ 1·6670	+ 1·6250	+ 1·6250	0
— 7·9600	— 7·9637	— 7·9630	+7	+ 0·7670	+ 0·7322	+ 0·7323	+1
— 5·8800	— 5·9131	— 5·9125	+6	+ 6·8270	+ 6·8013	+ 6·8013	0
+ 0·0450	— 0·0126	— 0·0125	+1	+11·9270	+11·9272	+11·9270	—2
+ 1·3200	+ 1·3157	+ 1·3160	+3	+ 0·8870	+ 0·8928	+ 0·8927	—1
+ 5·3650	+ 5·3625	+ 5·3625	0	+ 0·5270	+ 0·5504	+ 0·5503	—1
+ 9·6350	+ 9·6052	+ 9·6055	+3	+ 6·1470	+ 6·1891	+ 6·1890	—1
— 2·9300	— 2·9881	— 2·9880	+1	+12·0070	+11·9942	+11·9940	—2
+ 3·1200	+ 3·0600	+ 3·0600	0	+12·4070	+12·4206	+12·4207	+1

Plate centre. Epoch 1900 R.A. 9 4 0 Decl.—18°
,, 1855 ,, 9 1 55·32 ,, —17° 49′ 13·7″
Factots Q+·00102 R—·00336 S+·00304

Right Ascension.				*Declination.*			
x	x′	x″	Error. ·0001	y	y′	y″	Error. ·0001
—10·8060	—10·8543	—10·8550	—7	+11·0943	+11·0615	+11·0610	—5
—10·0610	—10·1143	—10·1150	—7	+12·7543	+12·7236	+12·7233	—3
— 6·3010	— 6·3430	— 6·3435	—5	+10·5943	+10·5751	+10·5750	—1
— 7·3560	— 7·4011	— 7·4015	—4	+11·1943	+11·1719	+11·1717	—2
— 2·9410	— 2·9563	— 2·9560	+3	+ 3·6543	+ 3·6453	+ 3·6453	0
+ 2·1690	+ 2·1587	+ 2·1590	+3	+ 3·6543	+ 3·6609	+ 3·6610	+1
+ 3·4190	+ 3·3969	+ 3·3970	+1	+ 7·6343	+ 7·6447	+ 7·6447	0
+ 3·7840	+ 3·7783	+ 3·7785	+2	+ 2·8543	+ 2·8658	+ 2·8660	+2
+ 5·1840	+ 5·1520	+ 5·1520	0	+11·1343	+11·1500	+11·1500	0
+ 7·2790	+ 7·2431	+ 7·2435	+4	+12·8743	+12·8964	+12·8963	—1

Plate Centre Epoch 1900 R. A. H. 12 M. 0 S. 0 Decl.—18°
,, 1855 ,, 11 57 41·84 Decl.—17° 44′ 57″6
Factors Q+·00142 R ·000 S ·000

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—11·6470	—11·6635	—11·6640	—5	+ 8·9680	...	+ 8·9673	—7
—10·3220	—10·3366	—10·3370	—4	+ 9·3480	...	+ 9·3477	—3
— 9·3770	— 9·3903	— 9·3905	—2	+ 5·7280	...	+ 5·7277	—3
— 7·2970	— 7·3074	— 7·3080	—6	+13·0280	...	+13·0277	—3
— 6·3470	— 6·3560	— 6·3565	—5	+ 7·9480	...	+ 7·9477	—3
— 4·7770	— 4·7838	— 4·7845	—7	+ 8·8880	...	+ 8·8880	0
— 0·5170	— 0·5177	— 0·5180	—3	+ 9·8280	...	+ 9·8280	0
+ 3·2630	+ 3·2676	+ 3·2675	—1	+ 4·0880	...	+ 4·0880	0
+ 5·6680	+ 5·6761	+ 5·6760	—1	+11·6680	...	+11·6680	0
+10·0080	+10·0222	+10·0220	—2	+ 6·2280	...	+ 6·2280	0

Plate Centre. Epoch 1900 R.A. H. 15 M. 4 S. 0 Decl.—18°
,, 1855 ,, 15 1 27·83 ,, —17° 49′ 29″·5
Factors Q+·00098 R+·00348 S—·00315

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—12·9215	—12·9241	—12·9245	—4	+ 2·8617	+ 2·9023	+ 2·9017	—6
—10·3115	—10·2815	—10·2815	0	+11·7817	+11·8141	+11·8137	—4
— 9·6565	— 9·6517	— 9·6520	—3	+ 4·1217	+ 4·1521	+ 4·1517	—4
— 3·1715	— 3·1301	— 3·1305	—4	+12·8417	+12·8517	+12·8513	—4
— 3·1465	— 3·1148	— 3·1150	—2	+10·0217	+10·0316	+10·0313	—3
+ 3·9385	+ 3·9508	+ 3·9505	—3	+ 2·4217	+ 2·4093	+ 2·4090	—3
+ 7·5235	+ 7·5614	+ 7·5615	+1	+ 8·7817	+ 8·7580	+ 8·7580	0
+ 9·6735	+ 9·7213	+ 9·7215	+2	+11·0417	+11·0112	+11·0110	—2

Plate Centre. Epoch 1900 R. A. H. 18 M. 0 S. 0 Decl.—18°
,, 1855 ,, 17 57 22·20 ,, —17° 59′ 54″·8
Factors Q=0. R=+·00484 S=—·00437

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—12·9400	—12·8953	—12·8950	+3	+ 9·2373	+ 9·2935	+ 9·2937	+ 2
— 8·6150	— 8·6108	— 8·6110	—2	+ 0·8773	+ 0·9149	+ 0·9150	+ 1
— 7·0400	— 7·0043	— 7·0040	+3	+ 7·3773	+ 7·4081	+ 7·4080	— 1
— 5·6150	— 5·5928	— 5·5930	—2	+ 4·5773	+ 4·6018	+ 4·6017	— 1
+ 2·4500	+ 2·5076	+ 2·5080	+4	+11·8973	+11·8866	+11·8863	— 3
+ 7·3050	+ 7·3602	+ 7·3605	+3	+11·4373	+11·4054	+11·4053	— 1
+ 8·7250	+ 8·7826	+ 8·7830	+4	+11·8773	+11·8392	+11·8390	— 2
+10·1500	+10·2071	+10·2075	+4	+11·8173	+11·7730	+11·7727	— 3
— 8·6700	— 8·6095	— 8·6095	0	+12·4773	+12·5152	+12·5150	— 2
— 3·3950	— 3·3345	— 3·3345	0	+12·3973	+12·4121	+12·4120	— 1
+ 7·8550	+ 7·9170	+ 7·9170	0	+12·7973	+12·7630	+12·7627	— 3

Plate Centre. Epoch 1900 R. A. H. 21 M. 4 S. 0 Decl.—18°
,, 1855 ,, 21 1 28·02 ,, —18° 10′ 45″·7
Factors Q=—·00102. R=+·00336 S=—·00304

Right Ascension.				*Declination.*			
x	x′	x″	Error.	y	y′	y″	Error.
			·0001				·0001
—12·7210	—12·7122	—12·7120	+ 2	— 1·2523	— 1·2137	— 1·2130	+7
— 7·4410	— 7·4376	— 7·4375	+ 1	— 1·2523	— 1·2297	— 1·2293	+4
— 5·5910	— 5·5911	— 5·5905	+ 6	— 1·7323	— 1·7153	— 1·7150	+3
+ 8·9390	+ 8·9635	+ 8·9625	—10	+ 9·6877	+ 9·6605	+ 9·6607	+2
+12·5890	+12·5751	+12·5750	— 1	— 0·3123	— 0·3506	— 0·3503	+3
+12·9090	+12·9133	+12·9130	— 3	+ 5·2077	+ 5·1685	+ 5·1687	+2
— 9·0160	— 8·9640	— 8·9630	+10	+12·7477	+12·7751	+12·7753	+2
— 2·1460	— 2·1024	— 2·1015	+ 9	+12·3477	+12·3542	+12·3543	+1
+ 2·1690	+ 2·2017	+ 2·2020	+ 3	+10·4077	+10·4011	+10·4010	—1
+ 9·2440	+ 9·2680	+ 9·2680	0	+ 9·9277	+ 9·8996	+ 9·8997	+1