NOTES.

B.A.A. MEETING, 1936 APRIL 29.—*The President*, Dr. H. Spencer Jones, said that it was his sad duty to inform the meeting of the great loss to the Association through the death of Dr. W. Alfred Parr and Mr. Alphonso King.

Dr. Crommelin in describing his paper on the Delporte Planet CA stated that the period was now probably known to within a few days, but that this amount of uncertainty would make considerable differences in the chances of again picking up the planet at future near approaches. He had confidence that a closer approximation to the period would be possible from the observations just made by the large American telescopes.

Mr. Evershed showed some slides of solar prominences of recent date. He remarked that they indicated a renewed activity of the Sun in this respect, these prominences being larger, brighter and denser in appearance than for some time. The dark markings on the solar disc had been more in evidence lately. Mr. Evershed also showed spectroheliograms and prominences photographed in Kashmir at the sunspot maximum of 1916. By measuring plates taken by himself and by Dr. Royds, velocities in these prominences of several hundred kilometres per second had been obtained.

Mr. Peek described a paper by Dr. Comrie and himself on the "Appulse of the Earth to the Ring-Plane of Saturn".

Dr. Steavenson spoke on the 200-inch telescope at present under construction in California. The mirror had now been safely received at Pasadena although the difficulties of transport had been exceedingly great. He read an extract from an American newspaper describing the arrival of the great mirror and the method of transit and delivery.

The President then announced that there would be an interval of half an hour for members and visitors to examine the exhibits. Amongst a number of interesting exhibits by members were :—a model showing the action of a diffraction grating ; a model design of a house for a Coudé ; books and other exhibits relating to the Rev. W. T. Webb from the Historical Section, and sheets of a 300-inch map of the Moon.

During the concluding part of the meeting, Mr. Cameron Walker gave an account of the history and construction of the Minchenden School Observatory.

The President said that all members would agree that Minchenden School should be congratulated on its fine Observatory and the work done by its masters and boys in building it. He hoped that the result would be the creation of a large number of interested students and workers in the science.

After the Meeting, the Annual Dinner was held at Frascati's Restaurant, Oxford Street, W. More than sixty members and their friends were present, in addition to the guests of honour, Sir Richard and Lady Gregory and Professor E. V. Appleton.

Solar Notes.—The most interesting features of solar activity during the last month have been associated with prominences at the Sun's limbs and disk markings (visible in $H\alpha$ or in H or K) rather than with sunspots. On April 22 a massive prominence was seen nearly 2′ in height and extending at the east limb from South latitudes 40° to 30°, with a filament extending downwards to the chromosphere at 20°. On April 23 the prominence was apparently dissipating into space, and by $8^h\ 45^m$ U.T. was nearly 4′ in height. On May 6 a prominence that had been represented earlier by an extensive absorption marking on the disk became eruptive between 11^h and $14\frac{1}{2}^h$. Mr. Newbegin reports radial velocities of at least +200 km./sec.; other parts of the prominence were moving outwards with velocities of the order of 60–70 km./sec. At $15^h\ 23^m$ an intensity measure made at Greenwich gave at the wave-length of maximum intensity 20 per cent. that of the continuous spectrum 10 A from the centre of $H\alpha$ referred to the centre of the disk. The wave-length at which the prominence was observed at its maximum brightness at $15^h\ 23^m$ indicated a velocity of recession of 70 km./sec.

Disk absorption markings seen in $H\alpha$ have been numerous, as well as conspicuous for their size and variety of shapes. Mr. Evershed reported the sudden disappearance of one in moderately high northern latitude between April 28–29. H. N.

COMET NOTES.—Comet 1936 *a* was discovered on May 15 by Mr. L. Peltier of Delphos, Ohio. It is the fifth comet that he has discovered in the course of his work on variable stars. It was of the ninth magnitude, diffuse, with central condensation, an extended coma and a short tail in P.A. 320°. It was just visible in a 3-inch finder. Several observations are now to hand, of which three are given :—

1936 U.T.	R.A. 1936·0	N. Decl.	Observer.	Place.
	h m s	° ′ ″		
May 16·16767	23 51 59·2	73 26 53	Prof. G. van Biesbroeck.	Yerkes Obs.
18·9136	23 55 49·47	73 10 44·2	Dr. W. H. Steavenson.	Norwood.
21·9115	23 59 29·80	72 53 27·7	,,	,,

The orbit has presented difficulties, as is frequently the case when the motion is slow ; the following three orbits are to hand : all are for 1936·0 :—

T	1936 July 4·85	1936 Apr. 14·515	1936 July 9·962 U.T.
ω	153° 49′	50° 55′	137° 19′ 50″
Ω	127 6	175 30	143 7 0
i	75 34	75 30	82 26 10
q	0·995	1·1900	1·30535

The first is by Dr. F. L. Whipple and Mr. L. E. Cunningham ; the second by Dr. Koebcke (Poznan) using the Yerkes observation of May 16, and his own observations on May 17 and 18 ; the third by Rev. M. Davidson, D.Sc., using the three observations printed above. It will be seen that there is a difference of opinion as to whether perihelion is past or future. On the balance of evidence it is probably in June. The following ephemeris is from the first orbit, but may be considerably in error :—

0^h.	R.A.	N. Decl.	Log r.	Log Δ.
	h m	° ′		
May 20....	23 57·4	73 4		
24....	0 2·1	72 40		
28....	0 6·1	72 16		
June 1....	0 9·3	71 51	0·0606	0·0797
5....	0 11·8	71 24	0·0484	0·0555
9....	0 14·1	70 53	0·0369	0·0281
13....	0 15·9	70 19	0·0267	9·9972
17....	0 17·7	69 38	0·0175	9·9618
21....	0 19·3	68 51	0·0099	9·9214
25....	0 20·7	67 51	0·0041	9·8749
29....	0 22·9	66 38	0·0001	9·8206
July 3....	0 25·6	65 3	9·9981	9·7566

It was hoped that comet 1935 *d* (van Biesbroeck)

would brighten on approaching perihelion; but the discoverer noted that on April 16 its magnitude was 16, which is 3 magnitudes fainter than the predicted value; however, the observations extend over nine months, which give sufficient material for a good orbit. He also observed comets Comas Sola and Schwassmann-Wachmann (2) in April, but did not expect to follow them much longer (*Pop. Astr.*, May) A. C. D. C.

KINEMATICS AND WORLD-STRUCTURE.—General relativity theory is a geometrization of certain parts of physics. After adopting a space-time, in the standard theory a Riemannian space-time, for reasons which must of course have some physical content, it proceeds to derive further physical results by a process of "interpretation" or "identification". For example, the geometry supplies geodesics, and these are "identified" with the world-lines of free particles, and the consequences of this identification are worked out. On the other hand, while not denying the success of this method, Milne's recent well-known work on kinematics and world-structure provides a way of seeing what can be got by the more direct use of physical postulates, without the intervention of a geometrical model. He supposes the existence of a fundamental set of equivalent observers in the universe, equipped with prescribed observing apparatus. If A, B are any two of these, he first postulates that the totality of observations which A can make on B are describable in the same way as the totality of those which B can make on A. Later he postulates that the totality of observations which A can make upon the whole universe is describable in the same way as the totality of those which B can make upon the whole universe. The latter is his form of the *cosmological principle*. He then investigates the restrictions imposed by these postulates upon the distribution of matter and motion in the universe.

Even should Milne's kinematical relativity be found ultimately to lead to the same results as those of general relativity, his work would have given greatly increased physical insight into the foundations of dynamics and gravitation. But the equivalence of the results has not yet been established. In order to do so it would first be necessary to show from his postulates that his space-time admits an invariant Riemannian metric of the same

form as that of general relativity. This is attempted by Professor H. P. Robertson in a series of papers in the *Astrophysical Journal*, two of which have already appeared (I. Vol. **82** (1935) 284–301; II. Vol. **83** (1936) 197–201). He does so by applying group theory to the transformations between the fundamental observers, and then appealing to the Helmholtz-Lie theorem concerning physical space. He finally reaches the conclusion that the kinematical space-time admits an invariant differential form of exactly the same character as that used in the general relativity theory of the "expanding universe". He further observes that this is an advance upon the usual relativity treatment, in which the existence of the invariant form is *assumed*, and then it is shown that it must possess this character.

Actually a similar conclusion had been previously announced by A. G. Walker, though details of his work have not yet been published (an abstract appears in *British Association Reports* 1935; details were given in Dr. Walker's paper read before the Association, Sept. 1935, and also in a colloquium at Oxford, May 1935).

The argumentation of Robertson's paper is somewhat difficult to follow, particularly his use of the cosmological principle. For, to begin with, he assumes that Milne's cosmological principle "is equivalent to that uniformity requirement on which the relativistic theory is based" (I, 285). This to some extent appears to be the question at issue, that is, whether Milne's principle, stated in terms of prescribed processes of observation, necessarily *implies* no more and no less than the general relativity requirement, which is not stated in terms of processes of observation. Again there appears to the reviewer to be a hiatus in the proof of the existence of the invariant form for the three-dimensional set of observers. It is first derived for a one-dimensional set. By an application of the cosmological principle it is then shown to follow for any one-dimensional set selected from the three-dimensional. Thence the existence of "a three-dimensional positive-definite metric 'u-space' of observers" (the parameter u need not be defined here) is immediately deduced, but I have not been able to follow this crucial step.

On the other hand, Walker's derivation makes a much more direct use of the cosmological principle in Milne's form, together with an explicitly stated principle of

symmetry, and dispenses with an appeal to anything like the Helmholtz-Lie theorem. It is unfortunate that Robertson uses such sophisticated methods, since the whole point of an investigation of this kind is to expose clearly where and what physical postulates have been introduced.

In his second paper Professor Robertson goes on to study the motion of a free test particle in an idealised universe of the sort discussed in the first one. It is not assumed that the world-line of the particle is a geodesic, as in general relativity. It is merely assumed that it must obey the cosmological principle in the sense that, if the fundamental observer A projects a test particle P under specified initial conditions, and if observer B projects a particle Q under the same relative conditions, then the subsequent motion of P relative to A must be the same as that of Q relative to B. This is shown to restrict the equations of motion to a certain form depending on a single unknown scalar function Γ. Thus the path of a free particle is in fact *not* in general a geodesic, as is remarked also by Walker in the abstract quoted above. Robertson then further shows how any suitable theory of gravitation may be imposed to determine Γ, and studies in particular the application of Einstein's theory of gravitation, and a relativistic extension of Newton's theory.

It is only fair to recognize that this paper is a modified discussion of work already described by Milne in his book *World-Structure* and elsewhere. In fact the whole method of finding acceleration formulæ by use of the cosmological principle is given in detail in § 98 *seq.* of that book, forming of course a very essential part of the work. Also the possibility and significance of further imposing some " law of gravitation " is discussed in § 103 more fully than in Robertson's paper, though it is rather Milne's own aim to see how far it is possible to go without having to do this. It is regrettable that Robertson has not mentioned the origin of these ideas, especially in view of his previous adverse and, in the reviewer's opinion, unjustifiable comments on Milne's work.

W. H. McC.

Obituary.—We regret to record the death on April 18 of Mr. Alphonso King, who for the last ten years has contributed the Meteor Notes to this magazine.