which genus it appears most nearly related, by (1) the presence of a functional P_1 of good size. This tooth is absent in *Aphelops;* (2) by a much more brachyodont dentition; (3) by the presence of a heavy external and internal cingulum on all teeth of the grinding series, but the last molar, where it is reduced.

This brachyodont condition, as compared with *Aphelops,* corresponds to the difference in horizon, assuming them to be in the same approximate ancestral line. The typical *Aphelops megalodum* is from the Middle Miocene, the present genus and species from the Lower Miocene.

Epiaphelops does not appear to be derivable from *Cœnopus,* as in all known species of *Cœnopus* the first lower premolar is absent, or a vestigial, variable, character. In this respect *Epiaphelops* is more primitive than *Cœnopus, as* P_1 is large and functional. Comparison with other Oligocene types does not appear profitable.

Epiaphelops virgasectus is somewhat larger than *Aphelops megalodum.* As the other specimens in the collection of the writer referable to this type are not surely associated, they are best unpublished for the present, but suffice it to say that when this form is better known, other characters are present which will more clearly characterize it. A more complete description will appear later.

Harold James Cook

Agate, Nebraska,
December 20, 1911

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION A—MATHEMATICS AND ASTRONOMY

As the Astronomical and Astrophysical Society of America held a regular meeting in affiliation with the American Association, and as the American Mathematical Society held its annual meeting at the same time in New York City, the special program of Section A was confined to one session. This was a joint session with the Astronomical and Astrophysical Society, and the program consisted of the vice-presidential address by E. H. Moore, of the University of Chicago, and of two papers given, on special invitation, by J. A. Metcalf and Lewis Boss.

An abstract of the paper by Lewis Boss, entitled "Recent Researches as to the Systematic Motions of the Stars," is as follows:

The proper motions of stars are so small, and are so difficult to measure with proportionate accuracy that the successful determination of systematic peculiarities in the arrangements of the motions themselves must depend upon great systematic accuracy in the measurements of those motions. Therefore, when the department of meridian astrometry was established at the Dudley Observatory about six years ago with the support of the Carnegie Institution of Washington its first work of investigation was to continue to completion the work it had begun with the object of ascertaining the proper motions of the brighter stars which had been most observed with precision in the past, with all practicable completeness and accuracy, both in the casual and systematic sense, with the ultimate purpose of making this work the basis of studying the systematic peculiarities of these motions in order to throw further light on the mechanism of the visible universe.

About two years ago the Carnegie Institution of Washington published the result of this research in a volume entitled "Preliminary Catalogue of 6,188 Stars." For each star the position was given for 1900 together with the proper motion, etc., necessary for reducing those positions to any other epoch. This material was first employed for deriving new values of the precession as well as the direction of solar motion. The latter was found to be, for 1875: R.A. 270°.7, Decl. + 34°.3 (A.J. 614). The stars employed in this discussion cover the entire sky from the north to the south pole; so that the direction of the solar motion came out with very great weight and at the same time independently of the precession.

Next were deduced the facts in regard to an interesting moving cluster of stars in the constellation, *Taurus.* Each of the 41 stars appears to be moving toward a point in the sky in R.A. $6^h\ 7^m$, Decl. + 7°. The velocities of motion of the several stars are approximately the same. Very recently Mr. Benjamin Boss, of the department of meridian astrometry, identified a group of 11 or 12 large proper motions scattered widely over the sky between declinations + 42° and — 81°, which converge nearly in a point at R.A. $6^h\ 37^m$, Decl. + 0°.5. The velocities of these stars toward the point cited seem to be uniformly about 95

kilometers per second. 61 *Cygni* appears to be a member of this group (A.J. 629).

Before seeking a systematic representation in direction and amount of the star motions generally the speaker had wished first to follow up the indications which had already appeared to the effect that the stars of differing spectral types are moving with differing mean velocities. Frost, eight years ago, had offered the earliest evidence that the Helium, or *Orion*, stars are moving slowly in comparison with those of older types. Quite recently he and Kapteyn and also Campbell added some preliminary evidence to the discussion of this question. In the winter of 1910–11 the department determined to take up this subject comprehensively by employing the cross-motion element of the proper motions. The results of this research on acceleration of stellar motion were published in the *Astronomical Journal*, Nos. 623 and 624. These results are given in the following table under the column designated "mean cross motions." For comparison, Campbell's results from mean radial motions are given in the next column. They were obtained from entirely different sources, independently and almost simultaneously. The letters in the first column, in which *B* is supposed to stand for the youngest spectral type (Helium), and *M* for the oldest considered in this investigation, are designations adopted from the Harvard classification (H. C. O., Vol. L.).

Type	Mean Cross Motions	Mean Radial Motions
B	6.3	6.2
A	10.2	10.5
F	16.2	14.4
G	18.6	15.9
K	15.1	16.8
M	17.1	17.1

The cross motions were originally expressed as a fractional part of the centennial motion of the sun. Both series, in good agreement, express the fact that the motion of a star accelerates up to about the time the spectrum develops into type *F* or *G*, after which it seems to gain no increase of velocity.

Seven years ago Professor Kapteyn, at the Scientific Congress of the St. Louis Exposition, introduced his now well-known hypothesis that the visible universe consists of two great intermingling streams moving in opposite directions. The direction of one he called the "vertex," which he fixed at R.A. $6^h\,4^m$, Decl. $+\,13°$. Quite recently Eddington, of the Greenwich Observatory, with the same hypothesis, and using the proper motions of the "Preliminary General Catalogue," found for this vertex: R.A. $6^h\,16^m$, Decl. $+\,12°$.

In 1907 Schwarzschild advanced the hypothesis that a systematic arrangement of the proper motions leads to an ellipsoidal arrangement of distribution and he endeavored to show that the proper motions of Groombridge's Catalogue are as well represented as they are by the hypothesis of two streams.

By a method entirely different from that employed by either of the two investigators, the department found nearly a year ago that when its proper motions were compared in a manner to bring out this systematic arrangement, it was seen that if all the actual motions of the stars in any considerable area of sky were brought to a common origin (freed from their solar parallactic motions) the figures so constructed would have an elliptic outline, which turned out to be different presentations of an ellipsoidal figure of which, if the major axis be taken as 7, the two minor axes would be 4. The major axis of all the figures points very nearly toward the vertex of Kapteyn; this point was found to be in R.A. $6^h\,15^m$ and Decl. $+\,7°$. Moreover, these ellipsoids have well-marked nuclei composed chiefly of stars of types *B* and *A*. This fact would require a third stream to complete the "two-stream" hypothesis, as some of the supporters of the latter have already perceived.

The speaker presented considerations in support of his belief that this ellipsoidal arrangement of the star-motions in space would be reduced to a simple and natural explanation, if we suppose that the stars had been originally formed in nebulas and repelled from the regions of their formation with a tendency to be impelled by some kind of polarity 50 to 75 per cent. faster in the direction of the major axis of the ellipsoid than in a direction at right angles to that. This hypothesis also fits in well with the undoubted phenomenon of acceleration of a star's motion with age.

The section elected President E. O. Lovett member of the council, Professor F. B. Littell member of the sectional committee, and Dean H. T. Eddy member of the general committee. On recommendation of the sectional committee Professor E. B. Van Vleck, University of Wisconsin, was elected chairman of the section by the general committee.

G. A. MILLER,
Secretary of Section A
UNIVERSITY OF ILLINOIS