except the Sun. This temperature corresponds to that which, according to a determination of my theory, prevailed upon the Earth during the latter part of the Huronian-Cambrian Age of geological history, when the primitive forms of life first appeared upon the Earth, as evidenced by the molluscan fossils, the *trilobites*, the noted Eozoon Canadense etc., in the animal kingdom, and by the casts of the vegetable, "fucoids" all well suited to their environment in the warm, shallow waters of that remote age, between 50 and 60 millions of years ago, according to my determination as set forth in the III Part of my work treating of the "genesis of the solar system". In the case of the planet Mercury the augmentation due to solar heat is 393°, and this, added to the intrinsic temperature, gives 530° F as the maximum surface temperature on Mercury,—which is not much below that of the melting-point of lead—a fact that precludes the possibility of the existence of any known form of life on that planet. All of the above results are quite consistent with the best known facts.

SEVERINUS J. CORRIGAN.

St. Paul, Minnesota.

The Orbits and "Velocity-Curves" of Spectroscopic Binaries.*

In looking over the published papers on spectroscopic binaries, it will be remarked that the "velocity-curves"—as hitherto drawn for these objects—are often unsymmetrical. A closer examination reveals a curious *general similarity* in the form of such curves; the *ascending* branch of the curve, with few exceptions, being of greater length than the *descending* branch. This fact, although of great theoretical interest, seems to have been hitherto overlooked by astronomers. Its significance will be seen when we try to interpret it in accordance with received ideas. The result may be stated as follows:

Let D denote the time-interval during which the star's "radial velocity" is *decreasing*; I the interval during which it is *increasing* (algebraically); ω the longitude of periastron, reckoned from the ascending node. On the hypothesis of elliptic motion we have:

$$D < I \text{ if } \omega \text{ is between } 0° \text{ and } 180°,$$
$$D > I \text{ if } \omega \text{ is between } 180° \text{ and } 360°.$$

Now for the list of thirty spectroscopic binaries given in the paper, we find:

$$D = I \text{ for 1 star,}$$
$$D > I \text{ for 4 stars,}$$
$$D < I \text{ for 25 stars.†}$$

---

*Abstract of a paper communicated to the Royal Astronomical Society of Canada, revised and amended by the author March 11, 1908.

† Excluding these stars for which e is equal to or less than 0.10, we have:

$$D = I \text{ for 1 star,}$$
$$D > I \text{ for 2 stars,}$$
$$D < I \text{ for 21 stars.}$$

It should be added that the list of 30 binaries—with one notable exception—includes only stars for which the oscillation curve appears to be certainly unsymmetrical.

Thus in a large proportion of cases, the periastron is located (apparently) in the first or second quadrant of the orbit. A yet more remarkable feature is the apparent *grouping* of the periastra about certain values of ω. That such a distribution of the apses really exists is of course very improbable—so improbable that we are certainly justified in seeking for a different explanation of the observed facts. In other words, the elliptic elements e and ω, as computed for the orbits in question, are probably illusory; the "observed radial velocities," upon which they are based, being vitiated by some neglected source of systematic error.

After a careful study of the problem involved, the writer has been led to formulate a definite theory on the subject as outlined below. Without underestimating the difficulties of the problem, or denying the possibility that some other (and perhaps more probable) solution may yet be found, it is believed that the explanation here given rests upon a snbstantial basis:

(1) The disks of the stars under notice are not uniformly bright. The distribution of surface brightness in *longitude* is, for each star, unequal, and for some stars, distinctly unsymmetrical. Such conditions, combined with rapid axial rotation, would result in an unsymmetrical broadening of the spectral lines. The *effective* result would be a periodic shift of these lines, as measured on the spectrograms.

(2) The orbits of such binaries (especially those of short period) are, in general, nearly circular.

(3) The measured "radial velocity" is the resultant of orbital motion and axial rotation—as indicated above.

(4) Tidal action, as modified by friction and the general circulation of the stellar material, will probably account fully for the conditions postulated in (1). One very interesting and important consequence of this theory should be stated here, viz., that many (perhaps all) spectroscopic binaries are variable in brightness; though the range of their periodic light-changes must, in general, be small. Accurate photometric observations of such objects should, therefore, afford a crucial test of our hypothesis.

It would appear that both the light- and "velocity"- curves of the δ Cephei variables may be explained in conformity with these views. Confirmatory evidence is afforded by other facts of observation—e.g., the asymmetry in the light-curves of certain Algol stars—notably S Cancri, U Coronæ, and δ Librae.

For stars of the δ Cephei type, we must assume that the distribution of surface brightness is distinctly unsymmetrical. In ordinary cases, however, such an assumption is unnecessary.* The usual form of the "velocity-curve" (as indicated by the relation $D < I$) admits of a very simple and direct explanation. It is only necessary to suppose that the star's surface brightness at any point depends upon the *height of the tide* (due to a revolving satellite) at that point: *high* tide corresponding to *minimum* and *low* tide to *maximum* brightness. The orbit is regarded as circular (or nearly so), and the star is assumed to *rotate* in the same general direction as it *revolves*—an assumption that is both natural and theoretically probable. It should be added that the influence of tidal friction—where the periods of axial and orbital motion are unequal—may modify, in an important degree, the resulting form of the oscillation-curve.

* The degree of asymmetry (where such exists) must depend largely upon the *relative* distance of the tide-raising body.

In a future paper I hope to deal with various details of the theory outlined above and to discuss some practical methods for the separation of effects due, respectively, to axial rotation and orbital revolution of the stars under notice.

J. MILLER BARR.

St. Catharine's, Ontario,
Canada.

Observatory of the Rev. J. H. Metcalf. In the sixty-second annual report E. C. Pickering the Director of the Astronomical Observatory of Harvard College, the following paragraph appears on page 8.

"It is the policy of the Harvard Observatory to aid, when possible, specialists who display marked skill in any department of astronomy. Coöperation has accordingly been established with the Observatory of the Rev. J. H. Metcalf so that the work there has been materially extended. This secures for the Harvard Observatory the immediate use of many excellent photographs and the eventual possession of certain valuable instruments. During the past year, Mr. Metcalf and his assistant have taken 200 photographs with a 12-inch doublet constructed by him. The greater portion of these plates were made by following upon a star, and giving an additional motion to the plate equal to that of an asteroid.

This method proves extremely effective in discovering and following asteroids and has led to the discovery of 33 asteroids, and of comet 1907 b, by Mr. Metcalf. The planet Eros also was found readily on July 4, 1907, on the first photograph taken for this purpose."

Mr. Metcalf is desirous that the orbits of these asteroids be computed so that a record of them may be made. He urges that observatories, colleges or individuals able to do the work and willing to make such a contribution to science will signify to him their desire to undertake the care of one or more of these planets.

The remarkable success of this new plan for photographic observation of faint comets and faint asteroids is claiming the attention of astronomers generally. It will be used more and more as time goes on.

Standard Tests of Photographic Plates by Edward S. King was published by Harvard College Observatory, as volume lix, No. 1, of its *Annals*.

Mr. King's discussion of the subject is full and detailed, the principal results attained in his investigation being summarized without respect to order of importance are given below.

1. The accuracy with which measures can be made with a photographic wedge, when it is under standard conditions. This is shown by the results in Table III, by the small residuals in Table IV, and by the almost exact duplication of the measures given in Table VI. It is shown also by the determination of the slight play of the scale, mentioned on page 5, amounting to only 0.03 magnitudes.

2. The difficulty of obtaining absolute results from photographic measures. This is shown by the diversity of results, when the experiments were made under almost exactly the same conditions.

3. The advantage of a system, in which the effect of the several elements contributing to the result have been studied from the same collection of plates.

4. The derivation of the nature of the error arising from the density of the film. The original plan did not provide for such an error, nevertheless