A Plan for securing Observations of the Variable Stars.

[Continued from p. 51.]

The problems to be undertaken may be defined as follows:—

1. To observe all the long-period variables once or twice every month throughout their variations according to such a system that all the observations may be reduced to the same absolute scale of magnitudes.

2. To observe the stars whose variability is suspected, and prove either that they are really variable, or that in all probability they do not belong to the first, second, or fourth class. If any are thought to belong to the fifth class, to watch them until such a variation is proved, or is shown to be improbable.

All of this work will depend on the possibility of readily determining the brightness of a star according to such a method that all the observations can ultimately be reduced to the same system. Herschel and Argelander have independently invented what appears to be the true method to be followed. If a star is seen to be very nearly equal to several others, from their light we can at any time define its brightness. It is essential that at least one of the stars selected should be a little brighter, another a little fainter, than the star to be observed. The range within which its light is known is thus also defined. Such observations will far exceed in value any direct estimate of magnitude. When stars are to be compared many times, it is convenient to designate them by letters for brevity. Let *v* represent a star which is suspected to be variable, and *a* an adjacent star of nearly equal brightness. Owing to fluctuations in the atmosphere, each star will appear to be constantly varying in brightness. If the stars appear equal after a careful examination, or if one appears brighter as often as it appears fainter than the other, we may denote this equality by *av* or *va*, these terms having precisely the same meaning. If one of the stars is suspected to be brighter,—that is, if it appears sometimes brighter and sometimes fainter, but more frequently brighter, the interval may be designated as one grade. The observation may be written *a* 1 *v* or *v* 1 *a*, the brightest star being named first. If one star is certainly brighter than the other, the difference, however, being very small, so that they sometimes appear equal, the difference will be two grades, and may be written *a* 2 *v* or *v* 2 *a*. Greater intervals may be estimated at three or four grades, but such observations have much less value. It is found in practice that a grade thus estimated will slightly exceed a tenth of a magnitude. A useful exercise for an observer is to select two stars of known magnitude and several others of intermediate brightness. Arrange them in a series in the order of brightness, and estimate the intervals in grades. The difference in magnitude of the first stars divided by the total number of grades gives the value of one grade. By using different intermediate stars, the same standard stars may be employed repeatedly. The following well-known polar stars will be convenient, since they are always visible:—α *Ursæ Minoris*, 2·2 magn.; 51 γ *Ursæ Minoris*, 3·0 magn.; δ *Ursæ Minoris*, 4·4 magn.; 51 *Cephei*, 5·4 magn.; λ *Ursæ Minoris*, 6·5 magn. The above method is essentially that of Argelander. Sir William Herschel had already employed a method which differed mainly in his notation, a . , and — being equivalent to one, two, or three grades.

In all work of this kind the observer must look directly at the star he is observing at the moment, and never try to compare two stars by a simultaneous inspection of both. After examining one star until he has a distinct impression of its average brightness, freed from the momentary changes due to atmospheric disturbance, he should observe the other in the same manner. Alternate observations of the two stars, each observation lasting for a few seconds, will give a truer impression than can be derived from a simultaneous observation in which the two images must be differently placed on the retina.

The principal objection to this method is the difficulty of determining the value of a grade, as it is liable to vary with the observer, the time, the condition of the air, and the brightness of the stars. These difficulties are avoided by the following method. Select two stars for comparison; one, a, slightly brighter than the star to be measured, v, the other, b, slightly fainter. The interval between a and b should never exceed one magnitude. Estimate the brightness of v in tenths of the interval from a to b. Thus, if v is midway between a and b the interval will be five tenths, and we may write a 5 b. If v is nearly as bright as a, we may have a 1 b or a 2 b; if v is not much brighter than b, we may have a 8 b or a 9 b. An advantage of this method is that larger intervals in brightness may be used between the comparison stars, and accordingly less distant stars employed. An increase in distance of the stars always renders the comparison more difficult. We can also obtain many independent comparisons by using several comparison stars. If we have m stars brighter and n fainter, we shall only have $m+n$ independent measures by the method of grades, while we have $m\ n$ comparisons by estimating tenths, since estimates may be made in terms of the intervals between each brighter and each fainter star. On the other hand, especially when observing stars not very near together, it is a decided advantage to have to compare two stars rather than three. Each method has its advantages, and that to be used should doubtless depend on the temperament of the observer.

Several precautions are needed to secure the best results. No observations should be made near the horizon; and, when the objects examined are at any considerable zenith-distance, stars differing several degrees in altitude should be avoided. If the stars are bright and there is no choice, a correction may be made for the error due to the varying absorption at these different altitudes if the time of observation has been noted. When using a telescope or opera-glass, the stars should be brought in turn to the centre of the field, as when near the edge they will not appear of their true brightness. This is found to be better than placing them at equal distances from the centre. In selecting comparison stars, the proximity of a brighter star is very objectionable, causing a large error, which varies with the magnifying-power used. Double stars should be avoided if the power used is sufficient to show the companion. Comparing stars of different colours is also objectionable.

Any persons who desire to take part in these observations are requested to communicate with the writer, and send answers to the questions given below.

1. What is the location of your point of observation? In the city or in the country, on the ground, from a roof, or from a window? Is any part of your horizon obstructed, or can you observe in all parts of the sky?

2. What is the aperture, focal length, and name of maker of your telescope? also the lowest magnifying-power and largest field of view you can obtain with it? Have you a field-glass or opera-glass?

3. Can you identify bright and faint stars from their designations or right ascensions and declinations? Have you Heis' 'Atlas Cœlestis Novus,' the 'Uranometria Argentina,' the Durchmusterung,' or other maps and catalogues of the stars?

4. Would you prefer to observe the known or the suspected variables, or to divide your time between them?

For convenience in making the reductions and for future reference, it is essential that all the observations should be made according to the same system. Observers are accordingly requested to adopt the following form. Use half-sheets of letter-paper (eight inches by ten), writing only on one side and leaving a margin of half an inch for binding. Begin with a new sheet every evening, and write the date and location (township and state) on the first line. Each sheet when completed should be signed, and all should be numbered consecutively. When several sheets are used on the same night, the date should be entered on each. The record should be made in pencil, and all subsequent remarks or corrections added or interlined with ink, taking especial care not to obliterate or render illegible the original record.

A general statement should be made each evening of the condition of the sky, as "clear," "hazy," "passing clouds," &c. The time of beginning and ending work should also be noted. One line should be assigned to each comparison. The hour and minute should be written to the left, and the comparison next to it. The right-hand half of the line will be left blank for reducing the observation.

Certain evenings or portions of evenings must also be devoted to the selection of the comparison stars of suspected variables. If they are contained in maps which are available, the letters assigned to each star may be marked on the maps and lines drawn to show with what suspected variable star they are associated. If preferred, a sketch may be made of the neighbouring stars and the letters entered on them. This sketch with a proper description should be entered on the observing sheets described above, and a copy should be retained for reference. Every month the observations will be interrupted by moonlight, and accordingly, three or four days before the full moon, all the sheets that have accumulated should be mailed, addressed Harvard College Observatory, Cambridge, Mass. An acknowledgment will be sent at once, so that if this is not received a second notification should be sent.

To attain success it is particularly important that the plan should not be local or national. Observers in the southern hemisphere are much needed, and for some purposes those in various longitudes. It is hoped that among the many amateurs of Europe, and especially of England, may be found some ready to participate in this work. No restriction regarding the observations or publication is intended; but it is hoped that a large addition to our present knowledge of the variable stars may be secured, without interfering with what would otherwise be obtained. Copies of this pamphlet and further information will be furnished on application. Any persons desiring to participate are requested to address the writer, sending answers to the questions given above. The details will differ with each observer, and will be arranged by correspondence. Apart from the value of the results attained, it is believed that many amateurs will find it a benefit to accustom themselves to work in a systematic manner, and that they will thus receive a training in their work not otherwise easily obtained outside of a large observatory. The lesson should be taught that time spent at a telescope is nearly wasted, unless results are secured worthy of publication and having a permanent value. Those who have once accomplished such work are likely in the future to appreciate its value, and will often continue to do useful work in some other department of practical astronomy, if not in that of variable stars. The education of a class of skilled observers would be a work of no less value than the results anticipated from the observation of the variable stars.

Harvard College Observatory,
Cambridge, Mass.

EDWARD C. PICKERING.

Arabic Names of the Stars.*

ALTHOUGH modern astronomers are disposed to set their faces against the retention of the old names for the individual stars which figure so abundantly in the earlier atlases and on our celestial globes, yet they are not without their interest and value. But few of

* The Names of the Stars and Constellations compiled from the Latin, Greek, and Arabic; with their derivations and meanings: together with the twenty-eight Moon-stations of the zodiac, known to the Arabs. By W. H. Higgins, M.B. (Copyright.) Leicester: Samuel Clarke, 5, Gallowtree Gate. London: Hamilton, Adams, and Co. 1882. 57 pp.