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Eye Estimate of Stellar Magnitudes

Instructions.

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General Plan. Description of Charts, Catalogue and Records.

It is proposed to make eye estimates of all stars not fainter than the sixth magnitude, north of the equator, and contained in the Atlas Coelestis Novae of Heis, the scale of magnitudes being derived from a large number of photometric measurements taken in the meridian at Harvard College Observatory. The catalogue of standards comprises 151⁺ stars each of which has been (or is to be) photometrically observed a large number of times. Of these, the greater part lie between 60° and 70° declination, as equally distributed as practicable, a few lie near the pole, and the remainder are bright stars of lower declination. They are numbered in his catalogue from 1 to 151⁷ inclusive, numbers 103, 132 and 141 being omitted.

The general method of estimation is to select two standards, respectively brighter and fainter than the star to be estimated, and not differing from each other more than two magnitudes, and to estimate the difference for the star in terms of the difference between the standards. In order to leave the observer unprejudiced, he is not informed the precise magnitudes of the standards, and the comparison is made at the Observatory after the work has left his hands.

In fact the precise standard magnitudes are not determined at the outset. To check, or to improve, the values to be adopted for the standards, they are also estimated in terms of each other in the same manner. The photometric observations then give preliminary standard values which may be amended in accordance with the results of the last mentioned comparisons.

To eliminate, as far as practicable, the effect of atmospheric absorption, the three stars involved in an estimate are preferably to lie near an arc of equal altitude passing through the pole. No star should be more than a few degrees below this altitude. ^{unless all three stars are of nearly the same altitude, and low altitudes should only be resorted to in an emergency.} To provide a means of correcting for the absorption, a few estimates are to be taken of standards near lower culmination in comparison with other standards at as high altitudes as may be.

The working lists are charts I, II, IV, V, VI, and VII of Heis. Each standard is surrounded with a circle in blue ink, adjacent to which is its catalogue number. The other stars are numbered in red. The polar standards, all those between 60° and 75° declination, and part of the bright stars of lower declination, are included upon charts I and II together. Of the remaining bright standards, the northern ones are upon the other sheets, while the southern ones are not given within the area covered by the charts. Single copies of other charts of the Heis Atlas will serve

each observer in turn for certain ^{north of the equator, but} small areas, ^{not} covered by the regular working lists.

The general catalogue is not needed by the observer. ~~An abstract of the catalogue of standards is furnished, those not given on the charts being denoted by an asterisk.~~ The standards have numbers in the general catalogue, which are ^{ordinarily} not ^{to} be used by the observer.

The observations are taken account of in series numbered continuously, each series ^{ordinarily} including all the work done without an interruption of an hour or more. The ^{facts regarding} particulars for each series being kept in journal form, ^{while most of} the observations ^{are entered in ledger form, the latter} need only the number of the series to connect them with all attendant circumstances.

For the record of the observations, ^{in ledger form} sheets are furnished, bearing the numbers of all the stars except the polar standards, ^{all the stars on any one chart being} arranged in order of right ascension. Three lines are ^{to be} devoted to each standard, and a single line to each of the other stars. The estimates of the polar standards and of standards near lower culmination, ^{to be} are entered in the journal.

All records are to be kept upon ^{single} sheets of letter size, leaving margin of nearly an inch blank at the left hand side of each. Such sheets as have been finished, so far as the observer is concerned, are to be sent to the Observatory ^{early in} ~~at the latter part~~ each month. ^{during the second quarter of the Moon.}

Directions for Conducting an Evening's Work.

An intermission of an hour or more constitutes a division between series. They are to be numbered continuously, regardless of date.

Each evening make such estimates as shall lead to the early filling out of individual ledger sheets, and also make the following entries in the journal. — An estimate of one standard near lower culmination taken near the beginning, ^{an estimate} of another ^{standard} near the middle, and of a third near the end of each evening's work. In addition to this, about once a week, an estimate of one of the polar standards, taking them in turn. For lower culminations the standards of comparison should be at as high altitudes as may be. Should it be necessary to observe on hazy evenings, take five lower culminations at nearly equal intervals of time. ~~For those taken on the same evening use as many different standards of comparison as may be. The use of the same pair of comparison stars for the same star whenever taken near lower culmination has some advantages.~~

^{of comparison}
^{standards, whose numbers are enclosed in brackets? I am not to be used as standard.}
 For example, ^{the} star 51 Cephei (No. [154] on the charts) is not to be used as a standard of comparison on account of its color, ^(numbers for comparing other colored stars) but it has been placed with the standards in order to associate it with the other polar stars whose occasional estimation is desired.

Ordinarily the observations for the ledger should be taken east of the meridian. Observation west of the meridian may

be resorted to when there is more than enough time to complete all that offers to the eastward, and also ^{in order} to complete stars which have escaped ^{observation} while in the east.

For the ledger estimates avoid undue use or abuse of individual standards of comparison. One method would be to select ^{at the beginning of the evening,} ten or a dozen standards of progressive magnitude, ^{to record their numbers in the journal (for reference during the series)} and ^{to} enter the number of the series against each of their numbers in the catalogue of standards. ^{This last entry could be made the following day.} For the succeeding series some of these stars would be dropped from the list and others added. The catalogue then becomes a check-list by which an equable employment of standards is secured. Absolute adherence to the list entered for any series would not be expected; but if any star entered were notably left unused, its number would be crossed off the check-list, while any other star frequently used would be added on the list. ^{Any such change in the journal would be made at the time of observing the series.}

^{At the same time, in the journal, of the standards of comparison used for that series, is an index of comparison.} In estimating faint stars an opera glass may be used, taking care to bring each star to the centre of the field, and recording "G." in the remarks. ^{Do not record G. when the glass is merely used in identifying the stars.} If a star is estimated to be fainter than λ Ursae minoris (No 156 on the charts), that fact will be considered an adequate observation.

Estimates may be made on moonlight nights, if care be taken that no star used is within 60° of the Moon. They should never be made, however, when δ Ursae minoris (No. 155 on the charts) is rendered invisible either by moon-light or twilight.

Additional observations should be made whenever variability is suspected, recording the time in the remarks.

Each evening's work should be examined the next day.

Directions for Making and Recording an Estimate.

Select two standards of proper position and brightness in relation to each other and to the star to be observed. Calling their difference in magnitude 10, estimate the increase in magnitude from the brighter standard to the star observed, in these units. Accuracy to single units is not to be expected.

Record each estimate on one line in the following form. — Number of star or of star observed (according as the record is in the ledger or the journal); number of brighter standard; estimated increase in magnitude; number of fainter standard. Leave a space for a number to be subsequently entered after each recorded number, and at the end of the space devoted to one record make such remarks as, ^{mean astronomical time in hours and minutes} the time (whenever desirable), any decided color (whenever noticed), and "O. G." (to denote the use of an opera glass). In the record the number of the standards, and the estimated difference for the star observed, stand in the order of the increasing magnitude of the stars to which they refer.

Record with graphite pencil. To change a figure draw a ^{vertical} line through it, and write the alteration near by. Use no india rubber or other eraser of pencil lines. Make no pencil marks on the record after the completion of the series. ^{(except a time estimate in brackets).} Any notes may be subsequently added in each line. ^{All notes or figures made by the observer are to be on the records, and not on waste paper. When not otherwise directed, they are to be made in the journal.}

The other specifications, and for examples, consult the directions for the journal and for the ledger.

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Directions for the Journal.

Each journal sheet is to be headed with the observer's name, the location at which the observations are taken, and the year.

The record of each series is to begin with the month and day, the number of the series, and the time of commencing. It is to end with the time of finishing the observation of the series. On the intermediate line are to be placed the estimate of standards near lower culmination, the estimate (when taken) of a polar standard, and general statements regarding weather, clearness, and other conditions affecting the observation. Among these items it is to be specified whether standard (polar) stars 156 and 157 are visible to the unaided eye.

Marked changes in these conditions is sufficient cause for a division between consecutive series.

The record of a star estimate in the journal is to begin with the number of the star observed, ^{adding "l.c." when the star is near its lower culmination} on the same line with the figure needed for the record, add only such remarks as relate to the particular observation. For standards near lower culmination the time should ^{also} be given. ~~Should occasion arise~~

~~For entries in the journal the estimate of a non-polar standard not near lower culmination, it should be marked "std" instead of l.c. Similarly a polar standard should be marked "polar". The general catalogue number instead of its number on the chart. Both numbers will be found in the log sheet and also in the abstract of the catalogue of standards.~~

In the following example, series 139 and 140 are supposed to have been observed Feb. 1, 1881, with an intermission for cause foreign to the observation. (Delay on account of cloud or haze would have been recorded.) In series 139, taken early in the evening, standard star 67 was estimated near lower culmination at $7^h 15^m$. It is recorded as having a magnitude greater than standard star 39 by 0.4 of the excess of the magnitude of the fainter standard star 34 over that of 39. In series 140, beginning an hour before midnight and continuing two hours, other lower culminations are taken, at $11^h 20^m$ and $12^h 55^m$ respectively, and also the polar standard 155.

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J. Smith. Obs. Harv. Coll. Observatory. 1881

Feb. 1 Series 139 Begin 7^h 05^m
 Moderately clear. 157 visible. 156 invisible.
 139 *l.c.* 39 4 34 7^h 15^m
 End 8^h 30^m

Feb. 1 Ser. 140 Begin 11^h
 Very clear. 156 visible
 83 *l.c.* 31 8 40 11^h 20^m
 155 *polar* 20 5 41
 156 invisible. 12^h 05^m
 91 *l.c.* 36 3 33 12^h 55^m
 End 13^h

J. Hunt. Mr. Wm. B. W. W. W. W.

Directions for the Ledger.

The sheets furnished bear the number of the ^{stars} sheets to be observed, one line being devoted to each star, except the standards. The latter have three lines each, there being one line for each estimate desired. ^{When three estimates are to be taken on different evenings,} The record is to be made upon ~~the first half of~~ the line bearing the number of the star, the first entry being the number of the series, as already directed. The observations are not limited to the order of the stars on the sheets, but the effort is to be made to avoid long standing vacancies. Each sheet is to receive the signature of the observer.

Duplicate observations, taken by mistake or otherwise, should be recorded without changing the earlier record. In repeating for suspected variability estimate the time at which the first observation was taken, and record it enclosed in [] against that observation. The [] will denote that the enclosed was not precisely noted when the observation was made.

In the following example, star 4100 is supposed to have been observed in series 138. It is recorded as having a magnitude greater than standard star 40 by 0.1 of the excess of the magnitude of the fainter standard 46 over that of 40. Standard star 36 (~~4101 in the general catalogue~~) is supposed to have been estimated once each in series 138 and 139, while another estimate remains to be taken. Star 4102 is recorded equal to standard star 34, the estimate having been made in series 138. Star 4104 is recorded fainter than λ Her. min. (156), ^{an open star, having been used.} Star 4105 having been observed in series 137, and its variation being suspected in series 139, a second estimate is taken in the latter series, and the time of taking the former is approximated to. Star 4103 and those from 4106 onward remain to be observed.

4100	138	40	1	46	
236 = ~~4101~~	138	33	7	32	
"	139	29	8	30	
4102	137	34	-	34	
4103					
4104	138	156	-	-	O. S.
4105	137	37	5	38	[8'10] } 139 36 4 29 8'25
4106					
237 = ~~4107~~					
"					
238 = ~~4108~~					
"					
4109					
4110					
239 = ~~4111~~					
"					
4112					

(Signature added when sheet is finished by the observer.)

J. Smith. Obs.

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