film or the results of imperfect development. The fact that they are found only in the immediate vicinity of the bright flash is additional testimony in the same direction. These markings are wholly different from any that I have seen, not having the form of branched flashes. Something in their resemblance to photographs of sound-waves started by a spark, which I have recently made (see *Phil. Mag.* for August) suggested to me that they might possibly be due to the illumination of the sound-wave due to a powerful discharge by a second discharge. Under ordinary conditions, that is with a uniformly illuminated background, such waves would, of course, be invisible, but conditions might possibly arise, due to the proximity of black clouds, under which they might show—a sort of 'Schlieren Methode' on a large scale. I have not attempted yet to plan an arrangement of clouds, which, by acting as screens to light coming from certain directions, might render visible a region of the air, in which the optical density underwent a rapid change. In Mr. Lumsden's picture there are many dark clouds close to the flash. The idea of a photograph of a thunder-wave is a pleasing fancy at all events.

It seems to me that it will be impossible to formulate even a reasonable guess as to the cause of these dark flashes until a good many pictures are gotten together for comparison, and as much testimony as possible secured as to the appearance of the flashes to the eye. Personally, I have seen very few of the pictures and never the original negative.

My intention in writing this letter is not so much to advance theories accounting for the phenomenon of the dark-flash as to re-awaken an interest in the subject and bring out ideas from persons better qualified than I to treat the matter.

R. W. WOOD.

MADISON, WIS.

## A REPLY.

EDITOR OF SCIENCE: The review of my 'Elements of Practical Astronomy' by G. C. C., in SCIENCE for June 16th, criticises adversely some eight or ten small points. In so far as the article expresses the reviewer's individual opinions, there is no call for a reply, since that is the prerogative in which a critic should be protected. But I venture to say that the reviewer's zeal has led him unconsciously to make several erroneous statements.

In answer to the reviewer's remark: "Throughout his entire work the author appears to have ignored the advantage offered by addition and subtraction logarithms," I respectfully refer him to page 50, where both addition and subtraction logarithms are employed, and to the statement, p. 243: "If two quantities are given by their logarithms, and the logarithm of their sum or difference is required, it should be found by means of addition and subtraction logarithms." This covers the whole case.

The reviewer regrets that the book gives up '4% to diurnal parallax as affected by the earth's compression.' Such is not the case. Less than 2% is devoted to this subject, and in reality only about 1%, if we deduct the space demanded for the substitute treatment of the earth regarded as a sphere. Besides, the inclusion of this subject is imperative, unless, indeed, we exclude observations of meteors, the moon and any other near-at-hand bodies. Is G. C. C. willing to send out students of Practical Astronomy ignorant of the fact that there can be a parallax in azimuth? His criticism means just that.

The formula expressing the rate of a chronometer, p. 160, criticised in all seriousness by G. C. C., will meet his requirements if we replace the missing exponent 2 over the parenthesis—the only omission of the slightest consequence yet brought to my notice in the more than 400 equations. This formula is as fundamental in dealing with a chronometer as $\sin^2 + \cos^2 = 1$ is in Trigonometry, and should give a reviewer no trouble.

The reviewer refers to a well-known method of computing the azimuth, p. 199, and curiously enough misses the whole point of the method. He suggests another method—also well known—which in practical use is actually longer, with the added disadvantage of requiring two kinds of logarithms in the same solution. It is true that one solution by the first method requires 21 entries on the computation sheet (all the quantities being recorded), whereas the substitute

requires only 15 entries. But in this problem it is the custom to make several solutions in succession, in parallel columns; and in all columns after the first the criticised method requires fewer entries than does the suggested substitute. The reviewer's failure to see the point is all the more surprising, since, on the same page, alongside the first column, is a second column, in which only 10 entries are required. In fact, if no unnecessary recording is done, five entries are sufficient.

And most teachers of 'Practical Astronomy' will agree in my opinion that the wider publication of addition and subtraction logarithms has not done away with the desirability of 'adapting formulæ to logarithmic computation.' The solution of most problems is actually shortened by transforming the equations so that such logarithms are not needed. These logarithms were well known to Chauvenet, were referred to by him, and he made it clear (Vol. I., p. 211) when they should be used. In the class of problems we are considering, their wider publication has not influenced the form of solution appreciably with many astronomers, nor does it deserve to, for valid reasons. Take the case most strongly criticised by G. C. C.—that of determining the hour angle $t$ from a measured altitude. I have—on five different pages—equally recommended using the well-known forms $\tan \frac{1}{2} t$ and $\sin \frac{1}{2} t$. I understand, and every reader of the criticism will understand, that G. C. C. would entirely replace these by the well-known form $\cos t$, not only in the example solved by me, but in all such solutions. A solution through $\tan \frac{1}{2} t$ requires 17 entries, but this method is the most accurate and most generally applicable of the three. Slightly less accurate and general is the solution through $\sin \frac{1}{2} t$, which requires 14 entries; and this is the form most frequently used by astronomers. The solution through $\cos t$ requires 13 entries, besides the use of two kinds of logarithms, and has the further disadvantage that it is less general than the other two forms. In fact, $\cos t$ should not be used at all if $t$ is less than 30°; and the observer's position, combined with clouded skies, will often make observations under such conditions desirable. There are many astronomers, of the greatest experience, who would not use the $\cos t$ formula when $t$ is less than 45°; they would employ the forms $\sin \frac{1}{2} t$ or $\tan \frac{1}{2} t$ in preference. To save one or two entries at the expense of accuracy and generality of the formulæ, strikes me as being poor astronomy and poor pedagogy.

It is plain that the reviewer regrets the insertion of an Appendix containing the principal 'Formulæ Resulting from the Method of Least Squares,' 'with no pretense at their derivation.' The Method of Least Squares is not a branch of Astronomy, any more than are Trigonometry and Logarithms. It is a method employed in all the sciences where quantitative observations are made. The formulæ used in applying the method have been appended for ready reference, and have been found convenient. There is no longer any practical reason for including a chapter on this subject, since several small text-books on Least Squares are available. There is one of some 60 pages written by a gentleman whose initials are G. C. C. (presumably the reviewer)—it is called a 'Treatise'—in which *the one fundamental equation of the subject is assumed*, 'with no pretense at its derivation.'

The reviewer objects to devoting $2\frac{1}{2}$ % "of the entire treatise to such an antiquated matter as lunar distances." As I explained in the book, this method "is occasionally of considerable importance to navigators and explorers." It is sufficient to say that the French *Connaissance des Temps* devotes about 5 % of its space, the British *Nautical Almanac* about 11 % and the American *Nautical Almanac* more than $13\frac{1}{2}$ % to the data for solving this problem.

Likewise, the objectionable $1\frac{1}{2}$ % devoted to the ring micrometer is introduced with the statement that results obtained with it "can be regarded as only approximately correct, and the ring micrometer should never be used with an equatorial telescope unless, in case of great haste, there is not time to attach the filar micrometer and adjust its wires by the diurnal motion;" and further "that it can be used with an instrument mounted in altitude and azimuth, * * whereas a filar micrometer cannot." These remarks cover the entire case, and it is impossible that they should mislead a student.

The reviewer has called attention to a real

error on p. 75, which I beg leave to acknowledge. By neglecting differential refraction in the determination of the value of a revolution of a micrometer screw (in the second of the three methods proposed) an error of about one part in 3,600 is introduced. That is, if the value of a revolution is 18″, the effect of neglected refraction is 0″.005.

Again, by a slip of the pen, p. 43, the author is made to say that "*In all cases* the refraction must be applied first." There is one exception that, in altitudes measured from the sea horizon, the correction for dip should be applied previous to the correction for refraction.

My statement concerning the surveyor's transit, that the time, latitude and azimuth "can easily be determined to an accuracy within the least readings of the circle" is the literal truth, so far as the methods given by me are concerned. I have not attempted to get everything possible out of the surveyor's transit, and why should I? If great accuracy is required, instruments and methods specially adapted to the solution of the problem, and described in the earlier chapters of the book, will be employed. Why should an astronomer make a fad of a surveyor's transit when he has an observatory full of instruments which will do his work better? No further explanation is needed for the reviewer's remark that the surveyor's transit 'has been strangely neglected by astronomers.' W. W. CAMPBELL.

The reviewer, after careful consideration of Professor Campbell's remarks printed above, finds no reason to modify any of the opinions expressed in the review. G. C. C.

FOEHN WINDS.

TO THE EDITOR OF SCIENCE: In connection with Professor Wilson's communication on Foehn Winds in SCIENCE for August 18th, I beg to say that the word *foehn* was misspelled *foehm* in the proof sent me from the publication office of this JOURNAL. I made the necessary corrections in the proof, but for some reason the final *m* was left standing, instead of being replaced by the *n*. Being away from Cambridge at the time, I did not notice the mistake in the final printing of my note (in SCIENCE for July 21st) until a few days ago, and hence it happened that Professor Wilson anticipated me in making the necessary correction. R. DEC. WARD.

HARVARD UNIVERSITY, DEPARTMENT OF GEOLOGY AND GEOGRAPHY.

## SCIENTIFIC NOTES AND NEWS.

THE University of Mississippi has conferred the degree of LL.D. on Dr. Eugene A. Smith, of the University of Alabama.

THE following appointments under the Department of Agriculture are announced: Mr. W. A. Orton, of the University of Vermont, Assistant in the Division of Vegetable Physiology and Pathology, and Mr. Hermann von Schrenk, Special Agent in this division: Messrs. C. R. Ball, E. D. Merrell and P. B. Kennedy Assistants in the Division of Agrostology.

DR. W. PFEFFER and Dr. Zirkel, professors of botany and of mineralogy, respectively, at Leipzig, have been elected foreign members of the Accademia dei Lincei, of Rome.

THE Académie Internationale de Géographie Botanique has conferred its international scientific medal upon Professor John M. Coulter, of the University of Chicago.

PROFESSOR G. H. HOWISON, of the department of philosophy of the University of California, and Professor Irving S. Stringham, of the department of mathematics, will spend the coming academic year abroad.

PROFESSOR A. C. ARMSTRONG, JR., who holds the chair of philosophy in Wesleyan University, will be abroad during the coming year.

PROFESSOR J. MARK BALDWIN has been given a half year's leave of absence from Princeton University to see the *Dictionary of Philosophy and Psychology* through the press in England. He intends to sail on September 19th and wishes all the American contributions, proofs, etc., to be in his hands in the first week of September. His London address is care Messrs. Macmillan & Co. His courses at Princeton will be in the hands of Professor H. C. Warren.

THE funeral of Sir Edward Frankland took place at Reigate on August 22, the services being conducted by the eminent geologist Professor Bonney. Among those present were Lord Lister, Sir Frederick Bramwell, Sir Henry