The *Sun*. New and revised edition. CHARLES A. YOUNG.
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& Co., New York, 1895.)

The success with which researches in solar physics have been prose-
cuted since 1881, when this well-known work first appeared, has been
recognized in the various subsequent editions by the addition of
numerous notes and appendices. The present edition, however, repre-
tsents a most thorough revision of the text, and the addition of much
new matter and many illustrations. In fact, a careful comparison of
the text with that of the 1884 edition shows that we are dealing with
what is almost a new work, retaining all the excellent qualities which
have rendered its predecessor so justly popular, with the added inter-
est of new observational and theoretical results, described without
prejudice, and estimated at their true value. Though written for the
general reader, to whom it has proved most acceptable, it is safe to say
that the book is kept within reach by every astronomer. To illustrate
how fully the revised edition represents the present state of our knowl-
dge of the Sun, it will perhaps be profitable to enumerate the principal
changes and additions which it embodies. These epitomize the
progress of solar research during the last eleven years.

The general remarks which form the introduction to the volume called
for no important modifications and remain substantially as they were
originally. The value of the solar parallax, with which chapter i. is
principally concerned, has undergone no very marked change during
the last decade, and the approximate result 8°.80 given in the earlier
edition, is retained. (The values adopted by Newcomb and Harkness
in their recent volumes of astronomical constants are 8°.797±0.004 and
8°.809±0.006 respectively.) The principal additions to this chapter
are an account of the observations of the transit of Venus in 1882, with
a cut of the photoheliograph, and a brief description of Gill and Elkins'
determination of the solar parallax from heliometric observations of the
minor planets. Chapter iii. has been considerably enlarged; it now
contains a description of Rowland's gratings, with a cut of the ordinary
form of mounting for concave gratings; remarks on spectrum photog-
raphy and its value for certain classes of work; an excellent cut of
the great Princeton spectrograph attached to the 23-inch telescope;
descriptions of the spectrum maps of Rowland, Higgs and Langley;
Rowland's latest list of the elements present in the reversing layer;
Trowbridge's results with regard to oxygen in the Sun, showing that none of the bright lines in the line spectrum of oxygen occur in the solar spectrum between $\lambda 3750$ and $\lambda 5034$; the spectroscopic investigations of Crew and Dunér on the solar rotation; and Cornu's method of picking out the telluric lines by causing them to vibrate in unison with an oscillating solar image. (It may be noted in passing that the references on p. 64, line 14, should be to pages 74 and 202.)

The chapter on "Sun-spots and the Solar Surface" describes the work of Deslandres and Hale, in photographing the solar surface with the spectroheliograph; corrects the popular belief in a sudden and decided magnetic disturbance precisely coinciding in time with Carrington's unique observation of a brilliant object moving across a Sun-spot; and includes Professor Young's own observations of the bulbous ends of penumbral filaments seen in Sun-spots. His success in resolving the ends of the filaments into fine, sharp-pointed hooks with the 23-inch Princeton refractor, seems to indicate that their ordinary appearance is due to poor "seeing" and insufficient resolving power. A cut of the great Sun-spot of October 1883, from a drawing by Tacchinini, appears on p. 128. A discussion of the observations of Howlett and Sidgreaves, whose results oppose those of Wilson and De La Rue, does not lead the author to abandon the long-established idea that spots are depressions in the photosphere. While the painstaking researches of the later investigators are entitled to most respectful consideration, and must be taken into account in all future discussions of the subject, it is probable

One passage here, which entirely misrepresents my views, cannot be allowed to pass without correction. It reads as follows: "This makes it more or less probable that the faculae, instead of being mere protrusions from the photosphere, are really luminous masses of calcium vapor floating in the solar atmosphere,—possibly as Professor Hale thinks, identical with the prominences themselves. But Deslandres and Maunder dissent from this, and say that while these objects shown by the spectroscope are clearly connected with the prominences, they are as clearly not identical with them." As a matter of fact, I have always considered the combined evidence to indicate that the brighter reversed regions represent the hot calcium vapor, rising from the Sun's interior through the faculae, and distributed throughout their upper portion. In certain exceptional cases, to some of which I have called attention, bright eruptive prominences on the disk may be photographed. M. Deslandres now holds that the spectroheliograph shows the calcium vapor in the chromosphere above the faculae, but not in the faculae themselves. The question at issue is simply this: At what height above the photosphere do the bright reversals originate? M. Deslandres' earlier view was as follows: "Cependant les flammes faculaires sont formées de calcium et d'hydrogène; elles ont la même composition que les protubérances; ce sont des protubérances se projetant sur le disque."—Knowledge, December 1893.
that to the majority of solar physicists the balance of evidence seems to lie on the side of the older view. The common lack of symmetry in Sun-spots, and the rapidity with which they develop while crossing the disk, render statistical studies of penumbral width somewhat inconclusive, as the conflicting evidence clearly testifies. Although observations of spots at the limb are ordinarily complicated by the presence of an encircling ring of faculae, they may be said to favor, rather than to oppose, the original idea of Wilson. It may be that micrometrical measures of the apparent width of the penumbra may ultimately assist in deciding the matter.

The period of the Sun’s axial rotation deduced by Hornstein, Bigelow and Veeder from periodic variations in the Earth’s magnetism are given in a new footnote “for what they are worth,” the author evidently wishing to see them much more firmly established than they are at present, before incorporating them in the text. The discussion of the important subject of the equatorial acceleration is somewhat augmented, and now includes Wilsing’s period deduced from measures of the faculae recorded on the Potsdam photographs. The fact that these results do not agree with observations of spots and Dunér’s spectroscopic measures in establishing a general equatorial acceleration has never been satisfactorily explained, though the necessity of determining the positions of the faculae from plates which show them only when near the limb, naturally lessens one’s confidence in Wilsing’s conclusions. The changes in form which ensue during the passage of a facula across the disk are such as to make subsequent identification of the point previously measured practically impossible. Bélopolsky’s results (which are not given by Professor Young) appear to him to contradict those of Wilsing, and to give periods corresponding with those of the spots. Wilsing rightly maintains that no very certain inferences can be drawn from the limited number of measures made by Bélopolsky, and concludes from a discussion of the observations that they merely show a constant difference from his own. Bélopolsky replies that they refer to a much higher latitude, and the constant difference pointed out is in very close agreement with the corresponding difference between the rotation periods of spots in the respective zones. Moreover, as Professor Young remarks, Stratanoff’s more recent results are in substantial accordance with Carrington’s spot period. The question demands a much more extended investigation than it has hitherto received. Other additions to this chapter include a reference to Bélopolsky’s application
to the Sun of Jukowsky's investigations on the rotation of fluid masses, a cut representing the apparent positions of the solar axis at different times of the year, and a correction to the previous edition regarding Spoerer's views as to the condition of the Sun's interior.

Chapter v., dealing with the periodicity of Sun-spots, their effects upon the Earth, and theories as to their cause and nature, has naturally received much attention in the revision. Wolf's Sun-spot numbers are brought down to 1891. It is fortunate that the continuity of the series, broken by the death of Professor Wolf in 1893, has been restored by his successor, Herr Wolfer. Spoerer's important discovery of the variation of spots in latitude during the eleven-year period is described, and illustrated by curves showing the distribution of the spots in latitude from 1855 to 1880. Dr. Veeder's idea that auroras are the direct result of disturbances at the eastern limb of the Sun does not commend itself to Professor Young, who quotes Maunder's statement that in a period of nearly nineteen years the three greatest magnetic storms have been simultaneous with the maximum development of the three greatest Sun-spots, none of which were near the eastern limb at the time. That in certain cases violent disturbances on the Sun's limb exactly coincide with twitches of the magnetic needle is illustrated by Professor Young's well-known observation of this kind at Mount Sherman in 1872. But equally violent phenomena with no corresponding magnetic perturbations have been far more frequently observed. Our author does not consider the Sun's effect upon terrestrial magnetism to be a direct one—the passage he quotes from Lord Kelvin's 1892 address seems to disprove that; but he does hold that there is a connection of some kind between solar activity and the oscillations of the magnetic needle. In the case of a magnetic storm he considers it not impossible that the Sun expends sufficient energy to "pull the trigger," but not necessarily to produce the explosion. Whence comes the energy represented by the storm itself remains an apparently insoluble mystery.

Wilson's recent measures of the heat radiated from Sun-spots are referred to in connection with those of Langley, and attention is called to the interesting fact that the radiation of the umbra as compared with that of the neighboring photosphere increases as the limb is approached. Among the recent theories of spot formation those of Lockyer, Schaeberle and Oppolzer are given in outline. The two former are in practical agreement with that of Sir John Herschel, in so far as they attribute the genesis of a spot to the fall of heavy masses upon
the photosphere,—an idea which can hardly be reconciled with the statements of Secchi, Sidgrees and others that faculæ sometimes appear upon the disk before the spot has formed. Oppolzer's theory is more favorably criticised, but the difficulty of accounting for the polar streams is pointed out, and it might have been added that as yet we have no substantial observational evidence of their existence.

In passing on to a discussion of the prominences no important changes are introduced until the list of chromospheric lines is reached. In this the lines $\lambda 7065.50$ and $f$ are now ascribed to helium, while H and K, which in the earlier addition were doubtfully credited to hydrogen, are now given to calcium. A woodcut, after an excellent photograph by Professor Reed of the C line doubly reversed in the chromosphere spectrum, is given on p. 209, Trouvelots "dark" prominences and Tacchini's "white" prominences are mentioned in the discussion of the ordinary types, but with the remark "that the evidence hardly warrants confident belief in the existence of such objects." Brester's theory of a quiescent solar atmosphere, with prominence forms produced by the effects of luminescence, is criticised on the ground that it offers no adequate explanation for the line distortions ordinarily attributed to motion in the line of sight. Until it is proved that a flash lighting up a succession of stationary particles can produce the spectroscopic phenomena observed in eruptive prominences, Brester's theory cannot be expected to receive favorable consideration from solar physicists. Schmidt's theory has gained rather wider acceptance, but a closer examination of its consequences is leading some of its former supporters to abandon it, at least in its application to the Sun. Among the numerous objections which have been raised against it, that pointed out by Professor Young is as simple and conclusive as any. A mass of metallic vapors exposed to the cold of space must inevitably form a photosphere within a short time. Permanent gases would not thus condense, and it may therefore be that some of the planetary nebulae conform to Schmidt's theory.

The remainder of the chapter is devoted to an account of the methods and results of prominence photography, a field in which Professor Young himself was the first to experiment. (On p. 230, line 22, "1884" should be "1889"). The cuts include excellent double reversals of H, K and $H\alpha$, and prominences photographed in the H, K and $H\alpha$ lines through a wide slit at Princeton; the spectroheliograph used from 1891 to 1895 at the Kenwood Observatory, and three groups of prominences.
photographed with it. The work of Deslandres and Hale is accurately described, though the spectroheliograph used by the former is much more efficient than that with which he is credited.

Chapter vii. is enriched with three new cuts of the corona, from photographs taken at the eclipses of 1882, 1889 and 1893. (In the title of Fig. 91, “Burckhardt” should be “Burckhalter.”) Unfortunately the beautiful detail of Professor Schaeberle’s photograph of the inner corona has been lost in the process of reproduction. An account of the unsuccessful attempts of Huggins, Wright and Hale to photograph the corona without an eclipse closes with the assurance that “to the writer at least, the case appears by no means hopeless”—a crumb of comfort that those who are still engaged upon the problem can hardly fail to appreciate. The five pages devoted to theories of the corona include those of Hastings, Schaeberle and Bigelow, with a brief description of the suggestive electrical experiments of Pupin.

The first half of the next chapter, on the Sun’s light and heat, remains practically unchanged, and is followed by a revised account of Langley’s bolometric work, with cuts of the spectrobolometer and a small map of the infra-red spectrum. The results of Langley, Frost and Wilson, on the radiation of the photosphere at various distances from the center of the disk, are tabulated for convenient comparison. Taken in connection with the earlier photometric measures of Pickering and Vogel, they agree in bringing out very clearly the rapid increase of absorption in the upper spectrum. In the discussion of the effective temperature of the Sun, Rosetti’s value of 10000° C. is now supplemented by Le Chatelier’s and Wilson and Gray’s results of 7600° C. and 8000° C. respectively. Scheiner’s conclusion, derived from a study of the relative intensities of two magnesium lines, that the temperature of the reversing layer at the altitude where the magnesium absorption is produced is about equal to that of the electric arc, is also given.

The volume closes with a valuable summary of the observatory and laboratory investigations of helium.

The present review, touching as it does upon only its new features, must fail to convey any sense of the continuity of an exceptionally well-constructed work. Professor Young’s well-known clearness of expression and attractive style will recommend the book to every intelligent reader.

G. E. H.