scientific workers give a personal touch to the text. We have tried it on a boy of ten and a somewhat *blasé* reader of fifty, and both give the same verdict—that it is extraordinarily interesting. We should like to have seen the authors' names, and we should like to cut the parts and bring, let us say, all the Hygiene together; but these are minor matters. We wish this popularisation all success, because it is sound; and what are the factors in this soundness?

It appears to us that the chief desiderata in an educational enterprise of this sort are the following:—Getting contributors with the gifts and graces already alluded to, plus the crowning humility of taking pains and obeying the editor (to whom our compliments); the good sense not to pretend that everything is easy, since nothing thorough is; the critical faculty of discerning what can be presented accurately, and at the same time intelligibly, for while most true ideas are clear there is a clarity that only dazzles the man in the street; and, last, the restraint which forbids "giving to the ignorant, as a gospel, in the name of Science, the rough guesses of yesterday that to-morrow should forget." We do not mean to suggest that this huge work has all these virtues in perfection, but it has striven after them, and therefore we wish it well.

OUR BOOKSHELF.

Arabische Gnomonik. No. 1. By Dr. Carl Schoy. Pp. 40+2 plates. Aus dem Archiv der Deutschen Seewarte.) (Hamburg, 1913.)

THIS mathematical account of Moslem dialling, by a writer already known for his studies of Arabic astronomy, forms one of the publications of the Deutsche Seewarte.

The author first touches on the bibliography. There is food for thought in the fact that but two references are given to English writers. The Arabic sun-dial differs from that of the Greeks in having a single point, at the apex of a spike, for index, in place of the gnomon. The horizontal dial is first treated, and rules are given for laying off "temporary hour-lines." These hours, duodecimal subdivisions of the daylight interval, vary in length; nevertheless, their inconvenience did not prevent their universal adoption until the time of Abu'l Hassan, who introduced equal hours about 1200 A.D. They are specially dealt with in the third chapter. The analysis of the clepsydra in this chapter gives unequal hours, since it assumes—erroneously—a constant rate of discharge.

Next follow two chapters on the determination of the Kibla and the times of prayer—sunset, nightfall, dawn, noon, and afternoon (asr). The last, with its various definitions, is discussed in some detail. The closing chapters concern vertical, cylindrical, and conical dials.

Though leaning towards the academic in places (the author employs declinations of 36°, −69°, −45°, and 63° on p. 21), the work is of high interest and much utility to all who have to do with Moslem chronometry. A few typographical errors apart, it is well printed, but an index would have been a useful addition. J. I. C.

Cotton Spinning. By W. S. Taggart. Vol. I. Including all Processes up to the End of Carding. Pp. xxxvi+262. Fourth edition. Vol. II. Including the Processes up to the End of Fly-frames. Pp. xiv+245. Fifth edition. (London: Macmillan and Co., Ltd., 1913.) Price 4*s*. net each.

THESE books have been brought up to date, and much new matter and many illustrations have been added. In all essential respects they resemble the previous editions, which have gained a wide circulation among students and practical cotton-spinners.

Modern Problems in Psychiatry. By Prof. Ernesto Lugaro. Translated by Drs. D. Orr and R. G. Rows. With a Foreword by Sir T. S. Clouston. Pp. vii+305. Second edition. (Manchester University Press, 1913.) Price 7*s*. 6*d*. net.

THE first English edition of Prof. Lugaro's book was reviewed in the issue of NATURE for January 6, 1910 (vol. lxxxii., p. 273). The present issue differs in no important respect from the former; a large number of minor changes, including the correction of several errors, have been made.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Spectra of Helium and Hydrogen.

RECENTLY Prof. Fowler (Month. Not. Roy. Astr. Soc., December, 1912) has observed a number of new lines by passing a condensed discharge through mixtures of hydrogen and helium. Some of these lines coincide closely with lines of the series observed by Pickering in the spectrum of the star ζ Puppis, and attributed to hydrogen in consequence of its simple numerical relation to the ordinary Balmer series. Other lines coincide closely with the series predicted by Rydberg and denoted as the principal series of the hydrogen spectrum. The rest of the new lines show a very simple relation to those of the latter series, but apparently have no place in Rydberg's theory.

From a theory of spectra (*Phil. Mag.*, July, 1913) based on Rutherford's theory of the structure of atoms and Planck's theory of black-radiation, I have been led to the assumption that the new lines observed by Fowler are not due to hydrogen, but that all the lines are due to helium and form a secondary helium spectrum exactly analogous to the ordinary hydrogen spectrum. This view is supported by recent experiments of Mr. Evans (NATURE, September 4, p. 5), who observed the line 4686 in a helium tube not showing the ordinary hydrogen lines. Prof. Fowler (NATURE, September 25, p. 95), on the other hand, brings forward some objections against the assumption that the lines are due to helium. In his communication Fowler states that the two series of lines, denoted by him as the first and the second principal series of the hydrogen spectrum, in his opinion cannot be united within the limits of error of observation in a single series, such as my theory claims. However, I believe that it is possible on the theory to account for the lines in satisfactory agreement with the measurements.

The first and the second columns of the table below contain the wave-lengths given by Fowler for the new lines and the corresponding limits of error of observation. The lines are marked by P_1, P_2, and S. according as they belong to the first or the second principal series or the Sharp series respectively. The figures in the third column are the products of the wave-lengths and the quantity $\frac{1}{n_1^2}-\frac{1}{n_2^2}$, where n_1 and n_2 are given in the bracket.

	$\lambda \cdot 10^8$	Limit of error	$\lambda\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right) \cdot 10^{10}$	
P_1	4685·98	0·01	22779·1	(3 : 4)
P_2	3203·30	0·05	22779·0	(3 : 5)
P_1	2733·34	0·05	22777·8	(3 : 6)
P_2	2511·31	0·05	22778·3	(3 : 7)
P_1	2385·47	0·05	22777·9	(3 : 8)
P_2	2306·20	0·10	22777·3	(3 : 9)
P_1	2252·88	0·10	22779·1	(3 : 10)
S	5410·5	1·0	22774	(4 : 7)
S	4541·3	0·25	22777	(4 : 9)
S	4200·3	0·5	22781	(4 : 11)

The figures in the third column are very nearly equal, and apparently there is no indication of a systematic difference in the figures corresponding to the lines denoted by P_1 and P_2.

The corresponding figures for the first lines in the ordinary spectrum of hydrogen (Ames, *Phil. Mag.*, xxx., p. 48, 1890) are:—

$\lambda \cdot 10^8$	$\lambda\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right) \cdot 10^{10}$	
6563·04	91153·3	(2 : 3)
4861·49	91152·9	(2 : 4)
4340·66	91153·9	(2 : 5)
4101·85	91152·2	(2 : 6)
3970·25	91153·7	(2 : 7)

According to the theory in question we have

$$K=\lambda\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)=\frac{ch^3(M+m)}{2\pi^2E^2e^2Mm},$$

where c is the velocity of light, h Planck's constant, e and m the charge and mass of an electron, and E and M the charge and mass of the central positive nucleus in the atom. This formula is deduced exactly as that given in the *Phil. Mag.*, where, however, in order to obtain a first approximation the mass of the electron is neglected in comparison with that of the nucleus.

The above tables give for hydrogen and for helium respectively

$$K_H=91153.10^{-10}, \quad K_{He}=22779.10^{-10}.$$

The ratio between these values is:—

$$\frac{K_H}{K_{He}}=4·0016.$$

From the theoretical formula we get for hydrogen, putting $E=e$ and $M=1835m$, and using recent determinations of h, e, and m:—

$$K=92.10^{-7}.$$

The agreement with the experimental value is within the uncertainty due to experimental errors in h, e, and m.

The theoretical value for the ratio between K for hydrogen and for helium can be deduced with great accuracy, as it is independent of the absolute values of h, e, and m. Putting $E_{He}=2E_H$ and $M_H=4M_H$, we get from the formula:

$$\frac{K_H}{K_{He}}=4·00163$$

in exact agreement with the experimental value.

It may be remarked that according to the theory helium must be expected to emit a series of lines closely, but not exactly, coinciding with the lines of the ordinary hydrogen spectrum. These lines, hitherto not observed, correspond to $n_1=4$ and $n_2=6$, 8, 10 . . ., and have the wave-lengths 6560·3, 4859·5, 4338·9 . . . The lines are expected to appear together with the lines of the Sharp series observed by Fowler and to have intensities of the same order as the latter lines.

N. BOHR.

The University, Copenhagen, October 8.

I AM glad to have elicited this interesting communication from Dr. Bohr, and I readily admit that the more exact form of his equation given above is in close accordance with the observations of the lines in question. It will be seen that the equation now introduces a modified value for the Rydberg series "constant," 109675, in addition to its multiplication by 4 for the particular series under consideration. The constant 22779, which is deduced from the wave-lengths of the lines is the reciprocal of this modified number, and in the usual numerical form, for oscillation frequencies corrected to vacuum, the equation for the lines would be:—

$$n=(4\times 109,720)\left\{\frac{1}{3^2}-\frac{1}{m^2}\right\}$$

where m takes the values 4, 5, 6 . . . .

With this modification, the agreement with the observations is very close; in only two cases do the calculated values differ from those observed by amounts greater than the estimated limits of error, and I should not like to insist that such errors in the measurements are inadmissible. It may therefore be possible to unite the P_1 and P_2 series in a single equation, as Dr. Bohr's theory requires, but it should be noted that the combination demands the recognition of a type of series differing from those previously known. The result of this combination is to give what may be called a "half-step" series, such as would be obtained by combining ordinary first and second subordinate series, in the special case where the fractional parts of the terms $(m+\mu)$ in Rydberg's equations for the two series differed by exactly 0·5. Consideration of the relative intensities of the two sets of lines would in general prohibit this procedure, but this objection cannot be made in the case of the lines under discussion. It is possible that the magnesium spark lines, which I have recently described, form another series of the same kind but I know of no others.

The corrected formula given by Dr. Bohr leads to the further important result that alternate members of the ζ Puppis series cannot be superposed on the Balmer hydrogen lines, as at first appeared, but should be slightly displaced with respect to them. Dr. Bohr, however, appears to have inadvertently interchanged the last two figures of the constant 22779 in working out the wave-lengths, and the lines should be expected, within very narrow limits, at 6560·37, 4859·53, 4338·86, 4100·22 . . . . This should provide a valuable test of the theory, as the lines near Hβ and Hγ, at least, should not be very difficult to detect, if present, in stars of the ζ Puppis