thus coinciding with the transmitted part of the first pencil; and the two pencils are thus brought to 'interfere.'[1] A little consideration will show that this arrangement is exactly equivalent to an air-film or plate between two plane surfaces. The interference phenomena are therefore the same as for such an air-plate.

If the virtual distance between the plane surfaces is small, white light may be employed, and we have then colored fringes like Newton's rings or the colors of a soap-film. If the distance exceeds a few wave-lengths, monochromatic light must be employed. We may confine our attention to the case of two parallel surfaces. Here it can readily be shown that the fringes are concentric circles, the common axis of the rings being the normal passing through the optical centre of the eye or telescope. Further, they are most distinct when the eye or the telescope is focused for parallel rays. In any other case we are troubled with the same perplexing changes of form and position of the fringes as already noted.

If, now, one of the mirrors have a motion normal to its surface, the interference rings expand or contract; and, by counting the fringes as they appear or disappear in the centre, we have a means of laying off any given distance in wave-lengths.

Should this work of connecting the arbitrary standard of length — the yard or the metre — with the unalterable length of a light-wave prove as feasible as it is hoped, a next step would be to furnish a standard of mass based upon the same unit.

Suppose a cube, ten centimetres on a side, with surfaces as nearly plane and parallel as possible. Next suppose a testing-instrument made of two parallel pieces of glass, whose inner surfaces are slightly farther apart than an edge of the cube. The parallelism and the distance of these surfaces can be verified to a twentieth of a wave. Now apply this testing-instrument to the three pairs of surfaces of the cube, and determine their form, parallelism, and distance to the same degree of accuracy. We have thus the means of measuring the volume of a cubic decimetre with an error less than one part in a million.

It does not seem extravagant to say that by some such plan as this we may obtain a standard kilogram which will be related to the standard of length with a degree of approximation far exceeding that of the present standard. The apparatus can also be used in the manufacture of plane surfaces, and in the measurement of co-efficients of expansion.

For all measurements of refraction and dispersion, — for solids and liquids as well as for gases, — and in the determination of the wave-length of standard lines, the accuracy of the measurement of absolute wave-lengths will depend on the accuracy with which the fixed distance can be compared with the standard metre; and this may be estimated as one part in two million.

The results of the remarkable work of Rowland do not claim a much greater degree of accuracy than one part in half a million for relative determinations; while the elaborate research of Bell on absolute wave-lengths claims but one in two hundred thousand.

It may possibly help to realize the very considerable superiority of this instrument over the grating — at any rate, for the class of work in question — if I recall to your attention the fact that by its means it has been possible to show that the red line of hydrogen is a very close double.

Closely connected with the preceding investigations is the study of the effect of the temperature, thickness, and density of the source on the composition of the radiations, as shown by the symmetrical or unsymmetrical broadening of the spectral lines, and the consequent shifting of their mean position. This question has quite recently been taken up by H. Ebert, and the results he has already obtained are very promising. Ebert has established two conclusions, which, if verified, are of the greatest importance: namely, first, that the chief factor in the broadening of the spectral lines is the increase in density of the radiating body; second, that the broadening, in all the cases examined, is unsymmetrical, causing a displacement of the line toward the red end of the spectrum. The importance of these conclusions, in their relation to the proper motions of the heavenly bodies and their physical condition, can hardly be overestimated. The value of results of this kind would, however, be much enhanced if it were possible to find a quantitative relation between the density of the radiating substance and the nature of its radiations. In the case of hydrogen enclosed in a vacuum tube this could readily be accomplished. It may, however, be objected that it would be difficult in this case to separate the effects of increased density from those due to the consequent increase in the temperature of the spark. The problem of the temperature of the electric discharge in rarefied gases is one which has not yet been solved. In fact, it may seriously be questioned whether in this case temperature has any thing to do with the accompanying phenomena of light; and it appears to me much more reasonable to suppose that the vibratory motion of the molecules is not produced by collisions at all, but rather by the sudden release of tension in the surrounding ether.

[1] A second plane parallel plate of the same thickness and inclination is placed (for compensation) in the path of the first pencil.

BOOK-REVIEWS.

The Philosophy of Kant. By JOHN WATSON. New York, Macmillan. 8°. $1.75.

THE present volume consists of a number of extracts from Kant's principal works, — 'The Critique of Pure Reason,' 'The Metaphysic of Morality,' 'The Critique of Practical Reason,' and 'The Critique of Judgment,' — and is intended for the use of teachers of philosophy. Undoubtedly the study of Kant is the best introduction into modern philosophy, and a powerful means of guarding students from falling into a shallow materialism or positivism. The extracts are well selected, and the difficult task of rendering Kant into intelligible English without altering the character of his style too much has been skilfully solved. The book is an enlarged edition of the author's 'Extracts from Kant's Writings,' which was originally printed for the use of his own students. Professor Watson says that he found by experience the results obtained by means of lectures on philosophy very unsatisfactory, as the students did not learn to think for themselves: therefore he adopted the plan of supplementing his lectures by the study of the writings of various philosophers. This is the same method which is so successfully followed at German universities in what are called 'seminaries.' The teacher who will take this course will find Watson's book very useful and convenient, as it contains the salient points of Kant's philosophy.

Latin Accidence and Exercises. By W. WELCH and C. G. DUFFIELD. London and New York, Macmillan. 24°. 40 cents.

THIS book is intended as an introduction to Macmillan's 'Elementary Classics.' The principles on which the authors' plan is based are a thorough and accurate mastery of the elements of the Latin language, and the putting into intelligent practice at once what has been learned, thus avoiding as much rote-work as possible. The examples have been taken largely from the 'Public Schools Latin Primer,' as the latter is most widely used in the higher forms. The authors do not deem it desirable that beginners should learn the conjunctive mood, which, for this reason, has been added in small type at the end of the 'Accidence.' The book is intended to be mastered in two terms.

Elementary School Atlas. By J. BARTHOLOMEW. London, Macmillan. 8°. 30 cents.

THE publication under review belongs to Macmillan's Geographical Series, edited by A. Geikie, who promoted the interests of teaching geography so well by his well-known essay on this subject. As might be expected, the atlas represents a great improvement upon the ordinary English elementary school-maps, the material which is embodied in the maps being carefully selected, and the abominable relief-plate printing being at last discarded, a clear lithograph taking its place. The atlas contains twenty-four maps or plates. The first shows a number of hemispheres: the northern and southern (land and water) and the European and South American. We would gladly miss the last, as it is intended only to show the central position of Europe. The second map is named 'Europe, illustrating Geographic Terms.' This map must be considered a failure, as it attempts the explanation of geographic terms, instead of by means of objects, by that of a highly and wrongly generalized map. The following plate, which illustrates the mapping of a landscape and the influence of reduction, ought

to precede the former, and we believe greater care in its technical execution would have been desirable. As the map is intended to explain the meaning of hill-shading, the view of the hills and the map ought to be clear, and it ought to be possible to compare them down to minute details. The fourth plate explains the system of meridians and parallels and the curvature of the earth's surface. The rest of the maps are well selected, and do not call for any special comment. The maps of the British Isles are very good. We think, however, that a hypsometric map like No. 11 is of no great value for educational purposes, as contour-lines, unaided by hill-shading, do not convey to the child a good idea of the physical features of a country. Considered as a whole, the atlas must be commended as a great improvement upon the ordinary school atlas.

NOTES AND NEWS.

THE United States Fish Commission is undertaking an extensive series of explorations of the fish fauna of the rivers of the Alleghany region. The work is in charge of Prof. D. S. Jordan, assisted by Prof. P. P. Jenkins, Prof. B. W. Evermann, and Mr. Barton A. Bean. The basins of the James, Kanawha, Roanoke, Holston, French Broad, Yadkin, and Catawba will be included in the work of the present summer. Similar explorations of the smaller lakes of Michigan are under direction of Mr. Charles H. Bollman.

— The fourth article in the Railway Series now appearing in *Scribner's Magazine* will be contributed to the September number by Gen. Horace Porter, who writes of 'Railway Passenger Travel.' —— 'The Record of a Human Soul' is the title of an anonymous little book to be published shortly by Longmans, Green, & Co. It is the honest account of the struggle of a sceptic, who ardently but unavailingly desired to believe, from the coming of the doubt until the hour when the doubter at last sees a light in heaven. It is introspective and subtle, but not morbid; its language is simple and direct; and the record is likely to be useful to not a few who have only the honest doubt in which there may be more faith than in half the creeds.

— The Canadian Institute, Toronto, Ont., is desirous of collecting, and incorporating in its Proceedings, reliable data respecting the political and social institutions, the customs, ceremonies, beliefs, pursuits, modes of living, habit, exchange, and the devolution of property and office, which obtain among the Indian peoples of the Dominion. It feels that this department of research has not been so fully cultivated in Canada as its importance demands, fears that the opportunity of gathering and carefully testing the necessary facts may with the advancing tide of European civilization soon pass away, and is of opinion that much light may be cast upon the genesis and growth of government as well as upon legal, sociological, and economic thought by an accurate study of the Indian tribes in their existing conditions and organizations. Contributions to the philology of the Indian tongues, and additions to their folk or myth lore, will be welcomed as heretofore. At the same time the institute begs leave, without desiring to contract the field of observation, to direct attention to the sociological matters.

— A new process for protecting iron against corrosion, now employed by a company at Port Chester, N.Y., is said to give satsfactory results. The company is now manufacturing sanitary soil-pipes treated by this method, which is described by Mr. H. Haupt as follows: "After the pipes have been lowered into the retorts by means of a traveller, the retorts are closed for about fifteen minutes until the contents are heated to the proper temperature. Steam from a boiler at sixty pounds pressure is then introduced into the superheater, which it traverses, and from which it escapes at the temperature of the iron, upon which it acts for about one hour. A measured quantity of some hydrocarbon is then admitted with a jet of steam, followed again by a fixing bath of superheated steam, which completes the process." Professor Gesner, the director of the works, says there is no pressure in the retort, and that there are no free explosive gases. The water-seals attached to the retorts show only slight oscillations, but not an inch of pressure; and when the covers are removed and air admitted there is no explosion, as there always is when free hydrogen or carbonic oxide is present. The absence of pressure and of explosive gases is a proof that all the operations have been so nicely regulated as regards material used, quantity, and time of application, that a perfect absorption and union of the carbon, oxygen, and hydrogen with the iron has been effected. The protection thus afforded to the iron is not a mere coating, like paint, but is said to be an actual conversion, to a greater or less depth, into a new material. When properly treated, this material does not seem to be detachable by pounding, bending, hammering, rolling, or heating. The pipes treated at Port Chester have been immersed in baths of dilute sulphuric acid and exposed to the salt air for weeks without change, while untreated pipes were quickly covered with red oxide, or with sulphate of iron.

LETTERS TO THE EDITOR.

Re-appearance of Song-Birds.

THE appearance of birds is always quite irregular, so far as numbers are concerned, with the possible exception of one or two varieties like the migratory thrush. We will find in any locality that the oriole is very plentiful for a few years, and then comparatively scarce for a few years. This cannot be mistaken by those on whose gardens he makes his inroads. The absence of grosbeaks and then their great abundance is equally marked. So of nearly all familiar birds. The cause is probably that they range over a large territory, and select different nesting-centres. It is well known that pigeons will cover the sky for two or three springs, moving to a camp in the farther north, and then for years not a pigeon be seen. I believe my catbirds alone have so taken to me that I can always count on their familiar forms and delicious notes.

The extraordinary abundance of song-birds is no doubt a simple coincidence or accidental agreement of action on the part of several species. In my own grounds I do not see any such unusual migration; for the reason, probably, that I have for many years so protected and fed them, that it is a paradise for birds. Yet it is true that several sorts of birds are on the increase here; owing, possibly, to finding their quarters disturbed elsewhere. The line of migration can be much more easily swerved than the ponderous and slow movements of animals. I think you may be sure that the abundance in some quarters is balanced by the deficit in other quarters. New influences constantly arise, affecting the peace and content of birds. I have all summer been fighting a band of pseudo-scientists; that is, boys who carry papers permitting them to shoot our birds to make collections for so-called scientific purposes. Before the law to protect our song-birds, no decent young man would prowl about near our residences to shoot the pets. But now they are 'scientists;' and we have no rights to be considered. They crack their guns under our very noses. But I have vowed to have a lawsuit with every budding Audubon that comes this way, and am at present ahead.

Now, here is a law that works not at the muzzle, but the but. Its effect is to scatter our birds in their favorite haunts. My grounds cover nine acres only, but several neighbors are in full accord; and there are full fifty acres of flowers, hedges, and fruit where the song-birds are wonderfully abundant. But how long would they remain with us if one after another fell victims the moment they flew outside our lines? Another year we should lament the absence of our birds, and somewhere else people would rejoice in their superabundance. E. P. POWELL.

Clinton, N.Y., Aug. 7.

The Physical Aspect of the Planet Mars.

THERE has been so much said of late, in the newspapers and elsewhere, in regard to the parallel canals of Mars, that perhaps a brief discussion of the facts observed in regard to them may be of interest. And first of all it may be remarked, that, of all the different methods of accounting for the appearances observed, perhaps the least probable is that they are water-canals.

Let us see what are the facts in the case. According to the observations of Schiaparelli (*Reale Accademia dei Lincei* 1881 and 1886) they lie almost entirely between 50° north and south latitude (that is, in the torrid and warmer portions of the temperate zones), and extend across the continent from the northern to the southern