problems which gave rise to the functions, deals with their properties, expansions involving them, semi-convergent expansions, Fourier-Bessel expansions, complex theory, definite integrals, and the relation of the functions to spherical harmonics. The physical applications embrace flow of heat and electricity, vibrations of membranes, hydrodynamics, electrical waves along wires, diffraction, and a number of miscellaneous problems. Numerical tables are appended, and also the Tables of Functions with imaginary argument, which have been prepared by Prof. A. Lodge for the British Association. A note containing useful formulæ for the calculation of the roots of Bessel Functions and others related to them, has been added from a manuscript placed at the disposal of the authors by Prof. J. McMahon.

WE have received Parts iv. and v. of *Indian Meteorological Memoirs* (vol. v.), containing the discussion of hourly observations made at Allahabad and Lucknow, forming a portion of the harmonic analysis of the observations recorded at twenty-five observatories in India, since the year 1873. The investigation is carried out in a most thorough manner, and there can be no doubt that when the work is complete, and the results correlated, much light will be thrown upon the laws which regulate atmospheric movements in those parts. In any case, the discussion will take rank amongst the most important of the kind hitherto undertaken by any country.

A COMPOUND of grape sugar with one of the acid radicle derivatives of hydrazine recently prepared by Herr Struve, a pupil of Prof. Curtius, is described by Dr. Wolff, of Berlin, in the current *Berichte* of the German Chemical Society, and, on account of its properties and mode of formation, appears likely to be of considerable service in the commercial extraction of pure dextrose from syrupy mixtures. It is first shown that the sugars of the aldose type react with the acidylhydrazides to produce an aldose-acidylhydrazide by direct addition with elimination of a molecule of water. Thus, in the case of dextrose and benzhydrazide the following equation represents the change:

$$C_6H_5.C:O.NH.NH_2 + O:C_6H_{12}O_5 = C_6H_5.C.O.NH.N.C_6H_{12}O_5 + H_2O.$$

When dextrose and benzhydrazide are digested with 96 per cent. alcohol for five or six hours in a flask provided with an upright condenser, the new compound is produced in solution in the alcohol, and upon subsequent evaporation it separates in the form of acicular crystals, which can readily be purified by recrystallisation from alcohol. The crystals melt at 171–172° with partial decomposition. As lævulose does not react with benzhydrazide, pure dextrose can readily be isolated from the mixture of lævulose and dextrose in ordinary invert sugar by utilising the above reaction. The invert sugar is evaporated to a thick syrup, and the latter digested with alcohol and benzhydrazide for about six hours in a reflux still. The alcoholic solution is then evaporated over a steam-bath almost to dryness, the lævulose is extracted by washing with a minimum of alcohol, and excess of benzhydrazide removed by means of ether. Pure dextrose-benzhydrazide is then obtained in good crystals by two recrystallisations from alcohol. The recovery of dextrose from this compound with benzhydrazide is a very simple matter, for the compound is immediately broken up by boiling water into dextrose and benzhydrazide. It is found convenient in practice, however, to remove one of the products of the dissociation, the benzhydrazide, by precipitation as the insoluble benzal-benzhydrazide by means of benzaldehyde, which is found to be a most valuable reagent for the purpose. After filtration the liquid is evaporated to dryness, dissolved in cold water, whereby any traces of unprecipitated benzal-benzhydrazide are left behind, and again evaporated to dryness. The last traces of impurities, chiefly benzaldehyde and benzoic acid, are finally removed by dissolving the dextrose in alcohol and precipitating with ether. The dextrose eventually obtained by evaporation of the clear solution is quite pure. Dr. Wolff lastly states that the above is a general process for separating aldoses from mixtures of sugars, and he is experimenting with a view to its adoption on the large scale.

THE additions to the Zoological Society's Gardens during the past week include a Snowy Owl (*Nyctea scandiaca*) from Norway, presented by Miss Wright; a Dunlin (*Tringa alpina*), British, purchased.

OUR ASTRONOMICAL COLUMN.

MARS IN 1894.—Signor G. Schiaparelli remarks, in No. 3271 of the *Astronomische Nachrichten*, that the unfavourable state of the atmosphere during the opposition of Mars last year rendered magnifications beyond 200 impossible except in rare instances. Speaking generally, he says that the "seas" were less pronounced than in 1877, and the "canals" were better visible in 1894, and seen in greater numbers. Some of the largest ones showed faint traces of doubling, but, with the magnifying powers used, nothing could be made out with certainty on this point. The southern pole cap became invisible in the 18-inch Milan refractor at the end of October. On October 8 it had already become very faint. The total disappearance cannot have been later than October 29, *i.e.* on the 59th day after the southern solstice of the planet. This is unusually early. In 1877–78 it was well seen as late as 98 days after the solstice. In the present case it is pretty certain that the whole of the southern pole cap was melted. A great change was also observed in the isthmus or peninsula of Hesperia, which separates the Mare Tyrrhenum from the Mare Cimmerium. It was apparently separated into two unequal portions by a newly formed channel. The Mare Sirenum, which in October, 1892, had been separated into two parts, was in October, 1894, seen to have resumed its ordinary aspect. But on November 21 the separation had reappeared. "This fact," says Schiaparelli, "and other analogous ones which I have observed in previous oppositions, lead to the conclusion that the abnormal changes in the markings of Mars do not take place by chance and without regularity, but that the same variation may reappear, with the same aspect, even after a long interval of time. The form and extent of such changes is determined by some element which is stable, or at least periodic."

NOVEL METHODS IN PHOTOMETRY.—The determination of the times of exposure of a photographic plate which are required to produce the same density of film when exposed to different light sources, forms the basis of the methods recently adopted by Dr. Janssen for investigating the brightnesses of the heavenly bodies (*Bull. Mens. Soc. Ast. de France*, February). In the case of stars, the plate is placed a little within the principal focus of a telescope, so that a disc, or "stellar circle," replaces the almost point-like image ordinarily obtained; a series of exposures is made on one star, and another series on the star to be compared with it; the two images of the same density are thus identified, and the photographic brightnesses of the two stars are inversely as the durations of the corresponding exposures. To compare the light of a star with the sun, an opaque screen, pierced with holes of the same size as the stellar circles, is placed in front of the photographic plate, and these holes admit sunlight to the plate at the moment a triangular aperture in another metal plate is passed over them on releasing a spring; in this way a series of circles of increasing intensity is impressed on the plate, and can be compared directly with the stellar circles.

In its application to nebulæ, Dr. Janssen's method promises to be of great value. On the same plate which has been exposed to a nebula, a series of "stellar circles" is formed by directing the instrument to a star in the neighbourhood which shows no signs of variability. In the future, when one wishes to obtain a photograph of the nebula which will be strictly comparable to one taken previously, it will only be necessary by means of stellar circles to determine the exact exposure which should be given.

From an inquiry into the photographic luminosity of the tail of comet *b* 1881, Dr. Janssen finds that the intensity decreased in a ratio between the fourth and sixth power of the distance from the nucleus.

ATMOSPHERIC DISPERSION.—The fact that the image of a star as seen in a telescope is drawn out into a short vertical spectrum, with the red end uppermost, was noticed as long ago as 1729 by Bouguer, and the effect of the difference in colours of stars upon refraction appears to have been indicated in a general way by Lee in 1815. Even in small instruments this atmospheric spectrum is very noticeable in the case of bright stars at low altitudes, but, if necessary, it can be corrected by means of a thin prism placed in front of the eyepiece, or by employing an eyepiece of the form devised by the late Sir George Airy. In a recent paper (*Monthly Notices R.A.S.*, January), Dr. Rambaut points out the importance, in these days of extreme accuracy, of introducing a correction for atmospheric dispersion—according to the varying colours of stars—more especially in connection with observations of two stars in close proximity, as in measures of double stars, and observations for parallax. The claims of this hitherto rather neglected factor appear to be fully substantiated by a series of measures at different hour angles of β Cygni, in which double star the colours of the components are strongly contrasted; they "show clearly a systematic difference affecting the distance between them, of the sort, and in the direction, that theoretical considerations indicate." Dr. Rambaut also shows that the systematic differences depending upon hour angle in the measures for the parallax of α Centauri by Drs. Gill and Elkin, which they corrected by empirical formulæ, are due to a difference in the mean refrangibility of the light of the star and of the comparison stars. Further confirmation is derived from a re-discussion of the Dunsink observations on the parallax of 61 Cygni, and the resulting value is corrected from $0''\cdot465$ to $0''\cdot400$.

An ingenious method of measuring atmospheric dispersion has been devised by M. Prosper Henry, and values determined for different colours (NATURE, vol. xliii. p. 400).

THE SUN'S PLACE IN NATURE.[1]

I.

I AM anxious to give in these lectures a statement, as clearly and as judicially as I can, of the discussions which have been going on since these results were published, to show what holes have been picked in the new views, and what new truths may be gathered from the new work which has now been brought to bear upon the old, so that as a result the place I have given to the sun among its fellow stars may be justified or withdrawn. These lectures will be different from the former ones, inasmuch as I then attempted to give you a piece of quiet history of several regions of fact and knowledge which had been well surveyed and mapped, and had become part and parcel of the common property of mankind. But now I shall have, in considering the discussion, rather to take you with me into the forefront of those who are fighting the battles on the confines of the unknown. I have to bring you news from the front, something like that which we are promised to-morrow or the next day from Port Arthur. I have to show how the battle is waging, who has lost, what positions have been occupied, and what things new and true and beautiful have been wrested from the unknown region; and I am the more anxious to do that because it enables me to bring before you the enormous advantages under which such work is now carried on; advantages in that now, when any question is put to any part of the heavens, we know that there are many good workers employed under the best possible conditions to get the particular information that we want; besides these advantages, in every branch of inquiry we find advances gigantic, marvellous, almost beyond belief.

I am sorry to say that in this work the centre of gravity of the activity has left our country and has gone out West. We have to look to our American cousins for a great deal that we want to know in these matters, for the reason that now they not only have the biggest telescopes, and most skilled observers, but also they have been wiser than we—they have occupied high points on the earth's surface, and thus got rid of the atmospheric difficulties under which we suffer in England, and especially in London.

Let me bring before you one of the most perfect pieces of workmanship in the world constructed to investigate the phenomena of the heavens. It is a photograph of the Lick Observatory, situated at an elevation of 4000 feet on Mount Hamilton. Mr. Lick, the founder, was a very ambitious man. He was, I believe, an hotel-keeper at San Francisco, but however that may be, he has made his name immortal by helping on the progress of mankind. I wish we had some hotels like the San Francisco hotel in this country, and some Mr. Licks, because then some Englishman might immortalise himself in the same way. This, then, is the magnificent locality in which a great deal of the work that I shall have to refer to has been done. The principal instrument of this great Observatory is a refracting telescope having an object-glass three feet in diameter, and a tube fifty-four feet in length. This is practically the most important telescope in the world at the present moment, and to give you an idea of the wonderfully

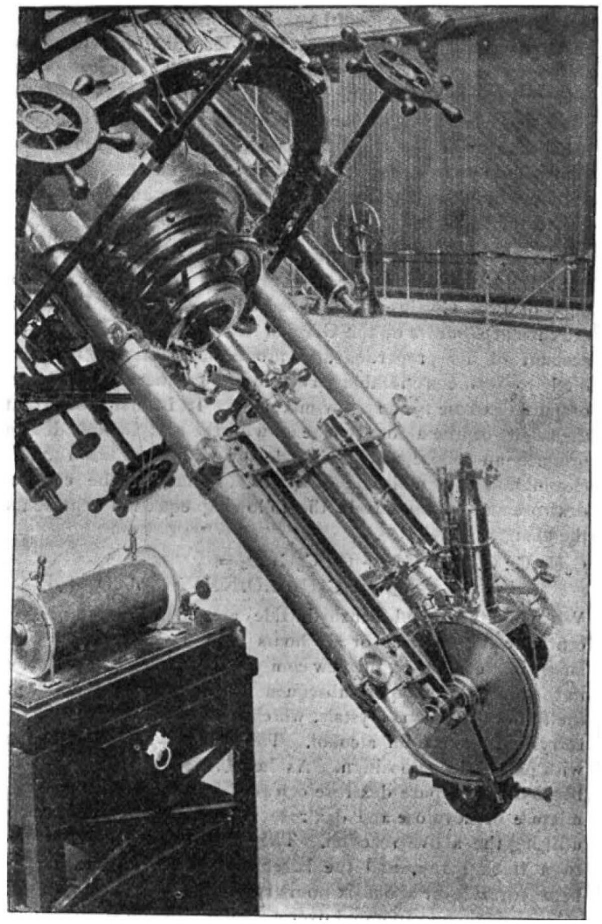

FIG. 4.—Spectroscope attached to the eye-end of the Lick Telescope.

broad way in which the authorities have gone to work, I need only state the following fact. Some of you who have been in an observatory may remember that it has sometimes been very difficult to get the observatory chair at the right height, or in the right position, for observing a star or any celestial body with any comfort. The Americans get over this by simply raising the floor. By means of hydraulics the enormous floor, some 80 feet in diameter, is moved up and down with the chair. The importance of spectroscopic work has not been lost sight of in the equipment of the Observatory, and a very powerful spectroscope can be used in conjunction with the great equatorial for observing or photographing the spectra of the various celestial bodies (Fig. 4).

One of the most important telescopes in England at present is Dr. Roberts' reflector, with which several majestic represen-

[1] Revised from shorthand notes of a course of lectures to working men at the Museum of Practical Geology during November and December, 1894. (Continued from page 377.)