isolated as a strongly basic volatile liquid, which yields a very hygroscopic hydrochloride with hydrochloric acid. On boiling this hydrochloride with dilute sulphuric acid, it is decomposed, with assimilation of the elements of water, into paraldehyde and hydrazine—

$$C_5H_{11}O_2 . C\begin{matrix}H\\ \diagup\\ \diagdown\\ N . NH_2\end{matrix} + H_2O = C_5H_{11}O_2 . C\begin{matrix}H\\ \diagup\\ \diagdown\\ O\end{matrix} + N_2H_4.$$

The hydrate of hydrazine is readily obtained from the sulphate by simple distillation with alkalies.

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Cat (*Felis chaus*) from North Africa, presented by Mrs. Florence J. Waghorn; a Stoat (*Mustela erminea* ♂), British, presented by Mr. Cuthbert Johnson; two Mantchurian Cranes (*Grus viridirostris*) from Corea, presented by Mr. Campbell; three Long-eared Owls (*Asio otus*), British, presented by Mr. W. Geoffrey N. Powell; a Black faced Weaver-Bird (*Hyphantornis* sp. inc.), from South Africa, presented by Commander W. M. Latham, R.N., F.Z.S.; a Three-toed Sand Skink (*Seps tridactylus*), European, presented by Mr. J. C. Warburg; two Hybrid Deer (between *Cervus elaphus* ♂ and *Cervus sika* ♀), deposited; a Diana Monkey (*Cercopithecus diana* ♀) from West Africa, eight Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, purchased; a Rhesus Monkey (*Macacus rhesus*), born in the Gardens.

## OUR ASTRONOMICAL COLUMN.

### OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on April 10 = 11h. 16m. 18s.

| Name. | Mag. | Colour. | R.A. 1890. | Decl. 1890. |
|---|---|---|---|---|
| | | | h. m. s. | ° ′ |
| (1) G.C. 2386 ... ... | — | — | 11 15 47 | + 3 50 |
| (2) 72 Leonis ... ... | 5 | Yellowish-red. | 11 9 22 | +23 42 |
| (3) ν Leonis ... ... | 4 | Yellowish-white. | 11 31 18 | − 0 13 |
| (4) δ Leonis... ... ... | 2 | White. | 11 8 18 | +21 8 |
| (5) 152 Schj. ... ... | 5 | Red. | 12 39 58 | +46 3 |
| (6) R Hydræ ... ... | Var. | Very red. | 13 23 43 | −22 43 |

*Remarks.*

(1) The General Catalogue description of this nebula is as follows: "Bright, pretty large, round, pretty suddenly much brighter in the middle." In 1869, Prof. Winlock observed the spectrum at Harvard College Observatory, and stated that it was continuous, with a possible bright line near λ 525. The nebula does not appear to have been spectroscopically examined by any other observer, so that further observations are required to confirm this result. If there really be a bright line as recorded, others may certainly be expected. Comparisons with the carbon flutings in the Bunsen or spirit-lamp flame spectrum should be made. It seems highly probable that many of the so-called "continuous" spectra of nebulæ really consist of bright lines or flutings superposed upon a continuous spectrum, as Dr. Huggins has stated that brighter parts have been suspected in some cases, and I myself have often noted irregularities, notably in the Great Nebula of Andromeda. In 1866 Dr. Huggins was careful to point out that his use of the term "continuous" was not to be understood to mean more than that, when the slit was made as narrow as the feeble light permitted, the spectrum was not resolved into bright lines.

(2) This star has a very fine spectrum of Group II. According to Dunér, the bands 2–8 are wide and dark, especially those in the red. This indicates, as I have pointed out on previous occasions, that the star is probably considerably advanced towards Group III., in which the bands will be replaced by lines. It will be interesting to know if any lines exist in the spectrum of the star at present, and, if so, what lines they are.

(3) A star of the solar type (Konkoly). The usual differential observations are required.

(4) A star of Group IV. (Gothard). Usual observations required.

(5) It is generally agreed that 152 Schj. is one of the finest examples of stars of Group VI. It shows the usual bands of carbon very strongly marked, and all of the secondary bands are well visible. We have certainly still a great deal to learn about stars of this group, and the present favourable position of a typical example may therefore be taken advantage of for further inquiry.

(6) At the last maximum of this interesting variable, Mr. Espin found that the F line was bright in its spectrum, the general spectrum being a very fine one of Group II. Mr. Espin also noted that the bright bands (probably the bright flutings of carbon) were relatively brighter as the star was on the increase, and weaker when its luminosity was decreasing. It is very important that a recurrence of these phenomena at the approaching maximum of April 11 should not escape observation, even though the star is not one which rises early in the evening at this time of the year. The period of the variable is about 434 days, but is apparently decreasing. In 1708 it was about 500 days. It varies from magnitude 4–5 at maximum to about 10 at minimum. A. FOWLER.

THE APEX OF THE SUN'S WAY.—A determination of the amount and direction of solar motion is given by Mr. Lewis Boss in *Astronomical Journal* No. 213. This determination is an important one, because of the fact that, out of the 253 stellar motions used, only 49 are known to have been previously employed in a similar research, and it is by means of new material and variations of arrangements in its use that any general facts or laws are likely to be discovered. The stars whose proper motions have been utilized were given in No. 200 of the above journal, and are all contained in the Albany zone, which is 4° 20′ in breadth, and at a mean declination of 3° north of the celestial equator.

The method employed is substantially that proposed by Airy, and in the first solution five stars having proper motion greater than 100″ in a century were excluded, with the following results:—

| | Mean magnitude. | Proper motion per century. | Maximum angular value of the solar motion for 100 years as viewed from the unit of distance. | R.A. of the apex of solar motion. | Decl. of the apex of solar motion. |
|---|---|---|---|---|---|
| | | ″ | ″ | ° | ° |
| First series (135 stars) | 6·6 | 21·9 | 12·39 | 280·4 | + 42·8 |
| Second series (144 stars) | 8·6 | 20·9 | 13·73 | 285·7 | + 45·1 |
| Both series combined | 7·6 | 21·4 | 13·09 | 283·3 | + 44·1 |
| Probable errors | — | — | ± 1·00 | ± 6·9 | ± 3·2 |

When stars are excluded whose proper motions per century amounted to 40″ or more, the following are the resulting values:—

| | | | | | |
|---|---|---|---|---|---|
| | | ″ | ″ | ° | ° |
| Single series (253 stars) | 7·7 | 17·80 | 10·58 | 288·7 | + 51·5 |
| Probable errors | — | — | ± 0·60 | ± 7·2 | ± 3·2 |

The values of the several elements of solar motion, as determined by Struve and Bischof, are as follows:—

| | | | | | |
|---|---|---|---|---|---|
| | | ″ | ″ | ° | ° |
| Struve ... ... | 6·0 | 8·00 | 4·36 | 273·3 | + 27·3 |
| Bischof ... ... | 7·5 | 47·58 | 33·67 | 290·8 | + 43·5 |
| ,, (using Argelander's method) | | — | | 285·7 | + 48·5 |

By using the present declinations of the American ephemeris, Mr. Boss finds that the value given by Struve for the declination of the sun's way requires a correction of + 10°·4, thus making it + 37°·7, which is more in accordance with the other values given above.

The most probable co-ordinates of solar motion might therefore be assumed to be—

R.A. = 280°; Decl. = + 40°.

STABILITY OF THE RINGS OF SATURN.—The *Bulletin Astronomique* for February 1890 contains an interesting paper by M. O. Callandreau, on the calculations of the late Clerk-Maxwell, relative to the movement of a rigid ring around Saturn. It is well known that Laplace found it impossible for a homogeneous and uniform ring surrounding a planet to be in a state of stable equilibrium, and remarked that irregularities must exist in the

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form of the ring, which, in combination with a slight eccentricity, secured its stability. Maxwell found that the irregularities of a ring possessing a permanent movement ought to be very sensible, and that the appearance of the rings of Saturn was incompatible with that required by his demonstration. He considered the case of a planet occupying the centre of the ring, whereas Laplace's hypothesis required a slight eccentricity. This question was not, however, treated separately, and M. Callandreau has subjected it to mathematical analysis. First, taking the case of a symmetrical ring when the centre of gravity will be on a symmetrical axis, and then the case required by Laplace, viz. that the centre of gravity is not exactly coincident with the geometrical centre, the author shows that the conditions stated by Laplace are not sufficient to ensure stability.

BROOKS'S COMET (*a* 1890).—This comet was observed at Paris on March 28 and 30. It was seen as a round nebulosity, about 40″ or 50″ in diameter, with a very pronounced central condensation, and was about the tenth magnitude.

BRIGHT LINES IN STELLAR SPECTRA.—The Rev. J. E. Espin reports the discovery of bright lines in the spectrum of $\theta_1$ as well as in that of $\theta_2$ Orionis, and possibly in that of S Coronæ as well.

## *ON THE DEFORMATION OF AN ELASTIC SHELL.*[1]

THIS paper treats of the deformation of an elastic shell whose radii of curvature are everywhere great in comparison with the thickness, which is supposed uniform. The subject has been dealt with in a very able manner by Mr. A. E. H. Love in a recent paper (Phil. Trans., 1885), but it seemed desirable, on various grounds, that it should be attacked from an independent point of view. The method here followed is that explained in a former communication, "On the Flexure of an Elastic Plate" (December 1889). The results, as regards the general theory, are closely analogous with those of Mr. Love, and a comparison of the two investigations gives a physical interpretation to the various groups of terms which enter into his equations. There are some differences of detail, arising from a slight difference in the quantities chosen to express the flexural strains, but they are not practically important.

The great difficulty of the present subject, as contrasted with the theory for a plane plate, is, that we cannot draw an absolute line of demarcation between the deformations in which the cardinal feature is the extension of the middle surface, and those which involve flexure with little or no extension. This appears to arise mainly from the fact pointed out by Mr. Love, that it is in general impossible to satisfy the boundary conditions by a deformation in which the middle surface is absolutely unextended. But, this being admitted, the question remains in any specific problem, as to the amount and distribution of the extension, and, in particular, whether there are any modes of deformation (or of free vibration) in which, after all, it plays only a subordinate part. Mr. Love answers this question in the negative, in opposition to the views advocated by Lord Rayleigh in two well-known papers. In the present communication Mr. Love's argument is examined, and it is pointed out that cases may occur in which the extensions (though comparable with the flexural strains) may be confined to so small a region of the shell (near the edges) that their contribution to the total energy of deformation is insignificant.

In order to bring the matter to an issue in a definite instance, I have chosen the case of a cylindrical plate (such as a boiler-plate) bent by a proper application of force over its straight edges, so that the strained form remains a surface of revolution, the circular edges being free. The analytical work in this case is very simple, and the physical meaning of the various terms which occur is easily recognized. In the interpretation of the result it appears that a good deal turns upon the ratio which the breadth of the plate (in the direction of the generating lines) bears to a mean proportional between the radius and the thickness. If this ratio is large, the bending forces may be practically replaced by two equal and opposite couples uniformly distributed over the straight edges, and having these edges as axes. The strained form is almost accurately cylindrical; near the circular edges we have extensions of the same order as the flexural strains, but these rapidly die out (at the same time fluctuating in sign) as we press inwards, and the anticipation that their total energy would be small compared with that due to flexure is confirmed. In such a case, then, the approximate methods used by Lord Rayleigh, in which no account is taken of the conditions at a free edge, are fully justified. But if, keeping the radius and the thickness constant, we diminish the breadth of the plate until it is comparable with the mean proportional aforesaid, we get a sort of transition case between a plate and a bar, which cannot be satisfactorily treated except on the basis of the general equations. Finally, when the breadth becomes small in comparison with the mean proportional, the plate behaves like a curved bar, and an approximate treatment is again applicable.

In an appendix I have worked out, from the general equations of elasticity, the uniform flexure of an infinitely long cylindrical plate; this being, at present, the only case of flexure in which it appears easy to carry out the solution (on these lines) to a full interpretation.

[1] Abstract of a Paper read by Prof. Horace Lamb, F.R.S., before the Mathematical Society on January 9.

## *SCIENTIFIC SERIALS.*

*Timehri*, being the Journal of the Royal Agricultural and Commercial Society of British Guiana (printed at the Argosy Press, Demerara, vol. iii., part ii., new series).—This interesting *brochure* contains matter of general interest, as well as information which might be expected in an agricultural and commercial journal. Specialization cannot be pushed to its extreme limits in a colony, and a Society of this nature naturally admits matter into its Journal which are not strictly either agricultural or commercial. Thus the papers on primitive games and on the wild flowers of Georgetown must be regarded, respectively, as of ethnological and purely botanical interest, but, nevertheless, occupy a great part of the number, especially if we leave out of consideration the reports of meetings and other official matter connected with the working of the Society. Fruit-growing in the Gulf States of America, Caracas as a place of resort, and a short paper on some scale insects inimical to vegetation are the principal topics of a distinctly economic value. The paper entitled the "Letters of Aristodemus and Sincerus" is a review of an old book published in 1785-88 in twelve volumes, dealing with the colonies of Demerara and Essequibo, and are therefore of great interest to the present population. In 1785 the colonies had just been given over by the French, who held them on behalf of the Dutch for about three years. No town existed up to that date in Demerara, but during the French occupation a little village had grown up in the neighbourhood of Brandwagt, which they called *la nouvelle ville*, or Longchamps. The fort on the east bank of the Demerara River (now called Fort William Frederick) was also built at the time, and named Le Dauphin, while another on the opposite side was called La Raine. From such historical, social, scientific, and economic materials a most interesting although somewhat diffusive number has been produced, showing evidence of mental activity and high culture, pleasant to see far away from the main centres of civilization. The style of the writing, the printing, and the illustrations are all of a high class. How far the London publisher, Mr. E. Stanford, of Cockspur Street, is responsible for the excellent "get up" of the volume we are unable to even conjecture; but we trust we may be permitted to say, without offence, that the number of *Timehri* before us is highly creditable to the literary talent and tastes of British Guiana.

*Quarterly Journal of Microscopical Science*, February.—On the anatomy of the Madreporia; V., by Dr. G. Herbert Fowler (plate xxviii.). Gives an account of the anatomy of *Duncania barbadensis*, *Galaxea esperi*, *Heteropsammia multilobata*, and *Bathyactis symmetrica*, and gives a figure of the typical structure of the genus Madrepora.—Contributions to the anatomy of earthworms, with descriptions of some new species, by Frank E. Beddard (plates xxix. and xxx.). This paper gives an account of the structure of three new species of Acanthodrilus, with remarks on other species of the genus. The new species are *A. antarcticus*, *A. rosæ*, and *A. dalei*. Further remarks on the reproductive organs of Eudrilus, with special reference to the continuity of ovary and oviduct.—On the certain points in the anatomy of Perichæta, with description of *Perichæta intermedia*, n.sp.—On the phagocytes of the alimentary canal, by Armand Ruffer (plate xxxi.). Concludes that the wandering cells of the lymphoid tissues of the alimentary canal have the power of proceeding to the free surfaces of such tissues, and of taking into their interior

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