

above it applies to the instrument used at Allegheny), and the narrow horizontal line in the lower part of the figure represents an undisplaced line in the spectrum, or solar line.

By Doppler's principle, the displacement of any point on this line is proportional to the velocity in the line of sight. The inclination of the planetary line to the solar line can be expressed by a simple formula. It is also possible to determine the form of a line in the spectrum of the ring, regarded as a collection of satellites, by the application of Kepler's third law. With the computed motions of different parts of the system, the dotted curves in the figure were plotted. For the ordinates, however, twice the calculated values were taken, since the displacement of a line, due to motion in the line of sight, is doubled in the case of a body which shines by reflected and not by inherent light, provided (as in this case) the Sun and the Earth are in sensibly the same direction from the body. The planetary line is drawn to the same scale, and the heavy lines in the figure represent accurately the aspect of a line in the spectrum of Saturn, with the slit in the axis of the ring, as photographed with a spectroscope having about three times the dispersion of the instrument used by Prof. Keeler.

The width of slit used is also represented in the figure.

If the whole system has a motion in the line of sight, the lines in the figure will be displaced towards the top or the bottom, as the case may be, but their relative positions will not be altered.

It is evident that in making a photograph of this kind the image must be kept very accurately in the same position on the slit-plate, as otherwise the form of the lines shown in the figure would be lost by the superposition of points having different velocities. The second plate was made with special care, and as the air was steadier than on the first occasion, the definition is on the whole somewhat better than that of plate 1, although the difference is not great. On both plates the aspect of the spectrum is closely in accordance with that indicated by theory, and represented in the figure. The planetary lines are inclined from 3° to 4° , and the lines in the spectra of the ansæ have the appearance already described.

If the ring revolved as a whole, the displacement of lines in its spectrum would follow the same law as for a rotating sphere; that is, the lines would be straight and inclined, their direction passing through the origin. If the ring rotated in the period of its mean radius, a glance at the figure shows that the lines would practically be continuations of the planetary lines. Such an aspect of the lines as this would be recognisable on the photographs at a glance.

It will be seen from the foregoing considerations that the photographs prove not only that the velocity of the inner edge of Saturn's ring exceeds the velocity of the outer edge, but that, within the limits of error of the method, the relative velocities at different parts are such as to satisfy Kepler's third law.

Besides (1) the proof of the meteoric constitution of the rings, explained above, each line of the photographs gives (2) the period of rotation of the planet, (3) the mean period of the rings, (4) the motion of the whole system in the line of sight. Prof. Keeler has measured a number of lines on each plate, and compared the results with the computed values of the corresponding quantities.

The results for (2) and (3) from both photographs are:

- (2) Velocity of limb = 10.3 ± 0.4 kilometres,
- (3) Mean velocity of ring = 18.0 ± 0.3 kilometres;

the computed values being 10.29 and 18.78 kilometres respectively.

Prof. Keeler has not yet determined from his photographs the motion of the whole system in the line of sight.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. T. J. I. Bromwich, Scholar of St. John's College, is the Senior Wrangler of the year. There are thirty Wranglers, of whom St. John's furnishes ten, and Trinity six. One lady only is among the Wranglers, namely Miss N. A. L. Thring, of Newnham, who is placed twenty-third in the list.

The Tyson Medal for Astronomy is awarded to Mr. A. Y. G. Campbell, of Trinity.

Sir Edward Maunde Thompson, K.C.B., has been appointed the first Sandars Reader in Bibliography for the year 1895-6.

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The Board of Managers of the Arnold Gerstenberg Studentship give notice that a Studentship on this Foundation will be offered for competition in 1896. The competition will be open to men and women who have obtained honours in Part I. or Part II. of the Natural Sciences Tripos, and whose first term of residence was not earlier than the Michaelmas term of 1890. The Studentship will be awarded to the writer of the best essay on one of the six subjects printed below. The essays must be sent before October 1, 1896, to Dr. Sidgwick, Newnham College, Cambridge. The Studentship will be of the value of nearly £90. It will be tenable for one year only, but subject to no conditions of tenure.

Subjects.—"A statement of the physicist's 'working conceptions' of Matter and Motion, together with a discussion of the philosophical questions to which they give rise." "A criticism of the diverse views that have prevailed from the time of Newton onwards as to the conceivability or otherwise of *Actio in distans*." "A critical examination of the doctrines of J. S. Mill concerning the ground of Induction and the Methods of Inductive Inquiry." "The limits and relations of mechanical and teleological explanations of natural phenomena." "A brief historical account and a critical examination of the views which make the phenomena of life dependent on the existence of a special vital principle." "Natural Selection considered as a special example of the general principle of Evolution."

WITH the view of encouraging University Extension students to take up systematic courses of study, the Local Examinations and Lectures Syndics have remodelled their scheme of Local Lectures Certificates, and have made several other changes of importance. The certificates are now arranged so as to form successive steps in a ladder of continuous work, beginning with the Terminal Certificate for one term's work passing through the Sessional Certificate for a year's work to the Vice-Chancellor's Certificate of Systematic Study for four years' work. There is also an Affiliation Certificate obtainable only at centres affiliated to the University. This certificate is accepted by the Education Department as qualifying a person to be recognised as an assistant teacher. This system is thus adapted to the needs of persons who merely desire a general acquaintance with the subjects taught, as well as to students who are anxious to make a more thorough study of them.

THE Technical Education Board of the London County Council will proceed in July next to award five of its valuable Senior County Scholarships. These scholarships, which are reserved as a rule for young men and women under nineteen years of age, are intended to enable promising and deserving students, who would otherwise be unable to afford the expense, to go through a three years' course at a University or at a Technical Institute of University rank. They are limited to those candidates whose parents are in receipt of not more than £400 a year. The scholarships not only give free tuition, but also a money payment of £60 during each of the years that the scholarship is tenable. They are primarily intended to encourage the pursuit of some branch of science, art, or technology, but they may also be awarded for the promotion of studies in modern languages or other branches of education. In making the award, the Board takes mainly into account the record of each candidate's past career and distinctions, and the evidence as to ability, industry, and good character which the candidate is able to supply. At the same time it reserves the right to apply any examination test that it may think fit. Full particulars may be obtained from the Secretary of the Board, at 13 Spring Gardens, S.W. Candidates should send in their names not later than June 29.

THE summer assembly of the National Home-Reading Union will be held at Leamington Spa, from Saturday, June 29, to Monday, July 8. Lectures will be given by Major Leonard Darwin, M.P., on "The National and International Advantages of the Study of Geography"; Sir Robert Ball, on "Comets"; Mr. H. Yule Oldham, on "The Discovery of America"; Mr. J. E. Marr on "The Geology of the District"; Mr. G. F. Scott Elliot, on "Interesting Problems in Botany, suggested by the Flora of the District." There will also be a conference on "The Wider Education," at which the chair will be taken by Dr. Hill, Master of Downing College, Cambridge. Addresses will be given by Miss Mondy, Dr. R. D. Roberts, a representative of the Oxford Delegation for University Extension, Mr. T.

C. Horsfall, Mr. J. E. Flower (Secretary Recreative Evening Schools Association), and other speakers. Excursions will be made to a number of places in the district, and Profs. W. Ridgeway and T. McKenny Hughes, Mr. J. G. Marr, Mr. Scott Elliot, and others, will accompany the excursions for the purpose of explaining the archæology, geology, and botany of the places visited.

Mr. C. J. FORTH, Mathematical Master at Bolton Grammar School, has been appointed Lecturer in Mathematics at the Plymouth Technical Schools.

THE textile department of the Yorkshire College at Leeds has just been added to by the opening of a museum which is to contain a complete collection of woven samples and models of weaving machinery. The building has cost the Clothworkers' Company £3000, and they will, to the extent of £1200, defray the cost of equipping the museum. The opening ceremony was performed by Mr. Sidney Wilson, Master of the Clothworkers, assisted by Mr. J. E. Horne, his senior warden, and other members and officials. Twenty years ago the Clothworkers established the textile department of the college at the cost of £34,000, and they make an annual grant to it of £2500.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 16.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—Kjeldahl's method for the determination of nitrogen, by B. Dyer. The author describes an exhaustive series of experiments made with the various modifications of Kjeldahl's process in order to ascertain their applicability to organic nitrogen compounds of different types.—Note on liquation in crystalline standard gold, by T. K. Rose.—Preparation of the active lactic acids, and the rotation of their metallic salts in solution, by T. Purdie and J. W. Walker. The optical activity of the metallic lactates in aqueous solution is in the opposite sense to that of the active acid from which they are derived; cryoscopic determinations made with the lithium and strontium lactates show that the racemic form is resolved into the two active ones in aqueous solution.—Derivatives of succinyl and phthalyl dithiocarbimides, by A. E. Dixon and R. E. Doran. On heating succinyl or phthalyl chlorides with lead thiocyanate and dry benzene, succinyl or phthalyl dithiocarbimide, respectively, is formed; a number of derivatives of these two substances are described.—The action of nitrous acid on dibromaniline, $C_6H_3Br_2.NH_2 = 1:4:2$, by R. Meldola and E. R. Andrews. The authors were unsuccessful in preparing a diazoxide from dibromaniline under the conditions which yield these compounds in the naphthalene series; in the present case a diazoamido-derivative, $C_6H_3Br_2.N_2.NH.C_6H_3Br_2$, was obtained.—A new modification of benzilosazone, by H. Ingle and H. H. Mann. The unstable α -benzilozone, corresponding to the known β -isomeride, is obtained, together with dibenzaldiphenylhydrotetrazone by the action of iodine on a mixture of benzalphenylhydrazine and sodium ethoxide.—Affinity of weak bases, by J. Walker and E. Aston.—Substitution derivatives of urea and thiourea, by A. E. Dixon. The properties of a number of substituted ureas are described.—Note on some reactions of ammonium salts, by W. R. E. Hodgkinson and N. E. Bellairs. Fused ammonium nitrate and sulphate are readily attacked by many metals with evolution of ammonia; other products, such as hydrogen and sulphites, also result in certain cases.

Zoological Society, May 21.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Vice-President, in the chair.—Dr. R. Bowdler Sharpe gave an account of the ornithological collection made by Dr. Donaldson Smith during his recent expedition into Somaliland and Gallaland. The present series contained about 500 specimens, which were referred to 182 species. Of these twelve were considered to be new to science.—Mr. G. A. Boulenger, F.R.S., read a synopsis of the genera and species of apodal batrachians, and gave a description of a new genus and species proposed to be called *Bdellophis vittatus*.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., read a list of the land-molluscs of the Andaman and Nicobar groups of islands in the Bay of Bengal, and gave descriptions of some new species, together with a complete account of the distribution of all the species in the various islands of these two groups.—A communication was

read from Dr. J. Anderson, F.R.S., containing the description of a new species of hedgehog from Somaliland, which he proposed to name *Erinaceus sclateri*.—A communication from Mr. R. Lydekker contained notes on the structure and habits of the sea-otter (*Lutra lutris*).—A communication was read from Dr. B. C. A. Windle containing remarks on some double malformations observed amongst fishes.—Mr. F. E. Beddard, F.R.S., read a paper on the visceral and muscular anatomy of *Cryptoprocta*, dealing chiefly with the brain, alimentary canal, and muscles of this carnivore.

Geological Society, May 22.—Dr. Henry Woodward, F.R.S., President, in the chair.—On a human skull and limb-bones found in the palæolithic terrace-gravels at Galley Hill, Kent, by E. T. Newton, F.R.S. A human skull with lower jaw and parts of the limb-bones were obtained by Mr. R. Elliott from the high-terrace gravels at Galley Hill, in which numerous palæolithic implements have been found. The skull is extremely long and narrow, its breadth-index being about 64, it is hyperdolichocephalic; it is likewise much depressed, having a height-index of about 67. The small extent of the cranium in both height and width shows that it has undergone little or no post-mortem compression, although it has become somewhat twisted in drying. The supraorbital ridges are large, the forehead somewhat receding, the probosc prominent, and the occiput flattened below. All the chief sutures are obliterated. Three lower molars and two premolars are in place and are well worn, the three molars being as nearly as possible equal in size. The limb-bones indicate an individual about 5 ft. 1 in. in height. These remains were compared with the fossil human relics which have been found in Britain and on the continent of Europe, as well as with the dolichocephalic races now living, and their relations to the "Spy," "River-bed," "Long-barrow," "Eskimo," and other types were pointed out. The gravels, in which these human bones were found, overlies the chalk at a height of about 90 feet above the Thames, and are about 10 feet thick. They form part of the high-terrace gravels extending from Dartford Heath to Northfleet, and their palæolithic age is shown by the numerous implements which have been found in them, as well as by the mammalian remains which have been met with in similar beds near by, although not at Galley Hill. The human bones were seen *in situ* by Mr. R. Elliott and Mr. Matthew Heys, both of whom speak positively as to the undisturbed condition of the 8 feet of gravel which overlay the bones when discovered.—Geological notes of a journey round the coast of Norway and into Northern Russia, by G. S. Boulenger. The author accompanied the Jackson-Harmsworth Polar Expedition as far as Archangel, and returned by way of the River Dvina. His observations relate mainly to four points: the origin of the foliation of the Norwegian gneiss; the question of raised beaches on the north-western coast of Norway; the boulders and boulder-formation of Northern Russia; and the Trias of the Dvina valley. Between Christiansund and Tromsø the author was struck with the wide-sweeping folds of the foliation-planes of the gneissose rocks, which appeared to him more readily explicable on a theory of dynamo-metamorphism of rocks originally in part igneous, than by any process of diagenesis. He noted that the terraces observed in the transverse fjords would be perfectly explained by the formation of ice-dammed lakes, though the terraces of the Gulf of Onega seemed less dubious raised beaches than those of the north-west of Norway. He confirmed the views of previous writers that many of the boulders of the boulder-formation of Northern Russia were of Scandinavian origin. The beds on the Dvina consist of sands and loams, often coloured red, with bands of alabaster and anhydrite. The strata are horizontal or inclined at a low angle. North of Ustyug Veliki the strata are marked as Permian on the Russian maps, and those to the south as Trias, but the author saw no perceptible break in the succession.—On some Foraminifera of Rhætic Age, from Wedmore in Somerset, by Frederick Chapman. The author has examined six samples of clays and limestones collected from a quarry south-east of the village of Wedmore, which has yielded Megalosaurian remains. The microscopical details of the various clay-washings were given, and the great abundance of some forms of the acervuline foraminifer *Stacheia* was noticed. In a comparison made with the foraminifer fauna of the older and younger rocks respectively, the Rhætic fauna shows marked affinities with both the Upper Palæozoic and the Liassic facies. Twenty-six species of foraminifera, chiefly of arenaceous types, were described, nine of which are new forms.