and Herr Homann considers that the velocity of translation may be taken as not greatly differing from 30 kilometres a second. The results from Dr. Huggins's and Mr. Seabroke's measures are as follows :—

Observer	Velocity of Translation km. per sec.	Apex of Solar Motion
Huggins ...	48·5 ± 23·1 ...	R.A. 309°·5, Decl. 69°·7 N.
Seabroke ...	24·5 ± 15·8 ...	R.A. 278°·8, Decl. 13° 6 N.

These results all differ very considerably from those obtained by Struve, Airy, Galloway, and others, from a consideration of the proper motions of stars as observed with the telescope, *i.e.* in a direction at right angles to the line of sight, the most probable mean value of the co-ordinates of the apex from all these discussions being about R.A. 260°, Decl. 35° N., whilst Struve found the velocity of translation to be about 7 kilometres per second. This speed was, however, based upon the assumption that the average annual parallax of stars of the first magnitude is about 0″·25, and it should be borne in mind that Airy obtained (*Mem. R.A.S.*, vol. xxviii. p. 161) from the discussion of 113 stars with large proper motions a speed of translation nearly six times as large as that of Struve. Plummer also (*Mem. R.A.S.*, vol. xlvii. p. 341), from a rediscussion of Galloway's data, found for the co-ordinates of the apex R.A. 276° 8′, and Decl. 26° 31′ N., a result which differs considerably from the earlier ones above referred to, and in the direction of greater accordance with those obtained by the spectroscopic method. It may, however, be doubted whether the spectroscopic results are yet ripe for satisfactory discussion ; the preliminary investigation undertaken by Plummer some time ago gave distinctly disappointing results, and, so recently as last May, Maunder (*Observatory*, vol. viii. p. 165) stated that but "some fifty stars in all had been observed a sufficient number of times for us to be able to deduce their speed to the nearest ten miles per second." He considered, however, that the results, so far as they went, "indicated a motion towards α Aquarii rather than towards any point in Hercules." This would agree well with Herr Homann's calculations in R.A., but not in Decl.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *MARCH* 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 14

Sun rises, 6h. 17m. ; souths, 12h. 9m. 19·2s. ; sets, 18h. 1m. ; decl. on meridian, 2° 26′ S. : Sidereal Time at Sunset, 5h. 30m.

Moon (one day after First Quarter) rises, 11h. 20m. ; souths, 19h. 14m. ; sets, 3h. 6m.* ; decl. on meridian, 18° 14′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	6 39 ...	13 6 ...	19 33 ...	4 33 N.
Venus ...	4 40 ...	10 3 ...	15 26 ...	7 57 S.
Mars ...	16 35 ...	23 32 ...	6 29* ...	10 27 N.
Jupiter...	18 37* ...	0 44 ...	6 51 ...	0 37 N.
Saturn...	10 26 ...	18 38 ...	2 50* ...	22 47 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·2	81 16 N.	...	Mar. 18,	19 55	*m*
Algol	3 0·8	40 31 N.	...	,, 18,	4 18	*m*
ζ Geminorum ...	6 57·4	20 44 N.	...	,, 15,	0 0	*M*
				,, 20,	4 50	*m*
S Cancri	8 37·4	19 27 N.	...	,, 17,	1 10	*m*
T Ursæ Majoris ...	12 31·2	60 7 N.	...	,, 14,		*M*
δ Libræ	14 54·9	8 4 S.	...	,, 18,	21 44	*m*
U Coronæ	15 13·6	32 4 N.	...	,, 16,	4 46	*m*
W Scorpii	16 5·1	19 50 S.	...	,, 16,		*M*
U Ophiuchi... ...	17 10·8	1 20 N.	...	,, 14,	23 15	*m*
		and at intervals of			20 8	
X Sagittarii... ...	17 40·4	27 47 S.	..	Mar. 17,	0 0	*m*
				,, 19,	21 40	*M*
W Sagittarii ...	17 57·8	29 35 S.	...	,, 18,	21 30	*m*
β Lyræ	18 45·9	33 14 N.	...	,, 18,	21 40	m_2
η Aquilæ	19 46·7	0 7 N.	...	,, 17,	19 10	*M*
T Cephei	21 8·0	68 2 N.	...	,, 14,		*M*
δ Cephei	22 24·9	57 50 N.	...	,, 19,	2 20	*M*

M signifies maximum ; *m* minimum ; m_2 secondary minimum.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14 ...	B.A.C. 1930 ...	6½ ...	0 40 ...	1 28 ...	152 279
15 ...	1 Cancri	6 ...	22 15 ...	23 12 ...	70 327
18 ...	37 Sextantis ...	6 ...	17 25 ...	18 17 ...	11 240
20 ...	B.A.C. 4043 ...	6½ ...	1 38 ...	2 34 ...	119 239

March	h.	
15 ...	6 ...	Mercury at least distance from the Sun.
20 ...	... ...	Sun in equator.
20 ...	8 ...	Jupiter in conjunction with and 0° 13′ north of the Moon.

GEOGRAPHICAL EDUCATION AND NATURAL SCIENCE [1]

ONE of my claims to address you on the subject of geographical education is that I have been a traveller. In my opinion nothing can better bring home to the mind the value of good geographical instruction, or make more keenly felt the disadvantages of the lack of it, than a scientific journey round the world. It is naturally the scientific side of geography which interests me most ; and it is on the importance and prospects of physical geography as a subject of education that I have now to speak.

To the naturalist a knowledge of physical geography is becoming yearly more and more essential. The geographical distribution of plants and animals is one of the most important and fascinating of all the branches of his subject, presenting an immense field for research, full of problems of the utmost interest. Such problems can only be approached, with hope of success in elucidating them, with a clear comprehension of the principles of physical geography, and a power of entering into the utmost details whenever required. The distribution of organisms, and often their very forms and existence, are the result of the relative positions of the various climatic and other physical barriers on the earth's surface. On the land surfaces, where these barriers present most sharply-defined and serious obstacles to migration, the complexity of the distribution of the terrestrial fauna and flora is most remarkable. On the shores, where the barriers are less complete, the isolation and geographical restriction of the littoral fauna and flora is less developed. Whilst in the ocean, with no absolute land-barriers, the pelagic fauna shows little more than a distribution of animal and vegetable forms, according to climatic zones. In the depths of the ocean, which the effects of climate do not reach, the distribution of the animal inhabitants almost approaches universality.

It is, however, scarcely necessary to insist on the especial importance of the study of physical geography as one of the bases required for the scientific pursuit of zoology ; and I am sure no one will be more ready than my friend Sir Joseph Hooker, to whom our knowledge of the geographical distribution of plants, and its meaning, is so largely due, to testify to its immense importance in the case of botany. It is obvious that it is equally indispensable in the cases of geology, astronomy, and meteorology.

Far more important is the question, Ought not physical geography to form part of every liberal education, as being a subject specially adapted for purposes of general learning, and as the only true basis on which can be founded a knowledge of what is termed political geography? Political geography may be regarded to some extent as the geographical distribution of mankind ; and its various features of importance—its boundaries, its lines of migration and commerce, its cities and battle-fields—have their positions determined by the physical conditions and conformation of the earth's surface, as much as in the case of the distribution of the lower organisms.

In Germany and Austria, and many other parts of Europe, the necessity of physical geography as a subject of general education and of higher University study seems to be thoroughly accepted. There can be little doubt that it is an excellent subject of general education. I have become more and more convinced of this from my own experience as an examiner in the subject, and especially when examining for the Public School medals of this Society.

[1] Abstract of Lecture by Prof. H. N. Moseley, F.R.S., at the Royal Geographical Society's Exhibition of Geographical Appliances, Sir Joseph Hooker, K.C.S.I., V.P.R.S., in the chair.

Dr. Archibald Geikie, than whom no one can speak with higher authority, has expressed a most decided opinion on the peculiar value of physical geography in education. He writes, in a letter published in Mr. Keltie's excellent Report, that he knows of no other subject "that lends itself so effectively to the teacher who wishes to inspire his pupils with some appreciation of the nature and value of scientific education and reasoning." He has long been of opinion that, in this sense of the term, geography (that is physical geography), should form an essential part of education.

It seems generally conceded that the teaching of geography in this country is at present in a very unsatisfactory condition, and far behind that existing over a great part of the Continent of Europe. It is most remarkable, and much to be regretted, that in England, of all countries where advanced education prevails, with her world-wide possessions and interests, such a condition should exist. There can be no doubt about the matter. The fact that it is not found by English publishers to pay to issue first-rate maps and works on physical geography, equivalent to those published in Germany, is striking evidence of its correctness. The present movement is founded on a conviction that it is so. The reasons for this condition of things are probably not far to seek. When we find that geography, whether in lower or higher schools, or at military training colleges, is best taught and provided for in such countries as Germany and Austria, where the subject is represented by special professors and systematically taught at the Universities, whilst at no British University is there any professor of geography at all, it is surely not unreasonable to conclude that the lack of professors and higher teaching of the subject at our Universities is the main cause of the inferior position of the subject here.

The present energetic effort of the Society to promote geographical teaching cannot but yield considerable results in improving the position of the subject in this country, but it is most important that a further attempt to introduce the subject in any form, as a University one, should be made.

Possibly, although at the present moment it may not be feasible to secure the representation of geography as a whole, because of the apparent vagueness of its bounds and the attacks on all sides to which it is in consequence liable, there may be a chance of success if the attempt be made to press the claims of physical geography. It is, however, scarcely possible that the establishment of physical geography at the Universities can ever be effected without the cordial co-operation of the leading geologists of this country. I know that several of these, including Prof. Bonney, to whom I am indebted for much advice in the present matter, believe that the time has come when special chairs of physical geography should be established, regarding the question as one of, as it were, splitting the subject of geology into two parts. Prof. Archibald Geikie expresses himself as of a similar opinion in his letter published in Mr. Keltie's Report. That there is a necessity for lectures on the higher branches of physical geography is shown by the fact that courses of lectures nearly relating to this subject are now being given by Prof. Hughes at Cambridge and Prof. Boyd Dawkins at the Owens College, and I venture to suggest to the Council of the Society that it would be well to make an attempt to secure the co-operation of the Geological Society in a joint endeavour to induce the Universities to establish professorships of physical geography. There are many reasons why success may attend an effort to establish the representation of physical geography rather than the wider subject. It is obvious that any professor who could hold such a chair must be a geologist, the two subjects of physical geography and geology being most closely allied and overlapping. I am not going to attempt to define physical geography as a subject. The term geography is, no doubt, a somewhat unfortunate one, and a great deal of serious opposition has been raised to the advancement of the subject on such grounds as that it is a "graphy" and not a "logy." But the Germans have not only practically separated geology and geography as subjects of University study with the highest success, but find no difficulty in the use of the term physical geography to cover such knowledge as is represented in Peschel's excellent work, "Allgemeine Erdkunde."

Regarding physical geography as a part of geology to be separated from it:—The reason why such a separation should be effected is that there is thus formed and brought together for special treatment a subject which is far more necessary and suitable for general educational purposes than the whole of geology itself, which will attract far more students and act as a lever for promoting the study of other branches of science as special subjects, as well as of geology itself.

The principal argument that is always brought against the establishment of professorships of physical geography at the Universities, is that the subject is already covered by the professors of geology; but Prof. Geikie evidently does not take that view, and points out in his letter already referred to, "Geology is every day increasing in its scope, which is already too vast for the physical powers of even the most indefatigable teacher." It is already impossible for one teacher to cover all which may be supposed to be included under the name geology. When both physical geography and geology are represented by a single professor in a University they must needs be inadequately covered, or one branch must receive but meagre treatment in proportion to the other; or the period covered by a course of lectures is too long for any one student to attend the whole. Convinced that it is a matter of the utmost importance for the progress of geography here to show that the two subjects, geology and physical geography, can be taught with perfect harmony and advantage by different professors at the same time at a University, I asked Mr. Keltie to write to some of the German professors of geography, and request them to express their views on the matter, and to ask for copies of the syllabuses of courses of lectures on geography and geology delivered at the same time within their Universities. He has handed me the following most interesting letter from Prof. Kirchhoff, Professor of Geography at Halle:—

"Unfortunately, I cannot send you syllabuses of the University lectures in geology like those of my own lectures on general geography, and on the countries of Europe, which I placed in your hands, since such do not exist.

"However, the question now being raised in England is already practically settled in Germany. All the Universities in Northern Germany, and now those in Austria also, possess geographical as well as geological professors, and it is not found in any instance that the two interfere with each other, or are superfluous to each other, but, on the contrary, they have proved to afford mutual support.

"It is, no doubt, correct that geology, in just the same way as geography, is concerned with the earth and all its various parts. But the point of view on either side is different. For example, whilst I am delivering in Halle during four successive semestres the course on geography, with the nature of which you are acquainted, Prof. von Fritsch and two colleagues are lecturing to almost entirely different audiences on mineralogy, crystallography, geology, and palæontology. In summer, Prof. von Fritsch arranges excursions for geological purposes, and many of the students attending my lectures take part in these, because a problem of great geographical importance is able to be solved during these excursions, namely, the explanation of the form of the land surface as resulting from its composition, and by means of the history of its development.

"The two sciences do, indeed, touch one another in what is termed superficial geology, but from this zone of contact they stretch wide apart from one another. Geology discusses not only the developmental history of the earth in the Quaternary period, a matter which concerns the geographer quite as much as the geologist, but it discusses also that of the most remote periods of the earth's antiquity, investigates the petrographic structure and the organic life of every formation, subjects which hardly concern the geographer at all.

"On the other hand, geography has to deal not only with the land surface and the waters, but also with climate, the flora and fauna, and human inhabitants, both of the earth as a whole and of each separate country, confining its view to the present only, that is to say to the Quaternary period. It might as well be said that the existence of history as a subject at Universities rendered geography unnecessary, because it also has to do with the entire earth's surface.

"In reality, geography embraces all facts relating to the earth, borrowing them often from other sources. The geology of the British Islands, for example, together with their history since the time of Cæsar, does not by any means represent the geography of the islands."

Prof. Wagner, of Göttingen, Professor of Geography in that University, a most eminent authority on geographical education, has sent a note, in which he gives a syllabus of his

own lectures and those of Prof. von Koenen, Professor of Geology.

From this it is evident, as Prof. Wagner concludes, "that there is no connection whatever (*gar kein Konnex*) between my lectures and those of the geologist."

Can any one doubt that the establishment of such a system of teaching geography and geology, side-by-side, as set forth in these two communications, would not be of the utmost benefit to our country and its education generally, if established in our Universities also? It will be impossible to obtain adequately trained teachers of physical geography until such courses of instruction are open; and until adequately trained teachers are produced for higher schools and training colleges, no real progress in the teaching of physical geography can be made throughout the country.

There can scarcely be a doubt that the establishment, at our Universities, of such a condition as that at the German ones, would be in every way to the advantage and advancement of geology, and to the increase of the numbers of its students; it would also advance the cause of all other branches of natural science, and all interested in the teaching of these subjects ought to support a movement in favour of its adoption warmly. No doubt the adoption of the system is merely a question of time,—England cannot lag behind in the study of geography for ever.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. J. E. Marr, M.A., Fellow of St. John's College, has been appointed University Lecturer in Geology.

It is estimated that the ethnological collections now displayed in the Antiquarian Museum are worth at least 2000*l.*, and with a little additional accommodation objects valued at 1000*l.* more can be displayed. These series are of inestimable value to the student of anthropology, and from the labours of Baron von Hügel in their arrangement the University is reaping a rich harvest. The baron contemplates illustrating them by a full series of maps and drawings.

The honorary degree of M.A. is to be conferred on Mr. C. Todd, Government Astronomer, Postmaster-General, and Director of Telegraphs in South Australia.

The Open Entrance Scholarships for Natural Science to be competed for in the ensuing months include those of Peterhouse, Chemistry and Physics, October; Clare, Natural Science, March 24; Downing, Natural Science, June 1; Non-Collegiate Students, Physical Science, July.

Mathematical Scholarships will be given at each College mentioned above (except Downing), and at Trinity Hall, March 17; Corpus Christi, March 23; Queens', April 27; St. Catherine's, May 11; Magdalene, March 17. Further information will be given by the Tutors of each College.

AT the City and Guilds of London Institute, Central Institution, Exhibition Road, S.W., Prof. Ayrton, F.R.S., will give a course of six lectures on some of the industrial applications of electricity, from 5 p.m. to 6 p.m. Friday afternoons, March 12, 19, 26, April 2, 9, and 16. The lecture on March 12 will be on Electric Lighting; March 19, Electricity as a Motive Power; March 26, Electric Storage of Energy; April 2, Electric Transmission of Power; April 9, Electric Meters; April 16, Electric Locomotion.

AT Clifton College a Scholarship of the value of 30*l.* per annum, tenable for three years at the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, is offered by the Committee of the Institute, and will be awarded, on the nomination of the headmaster, in July next. The candidate so nominated will be required to pass the Entrance Examination of the Institution, to be held in the following October. It is the intention of the Committee of the Institute to offer this Scholarship annually for six years, beginning with 1886. The object of the Central Institution is to provide advanced instruction in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts.

It is intended that a subdivision of the Military and Engineering Department of Clifton College shall have its studies specially, though not exclusively, directed with a view to prepare for entrance to the Central Institution and similar Engineering and Technical Colleges.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 4.—"On the Polarisation of Light by Reflection from the Surface of a Crystal of Iceland Spar." By Sir John Conroy, Bart., M.A. of Keble College, Oxford. Communicated by Prof. G. G. Stokes, P.R.S.

In the year 1819 Sir David Brewster communicated to the Royal Society (*Phil. Trans.*, 1819, p. 145) an account of some experiments he had made on the polarisation of light by reflection from the surface of double-refracting substances, and showed that Malus's statement with regard to Iceland spar was incorrect.

Malus said that Iceland spar behaves towards the light it reflects like a common transparent body, and that its polarising angle is about 56° 30′, and that, whatever be the angle comprehended between the plane of incidence and the principal section of the crystal, the ray reflected by the first surface is always polarised in the same manner ("Théorie de la Double Refraction," pp. 240, 241).

Some years later Seebeck made a number of very accurate observations on the same subject, and in 1835 and 1837 Neumann published an account of further experiments that he had made on the reflection of light by Iceland spar.

He begins his second paper by a brief summary of the results obtained by Brewster and Seebeck. "Brewster found that the angle of complete polarisation for calc-spar depends on the position of the reflecting surface relatively to the axis, and upon the position of its principal section to the plane of reflection; he also found that when the reflecting surface is covered with a liquid the plane of polarisation of the completely polarised ray does not coincide with the plane of reflection, but makes a smaller or greater angle with this; when a cleavage-face of calc-spar is covered with oil of cassia this deviation may amount to 90°. The knowledge of these phenomena has only been further advanced in recent times. Dr. Seebeck has so followed out, by means of most accurate determinations, the influence of optically uniaxial crystals upon complete polarisation that the angle of incidence at which this occurs can be determined as accurately beforehand as it can by Brewster's law in the case of uncrystallised bodies. Seebeck also discovered that the deviation of the plane of polarisation from the plane of reflection, which Brewster had observed, also occurs when the ray of light falls directly from air on to the surface of the crystal."

Seebeck's observations having been mainly directed to the determination of the angle of polarisation, Neumann's object was to determine the azimuth of the plane of polarisation of the reflected light.

Seebeck and Neumann only repeated a portion of Brewster's experiments, and no one except Sir David Brewster appears to have made any determinations of the angles and azimuths of polarisation when the spar was in contact with media other than air.

Prof. Stokes very kindly called my attention to these experiments of Sir David Brewster, and pointed out that, as they had never been published in detail, and had not been repeated by any one else, it was desirable that further observations should be made on this subject. The experiments, the results of which I have the honour of submitting to the Royal Society, were undertaken at Prof. Stokes's suggestion, and in carrying them out I had the benefit of his advice.

The apparatus used was essentially the same as that employed by Seebeck; the divided circle of the goniometer was, however, horizontal, and not vertical, as in Seebeck's instrument, and the arrangement for keeping the reflected ray constantly in the axis of the observing-tube, whilst the angle of incidence was varied, differed from that employed by him.

The measurements were made by altering the angle of incidence and the azimuth of the observing Nicol until the light reflected by the Iceland spar was reduced to a minimum, the position of the crystal remaining fixed.

In order to obtain anything like accurate results with observations of this kind it is necessary to make a large number of determinations and take their mean: it was obvious that there were two ways in which any given number of observations might be grouped, either by making a good many separate determinations for a few positions of the crystal, or by making a few observations at a number of different azimuths; the latter alternative being the one adopted, two readings were made at seventy-two different azimuths of the crystal.

Two complete series of observations were made with cleavage-