periodic comets due this year. The following is a search ephemeris for the present month for intervals of four days :—

1893.		R.A. h. m. s.		Decl. ° ′
May 20	...	23 48 12	...	−4 24
24	...	0 5 24	...	−2 34
28	...	0 22 57	...	−0 40
June 1	...	0 40 53	...	+1 16

L'Astronomie FOR MAY.—This number commences with the discourses delivered by M. Tisserand and M. Flammarion before the Astronomical Society of France, the former "On the Progress of Astronomy during the Past Year," and the latter "On the Progress of the Society itself.—A brief but interesting article from the pen of Dr. Lorin, on "Celestial Photography," will be of special value to possessors of small instruments, since he shows how they can be adapted for the taking of such photographs. With reference to the late solar eclipse, several observatories have communicated their observations as made on the Continent, accompanying them with drawings, which are here inserted.

THE LUNAR ATMOSPHERE.—At the Observatory of Alger, M. Spee (*Comptes Rendus*, April 24, No. 17) made some interesting observations to find out whether any modifications due to a lunar atmosphere were produced in the lines of the solar spectrum (1) in the neighbourhood of the horns, and (2) at the point of contact of the lunar disc with a sun-spot. The observations, he says, were made under the best conditions, but gave a negative answer to the first of these two investigations. With regard to the second he says that no change was noted until at the moment of the greatest phase when the lines of magnesium b^1 b^2 b^4 "appeared sharp and seemed to be accompanied on both sides with very fine lines reminding one of what in spectroscopy is known under the name of *persiennes.* C was terminated, as M. Spée says, "*en fer de lance*" penetrating the chromosphere.

BULLETIN ASTRONOMIQUE FOR APRIL.—In this periodical for the past month M. Haerdtl contributes some notes relative to some small inequalities of long period in the movements of the Moon, Earth, and Mars. The determination of the orbit of the periodical comet Finlay (1886 vii.) is the subject of a long article by M. Schulhof, but in this (to be continued in the next) he only limits himself to the ephemeris and the mean positions of the comparison stars, with copious notes giving the authorities, proper movements, and remarks. *Apropos* of the question of the variation of latitudes M. Boquet gives an interesting historical notice on the latitude of the Observatory of Paris, in which he recapitulates all the attempts made to fix the value of this important element. Now that we know that variations occur, it is most interesting to read the remarks of the authors of these various determinations at different times with respect to the discrepancies between the values. M. Yvon Villarceau for instance, from his observations in 1866 and 1867 says: "Quant à la mesure exacte de la latitude, nous ne voyons pas qu'elle puisse résulter des mesures faites aux Cercles muraux de Gambey et de Fordin." . . . .

GEOGRAPHICAL NOTES.

THE death of Mr. W. Cotton Oswell on May 1st, at the age of 75, removed a famous African traveller and hunter whose name had almost ceased to be remembered by the general public. In his early life Mr. Oswell spent five years in South Africa hunting and exploring. His adventures were of the most thrilling kind, and the trophies he preserved in his house at Groombridge form a unique collection. He was associated with Livingstone in his earlier travels, and charged himself with the care of the waggons and the provision of food, while his companion planned the route and made scientific observations. In this way Mr. Oswell was with Livingstone at the discovery of Lake Ngami. Subsequently Mr. Oswell travelled and made collections in South America and elsewhere, but his extreme modesty prevented him from thrusting himself before the public, and he wrote nothing. His geniality in private life was as remarkable a feature of his character as his shrinking from all public appearances.

THE Canadian Government has decided to despatch an expedition, under the charge of Mr. J. B. Tyrrell, of the Geological Survey of Canada, to explore the barren ground northward from Lake Athabasca, a region which has not been visited by competent observers since 1772.

M. MARCEL DUBOIS has been appointed to the Chair of Colonial Geography, the foundation of which at the Sorbonne we intimated last year.

THE higher teaching of geography in England is not confined to the lectures delivered at the two ancient Universities. For some years Prof. C. Lapworth, F.R.S., has given courses on physical and political geography at the Mason College, Birmingham, which are this session attended by over eighty students. The complete course occupies two years, lectures being given twice a week; the syllabus is drawn out on thoroughly scientific lines, and while entirely original in treatment is comparable with the best instruction given in the same subject in German Universities.

ENGINEERING works of such magnitude as to be of geographical importance have been for some time carried out on the Alsatian slope of the Vosges in order to regulate the water supply for industrial purposes. A series of reservoirs, so large as to be described as artificial lakes, has thus been formed, and the rainfall of the district can now be utilised much more completely than was formerly possible.

THE FUNDAMENTAL AXIOMS OF DYNAMICS.

IN view of a discussion at the Physical Society of London on Friday, the 26th inst., it may be convenient if I anticipate future communications so far as to give in a brief or summary form the "Laws of Motion" somewhat as I propose to advocate their acceptance; not, however, entering into details, and not being specially careful about precise form of words, rather aiming at giving the general sense with the object of assisting discussion by abbreviating or summarising my paper in a few definite statements.

Notions derived more or less directly from sensations, and here accepted as understood without special definition.

Motion, Space (extent and direction), Velocity (including direction), Time, Stress, Force (including direction), Matter.

About all these there is much to say; some are more immediate sense-perceptions than others, but a detailed discussion of them verges on metaphysics, and is not an *essential* preliminary to a physical treatise. All that is *necessary* is explanation and illustration sufficient to render the terms intelligible. All that I shall say here is that by "matter" is meant primarily something tangible or resisting; that we experience "force" when we push a truck; that a thumbscrew gives us a notion of "stress": and that pushing a truck does also, if we attend to both hands and feet.

Remarks, Practical Assumptions, and Experiments.

There is no need to discriminate a force from a vector in a fundamental treatment, because all ideas about moment of force, angular momentum, and the like, belong to a consideration of the behaviour of a rigid body, which is an artificial agglomeration of connected particles: convenient, not fundamental.

But there are some assumptions and experiments needful to be made concerning the measurement of force more precisely than by our muscles.

(*Assumption* 1). That the weight of a given piece of matter at a given place is not liable to capricious change.

(*Assumption* 2). That two similar lumps of matter weigh twice as much as either.

(*Experimental result* 1). That strains of elastic bodies are proportional to the stresses within certain limits.

(*Experimental result* 2). That the frequency of a loaded elastic body, vibrating within the above limits is independent of amplitude.

(*Experimental result* 3). That in cases of impact there is one point whose motion is undisturbed by the blow.

Definitions, Simple Experiences, and Axioms.

(*Experience* 1). A stress consists of two forces.

(*Definition* 1). Acceleration (including direction) = dv/dt.

(*Experience* 2). Acceleration occurs in matter subject to an unbalanced force.

(*Axiom* 1). Without force there can be no acceleration of matter.

(*Experience* 3). The acceleration appears to agree with the force in direction, and is in some cases demonstrably proportional to the force. (A deduction from experimental result 2 above.)

(*Axiom* 2). The acceleration of a given piece of matter is proportional to the (effective or resultant or unbalanced) force acting on it, and is in the same direction.

(*Experience* 4). Stresses in a body do not accelerate it as a whole.

(*Axiom* 3). The two forces of a stress are always balanced.

[*Or otherwise* (after Experience 3).]

(*Definition* 2). The ratio of the force acting to the acceleration produced in a given piece of matter is called its "inertia."

(*Axiom a*). The inertia of a given piece of matter is unconditionally constant, and has no direction.

(*Remark*). Inertia is therefore taken as the most fundamental property of matter, and is used to measure its massiveness or "mass."

Definition 3). The centre of mass of a system is a point such that $\Sigma(mr) = 0$; *or*, it is a point moving with speed v, such that $\Sigma(m)\text{v} = \Sigma(m\text{v})$.

(*Axiom b*). The centre of mass of a system is not accelerated by internal stresses, but only by one component of a stress whose other component acts on a body foreign to the system.

(*Deduction*). The two forces of a stress are always equal and opposite.

(*Remark*). A brief and convenient statement of Axiom 2, by help of Definitions 1 and 2, is $\text{F}dt = m\text{dv}$. Note that F and dv have necessarily the same sign; they are parallel vectors.

(*Experience* 5). Every force is one component of a stress; in other words, bodies can only mechanically act on one another (*i.e.* so as to affect each other's motion) by means of stress; or stress is essential to mechanical action.

(*Remark*). This might have been made part of Axiom 3, but it is really a distinct statement. Perhaps it should be stated as an axiom.

(*Axiom* 4). A stress cannot exist in or across empty space.

(*Deduction*). Therefore bodies (or any media) immediately acting on each other are necessarily in contact, and stress exists at the point of contact, where the normal components of their velocities (v) are identical.

(*Experience* 6). When stress and motion coexist, action occurs or activity is manifested.

(*Definition* 4). The scalar product of the two vectors Fv is called "activity."

(*Deduction*). The activities of two immediately acting bodies are equal and opposite.

(*Remark*). Elastic bodies under stress, and moving bodies with inertia, are found to be able to manifest activity, and are said to possess energy whereby they can do work on other bodies. Stress energy is called potential; motion energy is called kinetic.

(*Definition* 5). Work done $= \int(\text{activity})dt =$ energy gained or lost.

(*Remark*). There are two ways of regarding this quantity: $\int \text{F}vdt$; namely either as $\text{F}(vdt) = \text{F}ds =$ change of potential energy, or as $v(\text{F}dt) = v.m\text{d}v =$ change of kinetic energy.

A body for which Fv is positive is losing energy; a body for which Fv is negative is gaining energy.

(*Deduction*). Since the activities of two immediately acting bodies are equal and opposite it follows by Definition 5 that energy lost by one is gained by the other; *i.e.*, that energy is simply transferred without loss or gain across the point of contact in the direction of the common velocity.

(*Axiom* 5). Energy which is not being actively transferred from one body to another remains unaltered in quantity and form.

(*Remark*). Energy which is being transferred from one body to another changes its form. The kind of transformation depends on the sign of dv with respect to the common velocity of the acting bodies at their point of contact.

If vdv is positive, energy is being transformed into kinetic; if vdv is negative, it is being transformed into potential; if vdv is zero, there is a mere flux or transmission of energy without transformation.

(*Deduction*). Since transference of energy is essential to activity it follows that only bodies which are able automatically to part with some of their energy, are able automatically to do work. In other words, automatically transferable energy is alone available or potential.

(*Experience* 7). The automatically transferable or potential energy of a body or system is liable to transfer and transform itself into kinetic. Hence

(*Axiom* 6). The potential energy of a system tends towards zero.

(*Experience*). Kinetic energy is only available when associated with appreciable or relative momentum.

The following statements may be made about the irregular and aggregate motion of particles called Heat.

(*Experience*). Heat will not flow from low to high temperature by mere conduction (as it could, for a time, if it possessed inertia, like water, air, or electricity). It can only flow from cold to hot by help of convection by matter or something else. Such flow is therefore not a cyclical or perennial process.

(*Deduction*). Energy of average temperature is useless for continuous work. In other words, the only available or potential portion of heat-energy, when dealt with in the aggregate, is that which a body is able freely to emit to colder bodies.

(*Definition*). The absolute temperature of a body is to its total heat-energy as the available fall of temperature is to its potential heat-energy.

OLIVER LODGE.

THE ROYAL SOCIETY SOIRÉE.

THE Royal Society Soirée on May 10 was in every way most successful. It was very numerously attended, and much interest was excited by many of the exhibits and by the demonstrations. In the following account of the exhibits we give a full account only of such objects as have not before been referred to in NATURE:—

Captain Abney, C.B., F.R.S., and General Festing, F.R.S., exhibited experiments on the extinction of light and colour.

Sir J. B. Lawes, Bart., F.R.S., and Dr. J. H. Gilbert, F.R.S., exhibited a series of photographs relating to the working of the Rothamsted Laboratory. In experiments on the growth of root-crops year after year on the same land, it was found that after a very few years of growth without manure, the root no longer developed the swollen character of the cultivated plant, but remain fusiform as in the uncultivated condition. The photographs strikingly show the same characters in roots grown in rotation without manure; also that mineral manures alone greatly favour the development of the swollen root, but that mineral and nitrogenous manures together do so in a much greater degree. The results further show how artificial a product is the cultivated root-crop, and how dependent it is on an abundant supply of food within the soil—nitrogenous as well as mineral. Indeed, details of the experiments afford conclusive evidence that it is quite fallacious to suppose that root-crops derive a large amount of their nitrogen from atmospheric sources by means of their extended leaf surface.

Three instruments for the study of Crystals were shown by Mr. H. A. Miers. (1) A goniometer by which crystals can be measured under liquids, or during their growth from solution. (2) A stage-goniometer by which small crystals or fragments can be adjusted and rotated under the microscope. It is here fitted to the stage of the petrological microscope designed by Mr. A. Dick. (3) An improved form of polariscope on the plan devised by Prof. W. G. Adams, F.R.S. The hemispheres which enclose the crystal section can in this instrument be accurately centred so that exact measurement of the optic axial angle is possible.

Prof. Rücker, F.R.S., and Prof. Thorpe, F.R.S., exhibited maps showing the forms of the true lines of equal declination, equal horizontul force, and equal dip in the United Kingdom for the epoch, Jan. 1, 1891.

Mr. A. A. C. Swinton exhibited high frequency electric experiments. (1) The filament of an ordinary 5 c.p. 100-volt lamp is caused to incandesce with current conveyed through the human body. (2) Sparks, evidencing a difference of potential of some thousands of volts, produced between the two hands of the same operator. (3) Luminous spiral produced in exhausted glass tube by molecular bombardment from wire spiral wound outside tube. (4) Some effects produced by high frequency discharges passing through semi-conducting substances, and striking liquids.

Sodium potassium high temperature thermometers, and specimens of the alloy, were exhibited by Mr. E. C. C. Baly and Mr. J. C. Chorley. These thermometers are filled with an alloy of sodium and potassium which is liquid at ordinary temperatures. Their