approximation we find that the apsidal progress per revolution is

$$\frac{4\pi\lambda\gamma^2(m_1+m_2)^2}{C^2h^2}$$

The observed value requires that λ should be nearly $3/2$, and if $3/2$ is taken, we get the result obtained by Prof. Einstein by his new specification and principles.

It may be observed that the above specification by the Lagrangean function could be generalised for any number of particles, and that it involves no departure from recognised dynamics or the normal views of space and time. It does, however, involve the conclusion that the interaction of bodies through the æther, vaguely called "gravitation," is to a very slight degree not exactly in accordance with Newton's specification. Whether such conclusion is really necessary seems still a matter of doubt.

I have not seen any discussion of the problem of two bodies on Prof. Einstein's specification, but it appears to me that an exact determination of the relative orbit when m_1 and m_2 are comparable quantities is very desirable. GEORGE W. WALKER.

Portsmouth, March 29.

The Construction of a Magnetic Shell Equivalent to a Given Electric Current.

ACCORDING to Ampère's theorem, the magnetic field due to an electric current flowing in any circuit is equivalent at external points to that due to a simple magnetic shell the bounding edge of which coincides with the conductor, and the strength of which is equal to the strength of the current.

It is generally understood that any surface having the circuit as its boundary will serve as the surface of an equivalent magnetic shell, and the fact that there is a restriction on the nature of the surface does not appear generally to be recognised.

Thus, for example, in Maxwell's treatise (vol. ii., p. 142) we find the following:—"Conceive any surface S bounded by the circuit and not passing through the point P "; while further on he says: "It is manifest that the action of the circuit is independent of the form of the surface S , which was drawn in a perfectly arbitrary manner so as to fill it up."

I propose to show by means of a simple example that the surface is not drawn in a "perfectly arbitrary" manner.

Consider a narrow, rectangular strip of paper the opposite edges of which we shall denote by a and b , its opposite faces by A and B , and its two ends by 1 and 2. We shall represent the ends of the edges by a_1, b_1, a_2, b_2 , where the suffixes refer to the corresponding ends of the strip. Now let one end of the paper be turned round through an angle π and joined on to the other end, so that a_1 is joined to b_2 and b_1 to a_2 .

Then, since a_1 is joined to b_2 , the edges a and b form one continuous line, and, since b_1 is joined to a_2 , this line forms a closed circuit.

Thus we may bend a wire into the form of the edge, and can imagine an electric current to flow in it.

Although the electric circuit has the form of the edge, yet we could not have a simple magnetic shell the surface of which was that of the paper.

This is easily seen, for since, in addition to the edges, the faces A and B have also become continuous one with the other, we can no longer distinguish one as positive and the other as negative. The same thing is seen if we try to imagine the surface divided up into elementary portions, in the manner conceived

of by Ampère, with a current equal in strength to the given current flowing round the boundary of each.

It is easily seen that Ampère's construction fails for such a surface, which is known to mathematicians as a Möbius sheet.

Although the surface we have described would not serve as the surface of a simple magnetic shell equivalent to an electric current flowing round its boundary, yet it is possible to construct other surfaces having this boundary which would serve as surfaces of equivalent magnetic shells.

If we have one suitable surface we can obtain any number of others from it by continuous deformation while the edge remains fixed.

It is, therefore, desirable to give a general method of constructing a magnetic shell equivalent to a given electric circuit. The following appears to give a surface having the required property:—

Let O be a fixed point external to the circuit, and let P be a variable point. Let P travel once completely round the circuit, so that the radius vector OP traces out some conical surface.

The portion of this conical surface containing O and bounded by the circuit might then be taken as the surface of the equivalent magnetic shell.

In the particular case of the circuit we have considered (as well as in many others) the surface will cut itself, but will, nevertheless, have two distinct faces, one of which may be taken as positive and the other as negative. It thus appears to satisfy the necessary conditions. A. A. ROBB.

March 30.

Volcanic Rocks in the Anglo-Egyptian Sudan.

IN connection with Prof. J. W. Gregory's reference in NATURE of February 19, p. 667, to the discovery of the Bayuda volcanic field, and Mr. Campbell Smith's record of a riebeckite-rhyolite which constituted a number of stone implements found at Jebel Katul, in Northern Kordofan (*ibid.*, February 26, p. 693), some further notes may be of interest.

The rock collected by Sir Herbert Jackson at Merowe is a basaltic scoria, and the specimens either float or just sink in water. A few crystals of olivine are visible to the eye, and, under the microscope, a regular basaltic ground-mass, including felspar, iron ores, and probably glass, can be recognised in the powdered rock. The specimens have evidently been transported by a stream system which drains from the south-east and debouches on the river at the spot where they were found. Save for the neighbourhoods of the river and a few routes by which travellers avoid the long journey around the Abu Hamed bend of the Nile, the maps of the Bayuda Desert are almost blank. Near one of the routes a surveyor has recorded "Hosh Eddalam, crater," and the name means a dark enclosure. Some of the older travellers mistook ironstone concretions for volcanic bombs, and as the surfaces of many rocks are darkened in the desert such a record of a crater did not call for particular note until evidence of extrusive rocks appeared. It is situated in latitude $18^\circ 20' N.$, longitude $32^\circ 31' E.$, and consequently lies to the west of the route taken by Dr. Chalmers Mitchell. The volcanic field seen from the air probably does not lie on the established routes, as it would certainly have been referred to in reports, even if it were not described. Presumably there can be no doubt about the existence of craters seen by an observer such as Dr. Chalmers Mitchell, but the results of an examination on the ground will be of interest, even if only to know the types of rocks involved.

Mr. Stanley C. Dunn records the presence of rhyolites and felsites near Jakdul, and these are doubtless

similar to those of the Sixth Cataract, about forty miles north of Khartum, where the volcanic rocks are certainly older than the Nubian Sandstone. In the northern parts of Dongola basalt intrusions occur in the Nubian Sandstone, and there is a hot spring at Akasha, about eighty miles south-west of Halfa. Turning to more distant regions, one of the solitary landmarks on the White Nile is Jebel Ahmed Aga, in latitude 11° N., consisting of the remains of a volcanic cone formed of basaltic scoria and evidently of comparatively recent age. Towards the east there are the plateau basalts of Abyssinia, with outliers extending into the Sudan. Along the Langeb Valley, north of Kassala, there is an interesting suite of acid and intermediate volcanic rocks, but we are still in doubt about their age. Similar rhyolites certainly occur farther north among the Red Sea hills. The western parts of Kordofan have been traversed geologically without revealing the existence of volcanic rocks on the continuation of the line referred to by Mr. Campbell Smith. Farther west Darfur appears to be full of recent volcanic rocks, principally of scoriaceous types.

The N.E.-S.W. features seen by Dr. Chalmers Mitchell may have been to some extent due to erosion by sand driven from the N.N.E. by the prevalent wind. The direction of strike among the metamorphic rocks is another factor to be borne in mind. It is not constant over these large areas, but it is very often N.E.-S.W., and would then account for some of the features seen from the air. In these circumstances caution appears desirable in basing wide structural theories on rather scanty data.

G. W. GRABHAM.

Box 178, Khartum, March 25.

The FitzGerald-Lorentz Contraction Theory.

IN the discussion on relativity at the Royal Society on February 5 (*NATURE*, February 12), Mr. Jeans stated that the FitzGerald-Lorentz contraction theory presented grave difficulties in the case of a wheel rotating about a fixed axle, so that the circumference would contract while the radius would not. Surely these difficulties are not so grave as would appear at first sight? Let us adopt the point of view of the old-fashioned non-relativist to whom space is rigid and Euclidean, even though his measuring instruments may change and so introduce errors in his measurements. A scale is not a rigid invariable unit of length. Its length, even if its orientation is unchanged, depends on its temperature and the tensile or compression stresses to which it is subjected. If we change its temperature, keeping the stresses constant, its length (as measured by a standard scale at fixed temperature) varies. But we may by suitable means prevent the variation of length, in which case the change of temperature will cause a change of stress. Similarly, on the FitzGerald-Lorentz theory, turning the scale to a different orientation relative to the supposed æther stream causes a change in the electric forces to which the cohesion of the molecules is ultimately due, so that if the temperature and the external stresses remain constant, the length changes. In this case, however, we cannot detect the change directly, as it would be necessary to turn our standard scale also, and it, too, would change. If for any reason the change of length is prevented, the FitzGerald-Lorentz effect causes a change of stress.

Now in the case of the rotating wheel the ratio of the circumference to the radius must remain constant, so that any tendency of one to change its dimensions will affect the other, with the result that both

circumferential and radial stresses will be set up, and any changes of length caused must be compatible with the constancy of π . These stresses would in any actual case be almost vanishingly small compared with those due to centrifugal force, so that the only effect of the FitzGerald-Lorentz contraction would be to alter the latter stresses to an utterly negligible extent.

HORACE H. POOLE.

Physical Laboratory, Trinity College,
Dublin, March 19.

Moseley Memorial.

THE fund founded in the University of Manchester for the provision of a memorial to the late H. G. J. Moseley (killed in action at Gallipoli, 1915), and originally proposed as a private memorial from Moseley's personal friends and fellow-workers in Manchester, has now been extended in order to give other scientific bodies, both in England and abroad, an opportunity of participating. This extension has been made at the request of a number of scientific men interested in Moseley's work, but not personally connected with him, and it is in order to reach this wider public that you are asked to publish this letter.

The scheme of memorial proposed is (1) the provision of a memorial tablet in the physical laboratory and (2) the foundation of a Moseley prize or medal for physics in the University of Manchester.

The fund is administered by a committee consisting of Sir Henry A. Miers (chairman), Profs. W. L. Bragg and H. B. Dixon, Sir E. Rutherford, and Dr. E. J. Evans.

Subscriptions, which should be made payable to the "Moseley Memorial Fund," and crossed "Williams Deacon's Bank, Ltd.," may be sent to either of the hon. secretaries, Mr. C. G. Darwin, Christ's College, Cambridge, or Dr. H. Robinson, Physical Laboratory, University of Manchester.

About 170*l.* has already been received, comprising donations from Great Britain, Canada, the United States, and France (including contributions from the Société Française de Physique and the Société de Chimie-Physique).

It is desired to close the fund in July of this year.

HENRY A. MIERS,

Chairman.

C. G. DARWIN,

H. ROBINSON,

Hon. Secretaries.

The Aurora of March 22-23.

I HAD a fine view of this superb display at Workington between midnight and 1 o'clock a.m., in a clear and bright starlit sky. The whole sky was filled with the light except a small area in the south-east. I could detect no colour except creamy-white, the general intensity being, to my mind, at times equal to full moonlight. Curtains of light surrounded a point just east of the zenith, which seemed to mark the "hub" of the display. The bright star (α) in Canes Venatici almost exactly marked this point, and filmy sheets of light seemed to dash upwards from the south-west and north-east horizons and merge together at this star. The only display I have ever seen to equal this was on 1907 February 14 at Motherwell, in the previous sun-spot maximum period. It was the fact that I could see the great sun-spot train on March 22 without telescopic aid that made me expect and look out for the aurora that night.

W. B. HOUSMAN.

Seaton Cottage, Workington, April 9.