LETTERS TO THE EDITOR.

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The Eötvös "Tour de Force."

MAY I add to my article in NATURE of March 21, on the revolving balance of Baron Eötvös, that the method lends itself to determine the mass of the earth, or, more directly, the Newtonian constant of gravitation, with the same simplicity as it does to find the rotation of the earth. For this purpose it is merely necessary to place a large mass above the balance, say at the north end, and below the balance at the south end. Then if the direction of rotation is such that the north end is moving in the same direction as the earth the gravitational couple will act in the same direction as the $4Vv$ difference of centrifugal force, whereas if it turns in the opposite direction, the gravitational couple will be opposed to the centrifugal couple. If the large masses of radius c are spherical and are made of material of density d, and the fictitious distances of their centres vertically above and below the small masses at the ends of the balance-arms are also equal to c, the arm lengths being r, then the time of rotation necessary to make the one action equal to the other is given by the equation—

$$T = \frac{48\Omega}{Gd}\frac{r}{c}\cos^2\phi.$$

Making provisionally $r = c$, and taking for d the density of lead, the time T comes out as thirty-one minutes, which, I fear, is much greater than that which could be realised as a free period. If, however, the period were one minute, the gravitational couple would add or subtract $1/31$ part of the centrifugal effect, according to the direction of rotation, or the ultimate deflections in the two cases would have the ratio $15 : 16$, a difference which might be observable. By fictitious distance I mean the equivalent distance vertically above or below the centre of the small mass m at which the centre of the large mass may be imagined acting on the small masses with a cosine distribution of force. Actually it would have to be larger and further away. This could more readily be determined in any particular case by arithmetical treatment than otherwise.

I have been considering in some detail the best way of constructing an Eötvös *tour de force*, if I may be allowed so to call it, with a view to the utmost possible delicacy, and as I have all the material, I am hoping to set one up in a cellar in the country admirably adapted to the purpose in such time as I can glean from other occupations. C. V. BOYS.

The Motion of the Perihelion of Mercury.

IN NATURE for March 21 Sir Oliver Lodge suggests that the unexplained part of the motion of the perihelion of Mercury may be attributed to the action of a resisting medium. Such a medium would not necessarily produce any effect on the mean distance of a planet, for such an effect depends entirely on the relative velocity, and it is probable that the medium would revolve with the planets. The principal effect of the medium would be to reduce the eccentricity, and de/dt would contain e as a factor. There would be no motion of the perihelion if e were small enough. Any motion of this could arise only if the eccentricity were considerable, and thus would contain it as a factor. Hence $d\varpi/dt$ and de/dt would be of the same order. Now the observed anomalous variations of ϖ and e in a century are $43''$ and $-0.88''$, so that they are of

different orders, and therefore cannot be due to a resisting medium.

Or, again, consider the density needed to produce the effect. The average resultant velocity of Mercury relative to the medium is of the order of the eccentricity multiplied by the planet's mean orbital velocity, or about eight kilometres per second. If ρ be the density of the medium, a the radius of Mercury, U this relative velocity, and M the mass of the planet, the retarding force would be nearly $\rho a^2 U^2$, and de/edt would be of the order $\rho a^2 U^2/MU$. Substituting for all these quantities, except ρ, their known values, we see that ρ must be of the order 3×10^{-11} gm./cm.³, while the maximum density consistent with the observed luminosity of the Zodiacal light is only about 2×10^{-17} gm./cm.³. To account for the motion of the perihelion would, of course, require a still greater density.

Many recent writers on this subject have treated the discordance in the motion of the perihelion of Mercury as if it were the only unexplained perturbation in the solar system. Yet there is an unexplained advance of the node of Venus of the same order of magnitude, the motions in a century being $43''$ and $10''$ respectively. The latter estimate is admittedly subject to greater uncertainty, but it is 3.5 times its mean error, and the probability that so large a discrepancy is accidental is only about 0·0004. Now, whatever may be the effect of departure from simple Newtonian dynamics, it cannot alter the plane of an orbit, which can be done only by the attraction of other matter, or to a negligible extent by a moving resisting medium. It is found that a distribution of gravitating matter that would represent the motion of the node of Venus would necessarily account also for the whole of the discrepancy in the perihelion of Mercury, so that departures from Newtonian dynamics to explain the latter make the former impossible to account for. It is, of course, possible that the excess motion of the node of Venus may be due to errors of observation, but the probability against this is about 2500 to 1, and it must be admitted that any theory with such an *a priori* probability against it is open to very grave suspicion.

HAROLD JEFFREYS.

Bee Disease.

IN connection with the article on bee disease which appeared in NATURE of March 21, perhaps my experience with diseased bees may be of interest. I have subjected to microscopic examination the contents of the intestines and chyle stomachs of several dozen bees, all guaranteed by a professional lecturer in bee-keeping to be suffering at the time from the "Isle of Wight disease." In all cases the examination under the $1/12$ immersion was conducted within five minutes after the bees had been killed. In no case did I find a trace of *Nosema apis*. In some there was a predominance of wild yeasts in the affected parts; in others again bacterial multiplication was very far advanced. It may, of course, be advanced that these particular bees were not suffering from the "Isle of Wight disease," but in view of the conclusion adopted by several competent biologists that *Nosema apis* has no causal connection with the "Isle of Wight disease," and also of the importance of the subject, further investigation is urgently needed. The impression left on the present writer was that *Nosema apis*, when found, was an accessory, and not a causal agent; and the fact that in practically all the observations of this disease that have been made in Scotland *Nosema apis* has been conspicuous by its absence supports this impression. It would appear that different causative agents produce the same symptoms; from the practical point of view, as the agents may be protozoa, or yeasts,