A MAGNETIC SURVEY OF JAPAN.*

By

A. TANAKADATE.

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In "Nature" of April 20th, this year (Vol. 71 p. 578), Prof. A. Schuster has given a comprehensive review of the magnetic survey of Japan with a friendly criticism. The responsibility of its writer may be a sufficient excuse for the following remarks partly in way of reply.

Prof. Schuster draws attention to the small space given to the description of the working of the instruments. This arises from the fact that these instruments were essentially the same as the one used in the previous survey of 1887 and described in Vol. II, p. 178–193 of the Journal of the College of Science, Imperial University, Tōkyō, to which the reader is referred for details. A few improvements that have since been made are mentioned in the present Report p. 7–8.

We are glad to see that the methods adopted for calculating the corrections for heights of stations, and the way of disposing with the vertical current met his approval; only, Prof. Schuster seems to attribute these currents to uncertainties in the observations, whereas we infer that they are as much, if not more, due to the inadequacy of the empirical formulae, from the fact that they vanish near the middle of the several countries treated (p. 125).

Perhaps the more important point is with regard to the question of the seat of action. To avoid confusion, it might be well to remark, that the word potential is used in different senses by different writers; some use it to denote a function which satisfies the Laplacian equation \( \nabla^2 V = 0 \), and others, to denote the line integral of any irrotationally distributed vector, whether the solenoidal condition be satisfied or not. It is in the latter general sense that the word is used in the Report.

Now Gauss's method of separating internal and external sources of action is based upon the assumption that these sources are entirely...
separated from each other by a free space, in other words, Laplacian equation holds strictly over a finite portion of the space surrounding the earth surface. This is very plausible when we consider the earth as a magnetised body, as appears a posteriori. But when we abandon the restriction of the solenoidal distribution, the method is no more applicable, and the observation of force over a spherical surface is not sufficient to settle the seat of action, although it may be expandable in harmonic form if its distribution is continuous; so that the Gaussian expansion must be taken in "Gauss's sense" (end of 1st paragraph p. 140 of the Report).

The possibility of the distribution of magnetism in the space surrounding the earth surface might appear quite extravagant, and may be included amongst what Gauss calls "bodenlose Phantasien," so long as we are considering the main causes of the terrestrial magnetism; but when we come to discuss the external causes and the horizontal atmospheric current whose effects amount to only a small fraction of the observed force, our assumption of the distribution being thoroughly solenoidal would seem subject to doubt, or at least require observational evidence: so that "strictly speaking, the mode of distribution must remain perfectly arbitrary so long as we adhere solely to the observed elements" of the magnetic force on a spherical surface when no further assumption than the Newtonian law of action is admitted.

It may not be unnecessary to add here, that the search of the seat of action from observations of force over a surface is an inverse problem and includes any arbitrary distribution of magnetism whose resultant effect vanishes on that particular surface; we can put any system of magnets or electric circuits outside the surface, provided we envelope that surface with a counter-acting shell or shells over which a proper distribution of magnetism is made according to the Green's method of finding the density of induced electricity on a conductor, besides any amount of closed magnetic shells and solenoids. It will thus be seen, that even if we take the internal and external sources to be detached, the plain proposition given by Prof. Schuster would appear to require a modifying clause in order to be exact.