latitudes; for here, whilst in wooden ships, where the iron work is in detached masses, the ship can have but little, externally, of the character of a true magnet, and can possess but small comparative differences from the position of her head whilst building; in iron ships, on the converse, where the ship is rendered by percussive action a powerful and, *retentively*, true magnet, her deviating action must be expected to be different, as the polarity of the head or stern may differ in denomination, or as the ship's magnetic polar axis may happen to lie over to starboard or port.

As an objection might be made to deductions from experiments on simple individual bars or plates of iron being applied to the case of iron ships built up of thousands of pieces, I have repeated the experiments, substituting for an entire plate or bar of iron a plate about 18 inches long and 3 broad, made up of numerous separate plates, and combined in the manner of the plating of iron ships. The compound or combined plate of some eighteen or twenty pieces yielded, under percussion, vibration or bending, results precisely similar to those obtained by the use of single plates or bars.

III. Extract of a Letter from Professor Langberg of Christiania to Colonel Sabine, dated June 10th, 1855. Communicated by Colonel Sabine, V.P. and Treas. R.S.

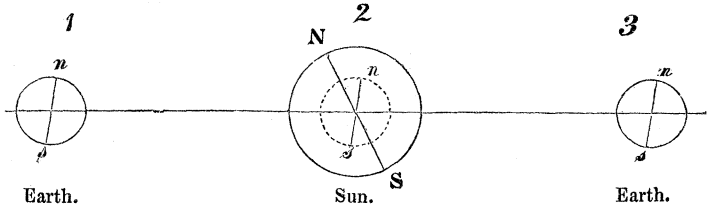
"Of all the important results from the discussions of the British Colonial Observatory, the discovery of the *direct* action of the sun on the magnetism of the earth is certainly a fact of the highest interest, in opening quite a new field for investigation; and few modern discoveries in this branch of science have interested me more than yours of the annual variation of the diurnal variation of declination. It seems that M. Secchi of Rome has nearly touched at the same discovery, and I am indeed glad that the enormous quantity of calculations, which you are superintending, did not prevent you from publishing your results before the ripening fruit was plucked by another. The first beautiful result of this annual variation is the explanation of the fact, which you have deduced from the observations at St. Helena and the Cape of Good Hope, that the horary variation

of declination does *not* vanish in passing from the northern to the southern magnetic hemisphere, but only changes signs at the equinoxes. I think every physicist will agree with you, that no thermic hypothesis will be able to explain this annual variation, but as you say (Toronto, ii. p. xix), it is 'obviously connected with, and dependent on, the earth's position in its orbit relatively to the sun, around which it revolves, as the diurnal variation is connected with the rotation of the earth on its axis.' But you have given no hint how this different position in its orbit can affect the magnetic condition of the earth, except so far as you suppose that the excentricity of the orbit is the reason that the total magnetic force is about $\frac{2}{1000}$ greater at the perihelion than at the aphelion (page xciii); but even granted that this variation is the effect of the excentricity, it cannot be the cause of the annual variation of the declination, as this is of contrary signs in the two semiannual periods.

"I have thought that this annual variation might possibly be explained by the following considerations, which I (although with extreme diffidence) shall venture to lay before you.

"As the recent magnetic observations have proved without doubt the *direct* magnetic action of the sun, or that the sun itself is a magnet, the sun must accordingly have magnetic polarity or magnetic poles. Now in our ignorance of the causes of the magnetic condition of the heavenly bodies, I think it reasonable to connect it in some way with their rotation on their axes, and to assume that generally their magnetic axis will nearly coincide with the axis of rotation; at all events, if these do not coincide, but include a small acute angle, the sum of the magnetic influences on a distant magnetic body during a whole rotation, will be nearly the same as if the magnetic poles were placed in the axis of rotation. If we suppose a magnet E revolving about another S, the magnetic axis of E remaining parallel with itself, but not parallel with the axis of S (as the earth around the sun), then the magnetic induction of S on E will depend on the relative position of both magnetic axes. Moreover, if we only regard the mean of the magnetic induction of the sun on the earth during several rotations of both on their axes, we may approximately assume that the magnetic axis of both coincides with the axis of rotation, and compare their relative position during a whole revolution or annual period, with the magnetic variation in

question. Now, if a plane is laid through the sun's axis parallel with the axis of the earth, this plane intersects the ecliptic in two points, whose longitudes are 286° and 106°, and has an inclination of 83°·2, both axes forming an angle of 25°·8. Accordingly, the northerly prolongation of both axes will *converge* (as in 1 and 2)



when the longitude is 286°, or about seventeen days after the summer solstice, and the southerly prolongation (as in 2 and 3) when the longitude of the earth is 106°, or sixteen days after the winter solstice. *About sixteen days after the equinoxes* the axes are in the position 2, and the radius vector forms the greatest angle with the above-named plane, viz. 83°·2. It is therefore evident, that the greatest magnetic induction takes place at the two solstices, but of opposite character, as the north poles converge in one, and the south poles in the other semiannual period: the change takes place *sixteen days after the equinoxes,* exactly as you have found by observation, and I regard this circumstance as very important evidence for my hypothesis, although you have shown that it could also be accounted for by the fact, that all magnetic induction takes some time ere it attains its maximum.

"If the sun's magnetic axis does not coincide with the axis of rotation, then I suppose we shall find, by more minute examination of the observations, that there exists also a small magnetic variation corresponding to the sun's geocentric rotation, or 27·68 days.

"There seems also to be strong reason to suppose that Hansteen's discovery about the annual periodic frequency of the aurora borealis, which has a marked maximum at the equinoxes, and even a more marked maximum at the solstices, is connected with the same cause."