Let them now be raised to a height where the potential of the earth's field is 200 volts positive. One sphere will now be charged negative to a potential of 300 volts, and the other will be negatively charged to a potential of 100 volts. They will now repel each other with a force proportional to the product of their like charges. This was virtually Erman's fundamental experiment.

Suppose a negatively charged particle to be in orbital revolution about a positively charged particle near the surface of the earth. Other conditions remaining unchanged, the frequency of revolution will change with every change of the product of their opposite charges. The same will be true for other forms of oscillation of the two particles; hence any change in their altitude above the earth will cause a change in their vibration frequency.

If the same laws apply within the atom, the wave-lengths of its spectral lines will vary with a change of potential of the electrostatic field in which it is placed. Thus, if the electrostatic field of the sun is different from that of the earth, the wave-lengths of the spectral lines in the sun's electric field will be different from those of the same kind of atom in the earth's field. We know that they are appreciably different.

We believe that the Fraunhofer lines in the solar spectrum are due to the absorption of gases at different elevations above the photosphere. Accordingly, these gases are differently charged. May not the broadening of some of the absorption lines be partly due to this cause?

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BOTTOM TEMPERATURES IN DEEP LAKES[1]

ALMOST without exception, published accounts of temperature cycles in lakes fail to mention the effect of pressure on the temperature of water at maximum density. That increased pressure lowers the point of maximum density has been known to physicists for half a century. Results obtained by various workers are not in complete agreement. According to Amagat[2] the lowering effect is in the neighborhood of 0.0235° C. per atmosphere, although the relationship is probably not strictly linear. Since a depth of 10.33 meters corresponds roughly to one atmosphere of pressure, it follows that deep lakes may have bottom temperatures below 4.0° C. in summer. A number of such observations have been made in this country and many more have been made elsewhere.

The first observations in North American lakes which have come to the attention of the writer were made in Lake Superior during August, 1871.[3] Most of the bottom readings were 3.8°or 3.9°; two very low readings were obviously erroneous. Yoshimura,[4] in a recent review of this subject, reported a temperature of 3.7° at 300 m for Lake Ontario in the same year, but the source of the data is not evident. Drummond[5] reported temperatures in Georgian Bay in 1886 which were well below the minima possible according to the calculations of Amagat. In the summer of 1889 he found 3.7° at 128 m and 3.9° at 115 m on different days and at different stations. In 1911 Hamberg,[6] noting similar records from European lakes, pointed out that they could be explained by the effect of pressure on the temperature at maximum density.

In Crater Lake, Kemmerer et al.[7] found 3.5° at 600 m, and all temperatures at 100 m or deeper were less than 4.0°. Kindle[8] reported 3.3° at 96 m and 1.1° at 130 m in Lake Ontario in late September. These readings are so low that they must be regarded as errors, and they cast doubt upon the accuracy of a reading of 3.9° at 121 m at another station.

During the summer of 1930 a large number of temperature observations were made from the Bureau of Fisheries vessel *Fulmar* in Lake Michigan. Of 26 readings in water over 100 m deep, nine gave 3.9°, one gave 3.8°, and the others were 4.0° or more. One station showed 3.9° water from a depth of 75 m to the bottom at 145 m. The greatest depth at which observations were made was 168 m and lower temperatures may be expected in the deepest part of the lake (264 m).

Summer temperatures below 4.0° have not been reported for Lake Erie or for Lake Nipigon. The same is true of Lake Tahoe,[5] with a depth of 501 m. Obviously very deep lakes can have bottom temperatures well above the minima possible under pressures corresponding to their depths.

While the number of lakes showing bottom temperatures below 4.0° in summer is not large and the lower temperatures probably have little biological significance, the phenomenon is worthy of mention, even in elementary texts. Ignorance of it may lead an inexperienced observer to question the accuracy of his thermometers.

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[1] Published by permission of the U. S. Commissioner of Fisheries.

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