

lengths can be readily discovered; these respond well to the forces, and their tides must be the ruling semi-diurnal tides of the oceans. The charts prove the existence of large stationary oscillations. To doubt this fact would be scarcely more reasonable than to doubt the existence of the tide itself. The large ranges of tide imply critical lengths, and critical lengths imply that the phase is controlled by the resistance to the movement.

In a second approximation it may be possible to take into account the actual departures from critical lengths, to make some numerical estimates of the resistance, and to fix more accurately the modes of oscillation having regard to the deflecting force of the earth's rotation. In my paper the latter effect has been considered only in reference to arms or bodies of water tidally dependent upon larger bodies.

As soon as my critics develop their tidal theories sufficiently far for making definite suggestions, I shall be pleased and bound to give such developments careful consideration. In the meantime, I believe that nothing is gained by criticism which does not constantly revert to such facts as have been brought out through observations upon the tides. These constitute the final test of all theories.

R. A. HARRIS.

Washington, D.C., January 26.

It is Mr. Harris's theory with which we were, and continue to be, at variance. We were unable to gather the part played by this theory in the construction of his series of cotidal charts, and hence our statement that this construction was but "vaguely indicated"; but we are glad to be assured that the theory has only been employed in regions where observational data were entirely wanting, and has not been allowed to vitiate, as we feared, results obtained direct from observation.

In reference to the phase theorem which we selected for special comment, Mr. Harris now states that "the large ranges of tide imply critical lengths, and critical lengths imply that the phase is controlled by resistance." The latter part of this theorem we are not prepared to admit unless it be further contended that the critical conditions implied are mathematically *exact*, especially in consideration of the comparatively small frictional influences which can be brought to bear on the motions of the sea. Any departure from the ideal critical state, and we contend that such departures must inevitably occur in a complex system like that of the ocean, will render the determination of phase dependent on such departures as well as on frictional influences, and we differ from Mr. Harris in regarding the former rather than the latter as the more powerful controlling influence in regard to phase. Whence can the large resistances to motion, implied in Mr. Harris's theory, arise?

S. S. H.

#### Atomic Disintegration.

ACCORDING to the investigations on radium, especially by Prof. Rutherford, there can be no longer any doubt that the formation of helium from radium is due to spontaneous disintegration of the radium atom, and it is the same with the other radio-active elements. Most competent investigators have not hesitated to apply the same point of view also to all the other elements.

The enormous amount of energy set free in the formation of helium—about  $10^8$  great calories for a gram-atom of helium—must render hopeless any attempts to reverse this process. Considering the conformity of the other gases of the helium type—neon, argon, krypton, and xenon—it seems probable that they owe their existence to a similar disintegration of atoms. It is not surprising, therefore, that all attempts have failed to obtain a chemical compound of those gases, and I do not think such attempts likely to succeed in future. That, as yet, those gases, excepting helium itself, have not been recognised as products of atomic disintegration may be due to their difficult test.

Now it seems to me there is nothing contrary to the view that *disintegration of atoms is an irreversible process, strictly analogous to dissipation of heat.*

Considered in this way, there exists a parallelism not only as regards the first law of thermodynamics—conserv-

ation of energy—with the principle of conservation of matter, but also regarding the second law—dissipation of energy, on the one hand, and atomic disintegration on the other. And as it has been stated by Clausius that the world's entropy tends towards a maximum, we may say that likewise the quantity of free helium and the similar "Edelgase" tends towards a maximum.

This parallelism in material and energetical law appears to me well worthy of notice.

W. MEIGEN.

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#### Phosphorescence of Pyro-soda Developer.

SOME time ago (January, 1904) you were good enough to publish a note on the "Phosphorescence of Photographic Plates," and the following additional particulars of this phenomenon may be of interest. The developer used is the ordinary pyro-metol-soda solution.

If a bromide plate is exposed in the camera, developed, washed for a few moments only, and then placed in aluminium sulphate solution in the dark, the picture becomes luminous and shows forth as a *negative*, the high lights being dark, whilst the shadows are bright, the darkest ones phosphorescing most strongly. If, however, the plate (after having been exposed and developed) is washed thoroughly for half an hour by means of a jet of water under pressure, no phosphorescence is observed on treating it with  $Al_2O_3$  solution, from which it appears that a trace of the developing solution is necessary to cause phosphorescence in the plate.

If a few spots of unused developing solution are placed in the bottom of a porcelain dish and  $Al_2O_3$  solution is added (in the dark), the mixture will phosphoresce. But if the developer has been used for developing exposed plates, then its power of phosphorescence is weakened, and if the same portion of solution is used repeatedly for developing, and tested periodically for phosphorescence between the developments, it will be found that its phosphorescing power is diminished after each development, and that it finally vanishes altogether. This explains the production of the phosphorescing negative. The most strongly lighted part of the film is that which will destroy the phosphorescing power of the developer it has absorbed, and the unlighted portion or shadow is that in which the absorbed developer will be least changed, and therefore most strongly phosphorescent.

The addition of various substances to the aluminium salt modifies its phosphorescing power, and some prevent it altogether, even when added in very small quantities. Among those substances which strongly counteract the phosphorescence may be mentioned the salts of thorium, uranium, copper, lead, bismuth, iron, tin, cobalt, nickel, chromium, zinc, cadmium, mercury, platinum, and silver in the order named, while the salts of potassium, sodium, ammonium, lithium, calcium, barium, strontium, magnesium, and manganese seem to have little influence one way or the other.

The only substance found which has the effect of much increasing the brilliancy of the phosphorescence is gold. A solution of  $AuCl_3$  alone, in fact, gives a more brilliant phosphorescence than  $Al_2O_3$ . The gold is reduced to the black metallic form, and while this reduction is proceeding light is emitted. Other reducing agents, however, do not appear to emit any light during the process of reduction of  $AuCl_3$ . The influence of the other metals on the phosphorescing power of the gold solution seems to be practically the same as for aluminium.

Other aluminium salts, such as the nitrate, phosphate (dissolved in HCl), chloride, &c., phosphoresce with pyro-metol developer, but none so brilliantly as the sulphate.

T. A. VAUGHTON.

Ley Hill House, Sutton Coldfield, February 13.

#### Emission of Light by Kanal-strahlen Normal to their Direction.

IN a former publication (*Physik. Zeitschrift*, vi., 892, 1905) I have proved that the stream of positive ions which form the Kanal-strahlen show the Doppler effect. In these rays we have, therefore, a positive charge, and at the same time velocity, and also, as a result of the vibrations of the negative electrons, emission of light. Therefore it is