Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rarity of the Inert Gases on the Earth.

IN NATURE of March 15 I published a diagram in which the abundance of the different species of atoms —up to mass number 79—was plotted on a log scale against their mass numbers. I have now extended this, with a small gap, up to mass number 142, and what was fairly obvious before has become, by the inclusion of the region containing xenon, a very striking feature. This is the abnormal scarcity of the inert gases.

I took for purposes of calculation an earth consisting of the atmosphere, the hydrosphere and a lithosphere of the average composition of the igneous rocks of mass equal to that of the whole globe. If we disregard the inert gases altogether, the points lie on at least the semblance of a curve. There are high peaks, O, Fe, Sr, Ba, abnormal depths, Sc, In, and a very marked depression in the region Ga, Ge, but nevertheless a curve is sufficiently well marked for any observer who had been given the mass numbers of the missing inert gases to allot them appropriate positions and so to calculate their most probable abundance. The point I wish to emphasise is that he would in every case state an abundance roughly 10^6 times greater than that obtained from actual atmospheric analysis.

This discrepancy will appear much the same if instead of mass number we plot by atomic number or by atomic weight, and it will not be affected seriously by supposing, as has been suggested, that the innermost quarter of the earth consists mainly of iron and nickel. It cannot very well be ignored, and three possible hypotheses suggest themselves, any or all of which might offer an explanation :—

(1) The fault lies in the method of calculating abundance; our sample is unfair, and if we could get a fair one, say from the interior of the earth, the discrepancy might vanish. This would require that the earth's atmosphere was entirely derived from a surface shell only a few metres thick—not a very hopeful view.

(2) The abnormal rarity of the inert gases is due to some nuclear property of instability held in common. We have good reason for supposing such a property common to the isotopes of a single element, but none whatever to ascribe it to a set of elements the mass numbers of which range from 4 to 136. It is true that these elements have a very definite property in common, chemical inertness, but this is, so far as we know, an extranuclear one. We are therefore driven to consider as more probable :—

(3) The earth has only one millionth part of its proper quota of inert gases. This very interesting conclusion is founded on very flimsy evidence, but it is not out of keeping with some such origin of the solar system as the planetesimal theory. In the hurly-burly of colliding bodies ranging in mass from atoms upwards, the atoms of the inert gases, unconstrained by irrevocable chemical combination and free to collide and rebound indefinitely, would inevitably gravitate towards the larger masses and forsake the less. On this view the earth's share of inert gases has been lost to the sun, though whether they still remain there unchanged is outside the question. Their abnormal rarity is at least a point of interest and invites comment from those interested in the evolution of our system and of the elements. F. W. ASTON.

Cavendish Laboratory,
Cambridge, November 19.

The Cause of Cyclones.

IN the winter of 1922–23 there appeared in NATURE some correspondence on "The Cause of Anti-cyclones," and on that occasion I put forward certain views as to the mechanism by which the more rapid increases of barometric pressure are brought about in temperate latitudes (NATURE of March 31, 1923, pp. 429-430). The present communication may be regarded as a sequel in that its object is to describe a mechanism by means of which the more rapid reductions of pressure can conceivably be produced. The idea arises naturally from consideration of a series of papers by Helmholz appearing in the *Sitzungs-berichte* of the Royal Prussian Academy of Sciences in 1888 and 1889, dealing with the equilibrium of rotating rings of air at different temperatures, and with the theory of winds and waves where strata of different density lie contiguous with one another.

The conditions for equilibrium in cases where a surface of discontinuity (of temperature and wind) exists in the atmosphere have since that time been dealt with by V. Bjerknes and others in somewhat more general fashion and need not be set out here.

Designating the warmer (southerly) mass by (1) and the colder (northerly) by (2), Helmholz calculates in terms of their velocities, temperatures and the latitude, the theoretical slope of the bounding surface for a state of stable equilibrium. But, as he points out, first small waves and then mixing of the two media must soon occur over this boundary; he therefore calculates the slope for stability of the bounding surface between mass (2) and the mixture and between the mixture and mass (1). He shows that these slopes are respectively more acute and less acute (relatively to the horizon) than the original slope between mass (2) and mass (1). Hence, he says, results the important consequence that (in tending towards the new requirements for equilibrium) "all newly formed mixtures of strata that *were* in equilibrium with each other must rise upwards between the two layers originally present, a process that of course goes on more energetically when precipitations are formed in the ascending masses. While the mixed strata are ascending, those parts of the strata on the north and south that have hitherto rested quietly approach each other until they even come in contact, by which motion the difference of their velocities must necessarily increase since the strata lying on the equatorial side acquire greater moment of rotation (about the earth's axis) with smaller radius, while those on the polar side acquire feebler rotation with a larger radius."

Now the importance of this reasoning, applied in the light of modern meteorological knowledge, appears to me enormous. Putting aside for the moment all theories as to the *origin* of cyclones, it appears to be pretty well established by the facts of observation that the normal *structure* of an active and recently formed depression at least approximates to that described by Bjerknes.

Further, observation tends to confirm (1) that the principal reduction of pressure and the principal area of rainfall lie at any moment within the "old" cold air in front of the Bjerknes Steering Line, (2) that where the warm air extends right down to the ground no appreciable pressure-change is taking place, unless quite close to the Steering Line, (3) that where the "new" cold air is undercutting the warm air there is rapidly rising pressure.

I have shown elsewhere that the rise of pressure in the new cold air and the comparative constancy