LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

The Forces Responsible for Continental Motions and Pacific Type Mountain Building

Geological data indicate that continental motions are characteristic of the earth's surface development but no forces adequate to produce these motions have been known.

Because of the lack of strength of the earth's outer shell below about 1000 km the upper layers are in isostatic equilibrium. The principle of the compensation of continents, as usually stated, suggests simply that the mass per unit area of the surface layers above some reference equipotential surface located at levels of negligible strength, is everywhere constant. This statement is not strictly true because in regions of no strength, motion is determined by *pressure* gradients. Therefore, not the mass per unit area but rather the product of the mass per unit area and mean gravity in the outer layers ($m\bar{g}$) must be constant. Average gravity $\bar{g}$ in the outer layers depends on the density of the layers which, to moderate depths at least, is known to be greater under the Pacific than under the continents. The observed distribution of radioactivity suggests that this density difference will persist at considerable depths. Therefore $\bar{g}$ is less and m systematically greater over the Pacific than over the continents. The resulting mass asymmetry gives rise to tangential gravitational forces urging North America, for example, toward the west with a force estimated at 10^{25} dynes.

The ratio of the tangential acceleration (a) to that of gravity (g) is given approximately by

$$\frac{a}{g}=\frac{h^2\rho_1}{2R^2\rho_0^2}\frac{d\rho_1}{d\Delta},$$

where h is the thickness of the earth's outer layer of appreciable strength, ρ_1 its mean density, R the earth's radius, ρ_0 its mean density and Δ the angular coordinate. The average magnitude of this ratio approximates 6×10^{-5}. Therefore the average crushing stress produced at the margin of the Pacific basin approximates 10^8 dynes/cm^2 and may in special surface layers of great strength actually exceed 10^9 dynes/cm^2 which is the crushing strength of basalt. Tangential forces of the calculated magnitude seem adequate to induce continental motions, even against a resisting crust of considerable strength.

The motion of the continent results in a great accumulation of light surface material on its "downstream" face and in considerable overthrusting. These are the principal requirements of physical mountain building (as distinct from mountain building by sedimentation processes with which this investigation is not concerned) and account well for the observed structure and characteristics of Pacific type mountains.

The tangential forces are proportional to the *square* of the *thickness* of the outer layer of appreciable strength and therefore became important only after the earth's cooling and development were well advanced. Thus in accordance with geological observation, the Pacific type mountains and the suspected continental motions were produced at a comparatively late date.

The author's earlier astronomical approach to the problem of the origin of the solar system[1] has been supplemented by a geological investigation. It is shown that the mode of formation of the earth there proposed leads to the production of distinct continental and oceanic hemispheres of the type observed. All other proposed theories lead to a symmetrical earth.

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[1] R. Gunn, Phys. Rev. **39**, 311 (1932); J. Frank. Inst. **213**, 639 (1932).

On the Slowing Down of Neutrons

"... *It is easily shown that an impact of a neutron against a proton reduces, on the average, the neutron energy by a factor 1/e.*"

According to reports from several sides, the above passage in a paper by Professor Fermi[1] is considered somewhat obscure. Since a more detailed explanation might be of interest also to others, it was thought advisable to make it generally known.

The mean energy of a neutron after an impact with a proton at rest is equal to one-half of the initial energy E_0. Therefore, calling E_n the energy after n such impacts, one has:

$$\bar{E}_1=E_0/2, \qquad \bar{E}_n=E_0/2^n.$$

We cannot however apply here Bernoulli's theorem on large numbers and conclude that the mean energy is the most probable, or, indeed, "by far the most probable" value of the energy. Fermi's argument was based on the consideration of the logarithmic decrement of the energy, which, being the sum of the partial decrements due to each collision, is subjected to Bernoulli's theorem.

Put: $\xi=\log(E_0/E_1)$; $\qquad x=\log(E_0/E_n)$.

One finds that:

$\bar{\xi}=1$ and therefore: $\bar{x}=n$.

Hence the above statement.

All further possible doubts may perhaps be answered