discrepancy is present whose source is difficult to determine. Peierls and Preston determine from the experimental points a value approximately $-0.8°$, while the calculations of Eisenbud and myself indicate a value in the neighborhood of $-0.4°$. Again, the above authors derive from the theoretical curve for the repulsive P-well in Wilson's paper a value $K_1=-2.1°$. Actually, this curve was computed for a value of $K_1=-1.4°$. A check of the calculations relative to this point has not disclosed any error. The difference between $K_1=-1.4°$ and the value $K_1=-0.8$, calculated by Peierls and Preston for a well of the same depth, is easily accounted for by the different ranges employed in the two computations. Since K_1 varies approximately as the fifth power of the range, we have $(2.8/2.5)^5\times 0.8°=1.7°$, which within the limited validity of the fifth-power law is in satisfactory agreement with 1.4°.

In addition, it was not found possible to verify the statement of Peierls and Preston that a repulsive potential of 12 Mev for the ^3P interaction of two protons is to be expected from a preponderance of charge independent "Majorana" and "Heisenberg" forces; on the contrary, a value of about 22 Mev was obtained. The value of 12 Mev would appear to follow from a preponderance of charge independent "Majorana" and "Bartlett" forces, however. This question is somewhat academic in consequence of the importance of the tensor force in the binding of the deuteron.

This brings us to perhaps the main purpose of this letter, which is to point out the fact that it is doubtful that an unambiguous analysis of the experimental results available at present on proton-proton scattering in terms of internucleonic potentials is possible in view of the limited accuracy of the experiments. This is due principally to the possibility of a tensor force between two protons in the ^3P state. Meson theories in fact predict the existence of such a force. Preliminary calculations indicate that Wilson's results would also be in substantial agreement with the charge and parity dependence of nuclear forces predicted by the symmetrical meson theories, though not with that predicted by the neutral meson theories. These questions will be dealt with in more detail in a forthcoming paper of the author.

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Radioactivity of Cu^{60}

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A POSITRON activity with a half-life of 24.6±0.3 minutes has been assigned to Cu^{60}. γ-radiation associated with this decay has an energy of 1.50±0.05 Mev, and two positron groups have energies of 1.8±0.2 and 3.3±0.2 Mev. This activity has been produced in three ways, using separated isotopes of Ni. These are listed with the cyclotron and particle energies used as follows:

$Ni^{60}(p, n)$	37-in. frequency-modulated cyclotron	5–15 Mev p
	60-in. cyclotron	9 Mev p (18 Mev H_2^+)
$Ni^{60}(d, 2n)$	60-in. cyclotron	18 Mev d
$Ni^{58}(\alpha, pn)$	60-in. cyclotron	36 Mev α.

In the 37 in. frequency-modulated cyclotron the Ni^{60} sample was mounted on a probe, and hence could be bombarded at an arbitrary distance from the cyclotron center. The threshold energy observed for the $Ni^{60}(p, n)$ reaction was 5.1±0.2 Mev.

The decay of the activity was observed with an ionization chamber and Ryerson-Lindemann electrometer. By exciting the activity in a Ni^{60} target with 5.5-Mev protons, the decay could be measured through six half-lives with no evidence of a foreign activity. That the particles emitted were positrons was determined by bending them in a magnetic field into a counter. Penetrating γ-radiation was slso observed.

Chemical separation of normal nickel targets after bombardment with 15-Mev and 6-Mev protons into Cu, Ni, and Co fractions, accomplished within one hour, showed in each case that more than 99 percent of the 24.6-minute activity followed the Cu-separation chemistry. Mass separation in a calutron, accomplished within one hour of the end of a proton bombardment, showed without question that this activity belonged to Cu^{60}.

The energy of γ-radiation was measured by absorption in lead. The absorption of Co^{60}, 1.1-and 1.3-Mev γ-radiation was used for calibration of the geometry which was similar to that of Cork and Pidd.[1] The absorption coefficient in lead for the γ-radiation of Cu^{60} decay was measured as 0.546±0.013 cm^{-1}, corresponding to an energy of 1.50±0.05 Mev.

From consideration of the (p, n) threshold energy a positron group of energy 1.8 Mev is expected to accompany the γ-radiation, with the possibility of a second group with energy 3.3 Mev providing a transition directly to the ground state. Rough data of absorption in aluminum are consistent with this expectation. The determination of the lower energy end point is made difficult by the presence of the higher energy group. The branching ratio of the 3.3-Mev positron group is less than 0.05.

The 81-second and 7.9-minute positron activities produced by proton bombardment of Ni, observed by Delsasso, *et al.*,[2] and tentatively assigned to either Cu^{58} or Cu^{60}, correspond to 81-second and 10-minute activities after bombarding Ni^{58} with protons in the 37-in. cyclotron. These are tentatively assigned to Cu^{59} and Cu^{58}, respectively, on the basis of threshold and excitation considerations. The longer life was shown to be a Cu activity by chemical separation. The 3.4-hour half-life activity assigned[3] to Cu^{61} was verified by being produced in a Ni^{61} (p, n) reaction. The 10.5-minutes half-life activity assigned[4] to Cu^{62} was also verified, but the half-life was found to be 10.1±0.1 minutes in measurements made through six half-lives.

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the mass separations on the calutron were performed by Keith Pierce.

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The Latitude Effect of the Hard Component as a Function of Altitude

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EIGHT counter-coincidence sets were installed in a B-29 plane for the purpose of measuring the vertical intensity of the penetrating component through 8, 14, and 20 cm of lead, and for studying the production of mesotrons by non-ionizing rays in 2 cm of lead. The measurements were made up to an altitude of 40,000 feet at a geomagnetic latitude of 40° N and at the equator. The geometry of the counters is shown in Fig. 1. The upper three and the lower three counters were each connected in a threefold coincidence. This arrangement is very similar to that used by Schein, Jesse, and Wollan.[1] The coincidence circuits had a resolving time of 5×10^{-6} second. As a consequence, accidentals were negligible at all altitudes reached. The upper coincidence set registered particles passing through 20 cm of Pb, while the lower one recorded particles through 22 cm of Pb, plus those produced by non-ionizing radiation in the upper 2 cm of Pb. All coincidence pulses were recorded on a rotating film. This paper deals only with the data obtained with 20 and 22 cm of Pb. The quantitative measurements with smaller thickness of lead will be reported at a later date.

It was found that at altitudes up to 40,000 ft. the upper and lower threefold coincidence set gave the same counting rate within a precision of 3 percent. It should be mentioned here, however, that this was not the case with smaller thicknesses of lead between the counters. In particular, with a lead absorber of 8-cm thickness a considerably higher counting rate was registered in the lower threefold set than in the upper one at altitudes above 25,000 feet. This leads to the conclusion that a considerable fraction of the penetrating particles produced by non-ionizing rays is capable of traversing 8 cm, whereas it is absorbed by 22 cm of Pb. Since most of the particles passing through large thicknesses of lead were found to be mesotrons, it follows that in the upper 2 cm of Pb only mesotrons of momenta smaller than 3.8×10^{8} ev/c are produced with a large cross section by non-ionizing radiation. This result is in agreement with data obtained in balloon experiments[2] up to an altitude of 80,000 ft.

In Fig. 1, curves *A*, *B*, and *C* represent the latitude effect of the hard component as a function of altitude. Curve *A* refers to the equator, curve *B* to a geomagnetic latitude of 40° N, and curve *C* to balloon data obtained at 52° N by using 18 cm of Pb between the counters.[3] The curves show very clearly that the latitude effect of the hard component increases very considerably with elevation. At 33,000 ft. the difference between 40° N and 0° is 30 percent, which is in satisfactory agreement with recent measurements of Swann.[4] On the other hand, Bhabha and his collaborators[5] found a somewhat smaller latitude effect. This might be due to the fact that the latitude curves given in their paper were deduced from experiments in which the geometry of the counter assembly was not the same at the various latitudes.

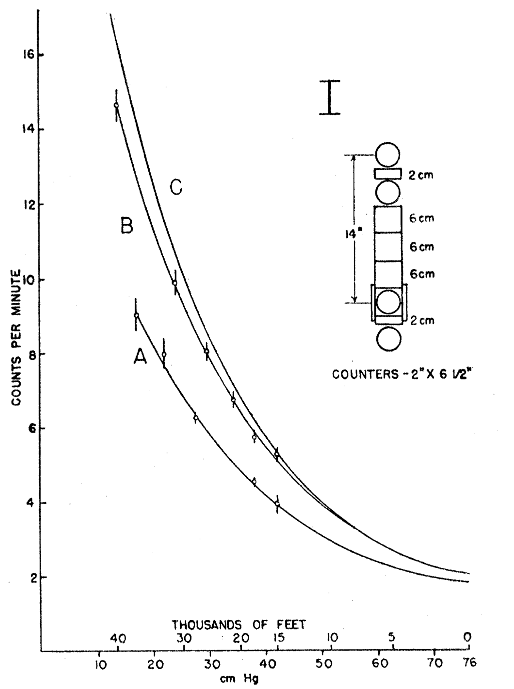

FIG. 1.

It is obvious from Fig. 1 that the difference between curves *C* and *B* is considerably smaller than the corresponding difference between *B* and *A*. This fact strongly indicates that the large majority of the mesotrons present at altitudes below 35,000 ft. are produced by primaries of energies considerably higher than 5×10^{9} ev (magnetic cut-off energy at 40°).

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