counter shield. A counting rate of several thousand counts per minute was to be expected from the value of the half-life given by Lougher and Rowlands. The actual counting rate after subtraction of background was $2.9\pm0.2$ counts per minute for the xenon counter and $2.6\pm0.2$ counts per minute for the argon-filled counter. These very small counting rates are equal within the limits of statistical accuracy and are due to beta-rays of approximately 1.7-Mev energy, from a trace of radioactive contamination. Hence, no activity caused by $K$ capture of $Os^{187}$ is indicated. This negative result leads to an estimated minimum value of $4\times10^{12}$ years for the half-life of $Os^{187}$ so far as possible $K$ capture is concerned. Taking into account the counter efficiencies for rhenium $L$ x-rays and the absorption in the counter walls, a minimum value for the half-life in the case of $L$ capture is estimated at $0.6\times10^{12}$ years.

The above result, showing the absence of x-rays due to an orbital electron capture of $Os^{187}$, is in agreement with the results of Naldrett and Libby, who, using counters filled with argon and $OsO_4$, respectively, showed that no Auger electrons are emitted by $Os^{187}$. They showed, moreover, that the other member of the pair, $Re^{187}$, is $\beta^-$-unstable.

This experiment was completed in January 1948.

* Work performed under Navy Contract N6ori-222, Task Order I.
** Now at the University of Rochester.
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## High Energy Neutron-Proton Scattering

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April 13, 1948

WE have investigated the scattering of high energy neutrons by protons with the interaction potential given by the symmetrical meson theory with the tensor force omitted:

$$V=\tfrac{1}{3}[1-\tfrac{1}{2}g+\tfrac{1}{2}g\boldsymbol{\sigma}_1\cdot\boldsymbol{\sigma}_2]\tau_1\cdot\tau_2\sigma_1\cdot\sigma_2(\mu B)(e^{-\mu r}/\mu r)$$

$\sigma_1$, $\sigma_2$, $\tau_1$, $\tau_2$ are the usual spin and isotopic spin operators. The constants $B$, $g$, and $\mu$ were chosen to give the correct binding energy of the deuteron and low energy neutron-proton scattering.[1] The values taken were $B\mu=67.8$ Mev, $1/\mu=1.18\times10^{-13}$ cm, $g=0.157$. [In order to fit the low energy proton-proton cross section, $g$ should be taken as 0.162.]

The method of phase shifts was used throughout since it was found that the Born approximation gives unreliable results especially with respect to the angular distribution, as has been stressed by Camac and Bethe.[2] At 2.2 Mev and 20 Mev the results are substantially the same as those obtained from the corresponding square well potential. The results at 80 Mev are cited in Table I, with the square well and Born approximation figures given for comparison.

One sees that the Yukawa potential gives an appreciably higher cross section than the square well, but a much more reasonable ratio $R$, which is found experimentally to be $\sim3$ in the 100-Mev region.[3] Inclusion of the tensor force will modify these results. A preliminary estimate, based on the Born approximation, predicts that $R$ will be reduced by

TABLE I.

| | $\sigma$ Total cross section $\times10^{24}$ cm$^2$ | $R$ Ratio of intensity at 180° to that at 90° in the c.g. system |
|---|---|---|
| Yukawa-exact | 0.140 | 6.81 |
| Yukawa-born approximation | 0.150 | 12.5 |
| Square well (range $2.8\times10^{-13}$ cm)[2] | 0.111 | 159 |

about a factor of 2, while the total cross section is increased slightly.

The constants for the tensor force case with a Yukawa potential have been calculated and tentative values are: $\gamma B\mu=85\pm2$ Mev, $(1-2g)B\mu=46.5$ Mev, $B\mu=0\pm3$ Mev, in the Rarita-Schwinger notation. The exact calculation of the high energy cross section for the tensor force case is being carried out.

* National Research Council Predoctoral Fellow.
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## Einstein's Equivalence Principle and the Problem of Blind Navigation

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April 13, 1948

THE importance of Einstein's equivalence principle[1] in the problem of blind navigation of aerial or space vehicles has been appreciated[2] for a long time. A formulation of the limitations this principle imposes in the practical solution of the problem has, however, never been published. The following discussion assumes a vehicle having no radiation connection with the earth and confining an observer who is posed with the problem of determining the vehicle's position with respect to the earth purely by dynamic measurements. A dynamic measurement is defined as a force measurement on a proof body, or a measurement of acceleration, velocity, or displacement on such a body. The gravitational field in the neighborhood of the vehicle is assumed locally uniform, and Newtonian mechanics is assumed.

The forces acting on the vehicle can be analyzed into three sets: forces, whose sum is $\mathbf{F}$, due to external, non-gravitational forces on the vehicle; forces, whose sum is $\mathbf{L}$, due to the reaction on the vehicle of the internal forces exerted on a proof body; and forces, whose sum (per unit mass) is $\mathbf{g}$, due to the gravitational attraction of all other