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SUMMARY OF THE RESEARCH PROGRESS MEETING OF MAY 29, 1952

Sergey Shewchuck

July 10, 1952

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Berkeley, California

SUMMARY OF WEEKLY RESEARCH PROGRESS MEETING OF May 29, 1952

Sergey Shewchuck

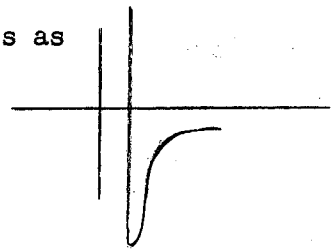
July 10, 1952

I. Low Energy Properties of Nuclear Forces. R. Jastrow.

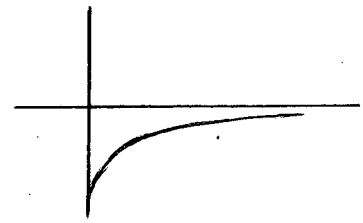
In high energy nucleon-nucleon processes one should be able to describe the interaction at large distances by well known and established field theories. The interaction at high energies and correspondingly short distances, however, cannot be described easily and so is considered in terms of some simple boundary conditions until more experimental data are available. Jastrow describes the forces between nucleons in terms of a pseudoscalar field at large distances terminated at small distances by a strong repulsion corresponding to a nucleon structure of finite dimensions.

With regard to the pseudoscalar interaction the first two terms, of order g^2 in the coupling constant, have been known for some time (Yukawa) to vary as $e^{-\mu r}/r$. Lepore and Watson, though, calculated the fourth order and found a term $\approx e^{-2\mu r}/r^{5/2}$ with a sizeable coefficient. This shows a high singularity and a short range ($1/2\mu$ instead of $1/\mu$), hence dominates at small distances.

It is not easy to predict what the higher order terms do even when cut off at some finite range. All one may say is that the perturbation calculation gives an indication of a different picture of the nuclear forces; i.e. perhaps as



rather than just



An attempt was made to check these forces in five cases with known experimental values of the low energy constants. Calculations were made over a range of coupling constants from $g^2/4\pi = 10 \rightarrow 13 \rightarrow 16$. For a pseudoscalar coupling constant of $g^2/4\pi = 13$, the results obtained are:

(Effective range)	$r_{triplet}$	1.8×10^{-13}	1.7
" "	$r_{singlet}$	2.5 "	2.7
Deuteron	quadrupole moment	2.8 "	2.7
"	P_D (% D state)	6.5%	2 - 10%

The core radii were chosen to fit the deuteron binding energy and singlet scattering length. The core radii so determined are $\sim 0.5 \times 10^{-13}$ cm, and roughly are same for both singlet and triplet states.

The results above lie in the right neighborhood which implies, for example, that there is a reasonable balance between the central and tensor contributions in this picture of the forces. The pseudoscalarity of the meson field seems to be well established but the nature of the coupling is not known. A pseudoscalar coupling was assumed over pseudovector because fewer ambiguities arise. The above picture does tend to lead to a state of saturation of forces.

In connection with this subject an abstract report UCRL-1722 has been published by Robert Jastrow, entitled "Low Energy Properties of Pseudoscalar Interaction with Hard Core"

II. Relation of Low Energy Meson Scattering Experiments to Nuclear Forces. M. Ruderman. The success of the nuclear force calculations [previous talk] in the low energy region for the pseudoscalar meson theory with pseudoscalar coupling presupposes that fourth order perturbation theory gives a good approximation to the interaction of low energy mesons with nucleons. In particular, one would expect an S-wave pair coupling of large magnitude. This pair field

is difficult to investigate in low energy production experiments. However, the low energy meson nucleon scattering is a direct test of the ratio of the strengths of the singular pair field coupling and the P-wave coupling which gives rise to the longer range tensor force. The apparently small low energy scattering argues against the reliability of the model which seems successful in the nuclear force problem.

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