Title
n- ABSORPTION IN D2 AND THE N-N FORCE

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π^- ABSORPTION IN D_2 AND THE N-N FORCE

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June 21, 1951

Berkeley, California

ABSORPTION IN D_2 AND THE N-N FORCE

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Watson and Stuart[1] have recently published detailed theoretical calculations concerning the gamma ray spectrum from the process $\pi^- + D \rightarrow 2n + \gamma$ previously observed.[2] The resultant spectrum is clearly sensitive to the n-n interaction at low energies. Since the analysis was based on unpublished data it appears advisable here to state the experimental status concerning this spectrum. The present data allow considerable latitude regarding the n-n interaction parameters. It is clear, however, that a not immeasurable improvement of the data could lead to quite conclusive evidence concerning the stability of the di-neutron.

When the curves of Watson and Stuart[1] are "folded" into the resolving power of the pair spectrometer used in the absorption experiments[2] the resultant curves for various values of the n-n interaction show a negligible difference in shape but are effectively displaced along the energy scale. Fig. 1 shows a curve of this effective displacement plotted against the binding energy of a hypothetical di-neutron, real or virtual. Fig. 2 shows the theoretical spectrum, with the resolution folded in, of the curve corresponding to zero binding. Marked on the abscissa is the value of $E_o = \left[(\pi^- + p)^2 - n^2\right] / 2(\pi^- + p)$; here π^-, p, and n are the rest

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[1] K. M. Watson and R. N. Stuart, Phys. Rev. 82, 738 (1951)

[2] Panofsky, Aamodt, and Hadley, Phys. Rev. 81, 565 (1951)

energies of the particular particles. E_0 is thus the expected value of the gamma ray from the process $\pi^- + p \longrightarrow n + \gamma$. Measurement of the gamma ray process in H on the same spectrometer will thus determine the value of E_0 without specific reference to the π^- mass. Plotted on Fig. 2 also is the theoretical shape of the gamma ray line from $\pi^- + p \longrightarrow n + \gamma$, i.e., the resolution of the instrument. The value of the binding energy will then simply result by comparing the separation of the gamma ray peaks of the two processes with that plotted in Fig. 2 and then reading E_B of Fig. 1. Fig. 3 shows the experimental hydrogen and deuterium data. On comparing Fig. 2 and Fig. 3 we estimate that the D data are displaced by an amount of 0.8 Mev $\pm$ 1.5 Mev toward lower energy, i.e., virtual binding. Accordingly, the nominal value of the lowest state of the n-n system is 1.2 Mev virtual; in terms of these data the probability is 25 percent that a real di-neutron of binding energy greater than 10 Kev exists; the probability is only 10 percent that the binding is in excess of 150 Kev.

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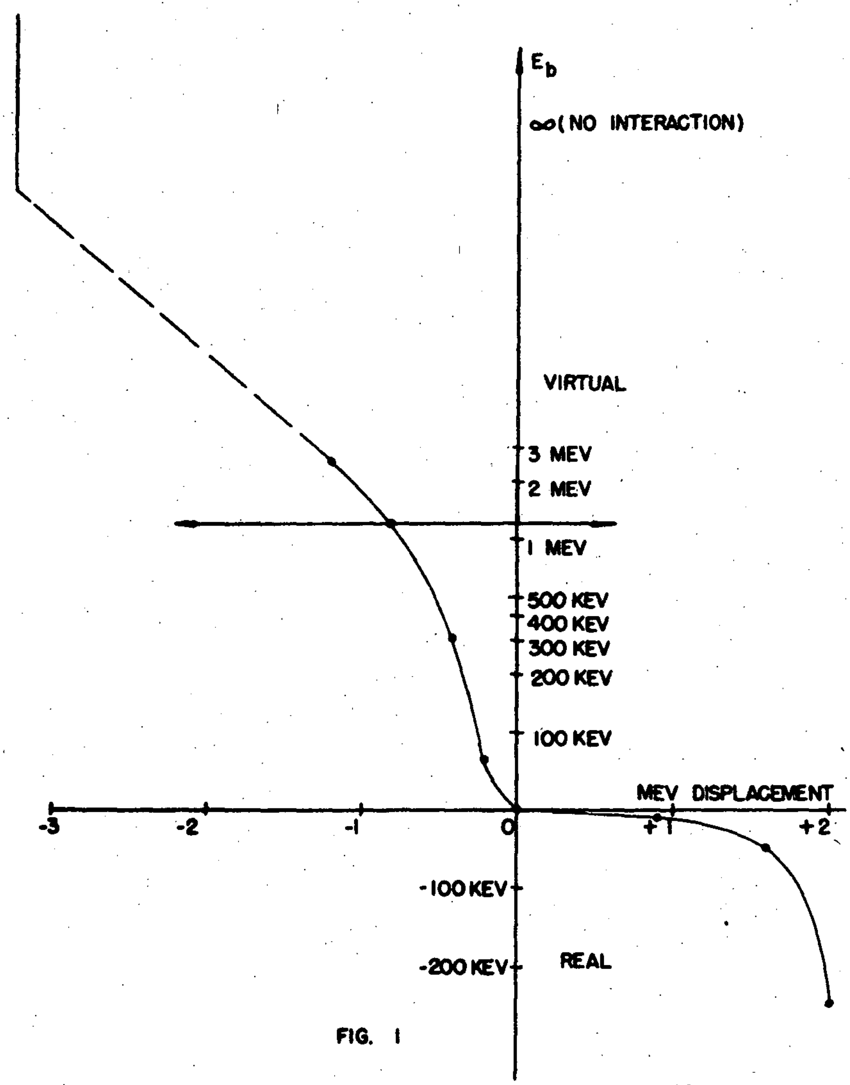
Figure Captions

Fig. 1 Plot of effective displacement of theoretically computed spectra[1] resulting from the process $\pi^- + D \longrightarrow 2n + \gamma$ as a function of the binding energy E_B of the lowest level of the n-n system.

Fig. 2 Theoretical γ spectra of the processes: $\pi^- + D \longrightarrow 2n + \gamma$ and $\pi^- + H \longrightarrow n + \gamma$; these spectra include the resolution.

Fig. 3 Experimental data on the processes $\pi^- + D \longrightarrow 2n + \gamma$ and $\pi^- + H \longrightarrow n + \gamma$. The theoretical curves giving the best fit are also given.



E_b
∞(NO INTERACTION)
VIRTUAL
3 MEV
2 MEV
1 MEV
500 KEV
400 KEV
300 KEV
200 KEV
100 KEV
MEV DISPLACEMENT
-3
-2
-1
0
+1
+2
-100 KEV
-200 KEV
REAL

FIG. 1

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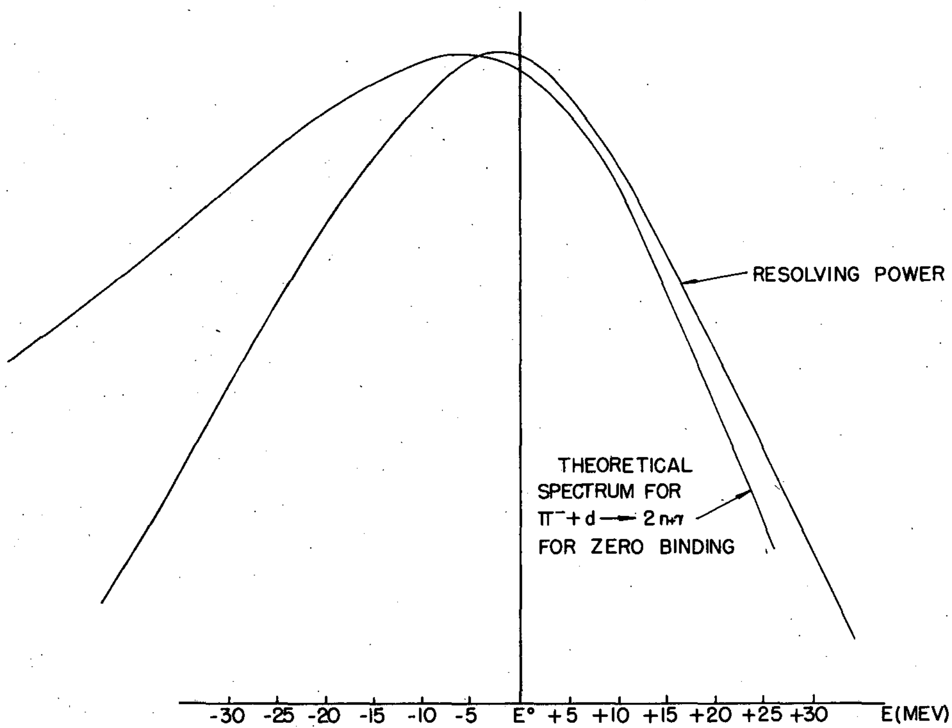
RESOLVING POWER
THEORETICAL SPECTRUM FOR $\pi^- + d \rightarrow 2n + \gamma$ FOR ZERO BINDING
-30 -25 -20 -15 -10 -5 E° +5 +10 +15 +20 +25 +30
E(MEV)

FIG. 2

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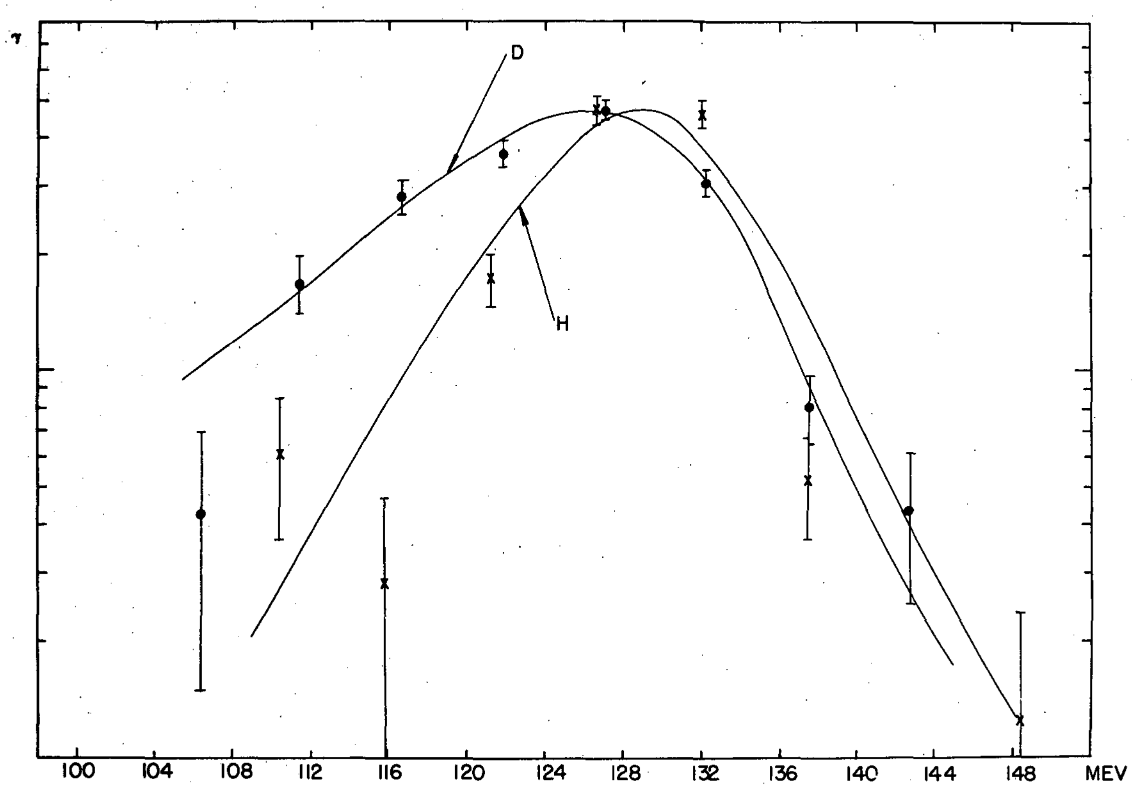

FIG. 3

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