Chapter III

RESULTS AND DISCUSSIONS

We intend to apply our formulation to calculate the ground state of the spherical ^{4}He nucleus using two sets of parameters [63, 64] given in tables 1-A, 2-A and 3-A, for scalar-isoscalar σ and the vector-isoscalar ω mesons, and use of three static functions, the generalized Yukawa function (GY), Yukawa function (Y), and single particle energy dependant function (SPED), $J_i(r)$, $i=\sigma,\omega$. The calculations are carried out using these three forms for both the Hartree and the Hartree-Fock problems. The generalized Yukawa function (GY),

$$J_i(r) = g_i^2\, \hbar\, c \left[\frac{e^{-\mu_i r}}{r} - \frac{e^{-\lambda_i r}}{r}\right]\left[1 + \frac{\lambda_i^2 - \mu_i^2}{2\lambda} r\right] \tag{47}$$

with $i=\sigma,\omega$ where g_i^2 is the meson-nucleon coupling constant, λ is a parameter related to the structure function of the form factor and μ is associated with the meson mass $\mu = \mathrm{m}c\frac{1}{\hbar}$, this function has been used by Miller-Green [43]. However, we used in our calculations the parameters given by Brockmann [63].

The second NN interaction function is the Yukawa function (Y),

$$J_i(r) = g_i^2 \frac{1}{4\pi}\left[\frac{e^{-\mathrm{m}_i r}}{r}\right] \tag{48}$$

this function has been used by Boussy et al [64] and we preserve their parameterization. The third NN function is the single particle energy dependant function (SPED), which was used by Jaminon et al [57] and also we apply here the same parameterization.

$$J_i(r) = g_i^2 \frac{1}{4\pi}\left[\frac{\lambda_i^2}{\lambda_i^2 - m_i^2}\right]\left[\frac{e^{-m_i r}}{r} - \frac{e^{-\lambda_i r}}{r}\right] \tag{49}$$

The results are given in tables' 1-B, 2-B and 3-B and schematically are given in figures 1.B, 2.B and 3.B. It is to be noted that we have used in some of our results modified mass of the nucleon as given by Machleidt [37] to take care of the nuclear medium effects. In addition, a small variation of the oscillator strength $\hbar\omega$ was made to test our results against this parameter.

Table 1-A

Meson parameters for the OBEP as given in references [63] and [64]

$\hbar\omega$=20 M=939.6 MeV (GY, SPED) M=938.9 MeV (Y)

Parameter Set	Meson	m Mev	$g^2/4\pi$				λ MeV
			Y, GY, SPED		Y		GY, SPED
			H	H-F	H	H-F	
I [63]	σ	550	6.57		-	-	1530
	ω	782.8	9.25		-	-	1530
II [64]	σ	440	-		6.25	5.54	-
	ω	783	-		15.16	12.24	-

Table 1-B

Ground state energy for ^{4}He using parameters of Table 1-A

Parameter Set	Problem Type	NN Potential Type MeV			Experimental Result [65]
		Y	GY	SPED	
I	H	-19.11	-25.02	-18.73	-19.81 MeV
	H-F	-17.26	-22.10	-17.01	
II	H	-12.66	-	-	
	H-F	-16.37	-	-	

Fig. 1.B. Schematic representation for ^{4}He ground state.

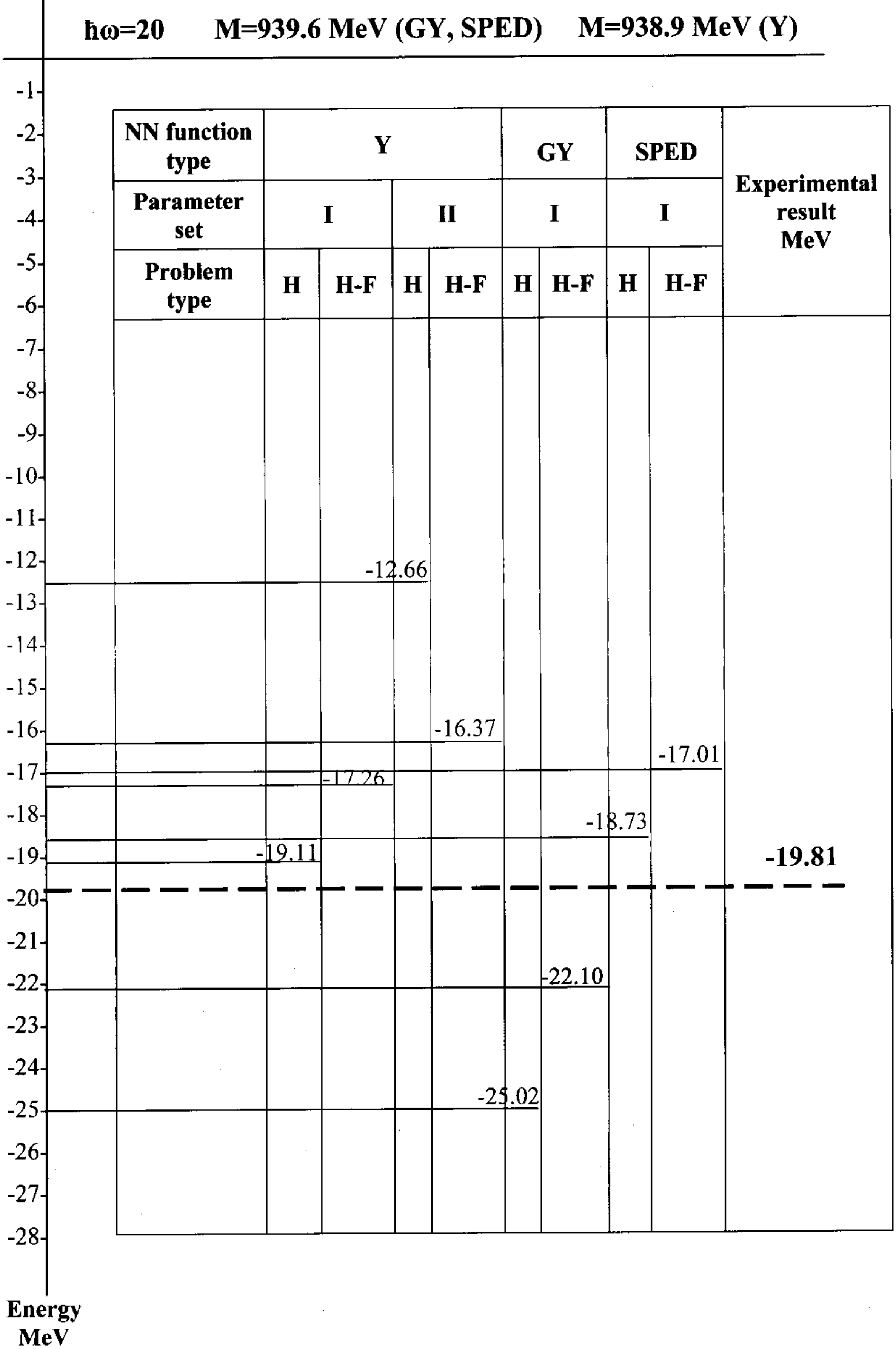

Table 2-A

Meson parameters as in Table I-A with little variated ħω and M

ħω=21 M=938.91875 MeV (GY, SPED, Y)

Parameter Set	Meson	m MeV	$g^2/4\pi$				λ MeV [64]
			Y, GY, SPED		Y		GY, SPED
			H	H-F	H	H-F	
I [63]	σ	550	6.57		-	-	1530
	ω	782.8	9.25		-	5.54	1530
II [64]	σ	440	-		6.25	12.24	-
	ω	783	-		15.16	12.24	

Table 2-B

Ground state energy for ^{4}He using parameters of Table 2-A

Parameter Set	Problem Type	NN Potential Type MeV			Experimental Result [65]
		Y	GY	SPED	
I	H	-20.36	-26.68	-19.94	-19.81 MeV
	H-F	-18.29	-23.48	-18.01	
II	H	-13.15	-	-	
	H-F	-17.13	-	-	