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EVALUACIÓN TEÓRICA DE LA DISPERSIÓN INELÁSTICA DE LEPTONES DE EFECTOS NUCLEARES

Theoretical Evaluation on Inelastic Lepton Scattering of Nuclear Effects

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RESUMEN

La dispersión inelástica es un proceso en el que no se conserva la energía cinética de una partícula incidente debido a la interacción entre un electrón y un fotón provocando un estado nuclear inestable. En una interacción del fotón incidente con la materia se produce dispersión Raman donde la frecuencia del fotón se desplaza hacia al rojo o el azul. La dispersión de electrones de naturaleza profundamente inelástica que emana de los protones proporciona la evidencia primordial de la presencia de quarks, los neutrones sufren dispersión inelástica que excita al núcleo y hace que emita partículas corpusculares y electromagnéticas. El objetivo de este trabajo fue obtener teóricamente el efecto nuclear sobre la dispersión de leptones inelásticos y observar la dependencia nuclear. Se utilizaron los métodos, función de transferencia del momento al cuadrado y el producto escalar de Lorentz. Se obtuvo la correlación entre los parámetros de baja energía y la valencia de quarks, el valor indicativo en cromodinámica cuántica es el 5% y el material nuclear infinito no conduce a ningún informe de tamaño finito. El origen de los efectos nucleares aún no se evidencia; sin embargo, las funciones estructurales y los efectos de tamaño finito fueron probados teóricamente.

Palabras Clave: *Quark Valance, Nuclear Infinito, Cromodinámica cuántica, Función de la estructura y Lepton.*

ABSTRACT

Inelastic scattering is a process in which the kinetic energy of an incident particle is not conserved due to the interaction between an electron and a photon causing an unstable nuclear state. Upon the interaction of the incident photon with matter, Raman scattering occurs where the frequency of the photon shifts towards red or blue. Electron scattering of a profoundly inelastic nature emanating from protons provides the primary evidence for the presence of quarks, neutrons undergo inelastic scattering that excites the nucleus and causes it to emit corpuscular and electromagnetic particles. The aim of this work was to theoretically obtain the nuclear effect on the scattering of inelastic leptons and to observe the nuclear dependence. The methods, cross-section four-momentum transfer squared function and the Lorentz scalar product, were used. The correlation between low energy parameters and quark valence was obtained, the indicative value in quantum chromodynamics is 5% and infinite nuclear material does not lead to any finite size report. The origin of the nuclear effects is not yet evident; however, the structural functions and the effects of finite size were theoretically tested.

Keyword: *Quark Valance, Infinite Nuclear, Quantum Chromodynamic, Structure function and Lepton*.

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I. INTRODUCCIÓN

Inelastic scattering is a fundamental scattering process in which the kinetic energy of an incident particle is not conserved. In contrast to elastic scattering some of the incident particle energy is lost or increased (1). The principle of inelastic collision in dynamics is quite distinct; inelastic collision in dynamics refers to processes in which the total macroscopic kinetic energy is not conserved (2). Scattering due to inelastic collisions will be inelastic but elastic collisions often transfer kinetic energy between particles. As in Compton, scattering due to elastic collisions can also be inelastic (3).

The inelastic scattering probability that depends on the incident electron energy is usually smaller than the elastic scattering one (4). In regard to gas electron diffraction (GED), reflection high-energy electron diffraction (RHEED), and transmission electron diffraction (5). The incident electron energy is high, and the contribution of inelastic electron scattering can be ignored (6). Deep inelastic scattering of electrons from protons provided the first direct evidence of quark existence (7).

Raman scattering, also known as inelastic scattering due to a photon being the incident particle (8). The incident photon interacts with matter and the photon frequency is shifted toward red or blue (9). A red shift can be observed when part of the photon energy is transferred to the interacting matter, where it adds to its internal energy through a process (10). The blue shift can be observed when the internal energy of the matter is transferred to the photon. The red and blue shift processes are known as Stokes and anti-stokes Raman Scattering respectively (11).

Inelastic scattering is the interaction between an electron and a photon. A high-energy photon collides with a free electron and transfers energy (12). An electron with relativistic energy collides with an infrared or visible photon, the electron gives energy to the photon (13).

It is known that neutrons undergo many types of scattering, including both elastic and inelastic scattering. Whether elastic or inelastic scatter occurs depends on the neutron speed; fast, thermal, or somewhere in between (14). It also depends on the nucleus it strikes and its neutron cross-section (15). The neutron interacts with the nucleus and the system's kinetic energy changes in the inelastic scattering (16). It often activates the nucleus putting it into an excited unstable short-lived energy state which causes it to quickly emit some kind of radiation to bring it back down to a stable or ground state. Alpha, beta, gamma, and protons may be emitted (17). It is known in Nuclear Physics that scattered Particles are a type of nuclear reaction that can cause the nucleus to recoil in other directions (18).

II. MATERIALS AND METHOD

The cross-section has a four-momentum transfer squared function carried by the virtual photon and the Lorentz scalar product (19). For a quark to carry a fraction x of the nucleon momentum with $\vec{p} \to \infty$ when probed with resolution $\frac{1}{Q^{\varepsilon}}$

$$q(x,Q^2) \qquad (1)$$

in rest frame $\vec{p} = 0$

$$X = \frac{(P_0 \ + P_3)}{Mn} \qquad (2)$$

This can be justified in quantum chromodynamics since anything can be justified in a theory that has not been solved (20). The successful prediction that the same quark distributions are given simply by the square averages of relevant quark changes (21).

$$X = \frac{F_2^{ep\,+\,en}}{F_2^{vp\,+\,vn}} = \frac{5}{18} \qquad (3)$$

An integral which measures the excess of fermions over antifermions in the nucleon should be equal to three (22). Finally, the black box $q(x\ \mu^2)$) is the Fourier transform of the light cone correlation function$C\ (Z\ \mu^2)$) renormalized at μ^2 that is calculated in terms of α (μ^2).

Explicitly,

$$q(x,\mu^2) \pm \bar{q}(x,\mu^2) = \int \begin{Bmatrix} \sin(M_N Zx) \\ \cos(M_N ZX) \end{Bmatrix} C_{\pm}(Z,\mu^2)dZ \qquad (4)$$

Where

$$C_{\pm}(Z,\mu^2) = \pi^{-1} < N \,|\, \bar{q}(\tilde{Z})\gamma_+ q(0) \pm \bar{q}(-\tilde{Z})\gamma_+ q(0) \,|\, N > \qquad (5)$$

Is defined for a nucleon at rest, with

$$\gamma_+ = \gamma_o + \gamma_3 \qquad (6)$$

$$\tilde{Z} = (\frac{Z}{C}, 0, 0, -Z) \qquad (7)$$

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Where *q (Z)* and *q(o)* are quark field operations. The quark contribution reduces the equal-time correlation function of non-relativistic quantum mechanics (23). A familiar function is:

$$< A \left| \Psi(\vec{x}, t = 0)\Psi(0,0) \right| A > \quad (8)$$

Where |A represents a nucleus at rest and Ψ is the nucleon field operator (24).The alternative representation as a displaced overlap function

$$\int \Psi^* (\vec{x} + \vec{y})\Psi(\vec{y})d^3y \quad (9)$$

Where Ψ is the one nucleon wave function, understanding that the correlation fraction measures the system size (25).

III. RESULTS AND DISCUSSION

Considering the Rayleigh-Schrödinger perturbation theory, the energy difference is:

$$\nabla E = q_0 - E \quad (10)$$

$$\nabla E = \frac{m^2+Q^2}{2v} \quad (11)$$

Tends to zero as v → ∞ with *m* and *Q* fixed. The only change in the formalism is that with nuclear target *x* is usually replaced by

$$x = \frac{M_A Q^2}{M_N 2q.P} \quad (12)$$

Which can, in principle range from 0 to *A*. It is known that for x ≲ 0.3 there are no sea quarks and therefore:

$$\delta(q - \bar{q})_{Fe-D} \propto \frac{1}{x}(F_2^{Fe} - F_2^{D}) \quad (13)$$

Thus $\delta\ (q - \bar{q})$must have the form since the quark per nucleon is fixed:

$$\int \delta\,(q(x) - \bar{q}(x))dx = 0 \quad (14)$$

So $\delta\ (q - \bar{q})$ must be positive in some, if not all the regions *x* <0.3.

Table 1: *Quark Valence Distribution for Z*

Z	Quark	Valence
	X	Y
0	4	5
1	2.9	3.9
2	0.4	2.1
3	0.1	2
4	-	1.9
5	-	1.8
6	-	1.7
7	-	1.6
8	-	1.5
9	-	1.4

Table 2: *Infinite Nuclear matter for w*

w	Infinite		Nuclear	
	g	H	I	J
31	2	1.7	1.3	1.2
40	1.8	1.55	1.35	1.3
50	1.6	1.5	1.36	1.32
60	1.5	1.45	1.37	1.35
70	1.4	1.38	1.38	1.36
80	1.37	1.37	1.37	1.37
90	1.36	1.36	1.39	1.38
100	1.35	1.35	1.4	1.39

Table 3: *Perturbation Quantum Chromodynamic for Q^2*

Q^2	Quantum	Chromodynamic
	A	B
5	8	-
6	8	-
7	11	12.5
8	11	12
11	9	10
13	10	9
14	9.5	8.5
15	9	8
16	5	7.5
20	7	6.5
22	6	6
24	5.7	5.7
26	5	5.7
28	4.95	4.95
29	4.7	4.7
32	3	4.5
34	4.5	4
36	2.5	2.8
38	3	2.5
39	4	2
42	8	-
44	12.5	-

Table 4: *Structure function of Deuterium*

Q	Structure function	
	F	D
0.5	20	-
0.6	19.9	20
0.75	10	11
1	5	8
1.5	3	7.5
2	3	7.5
2.5	3	7.5
3	3	7.5

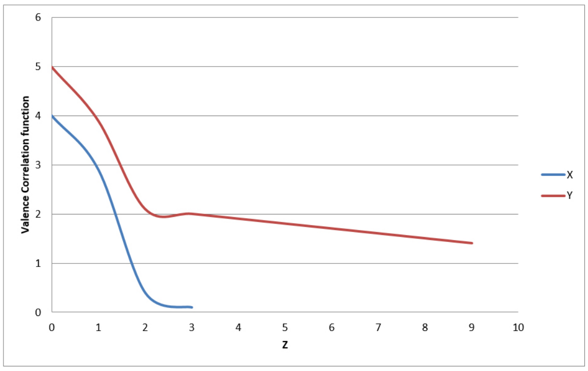

Fig. 1: *Z against the Valence Correlation Function (This figure is plotted from results obtained in table 1)*

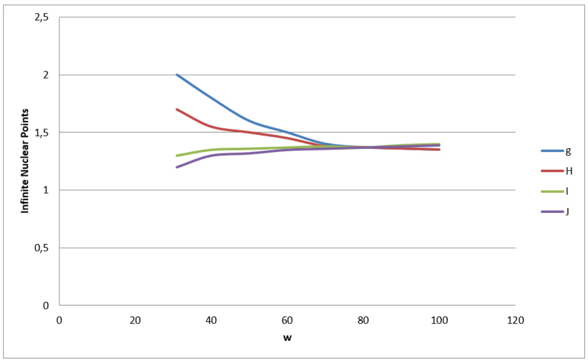

Fig. 2: *w against Infinite Nuclear Points (This figure is plotted from results obtained in table 2.)*

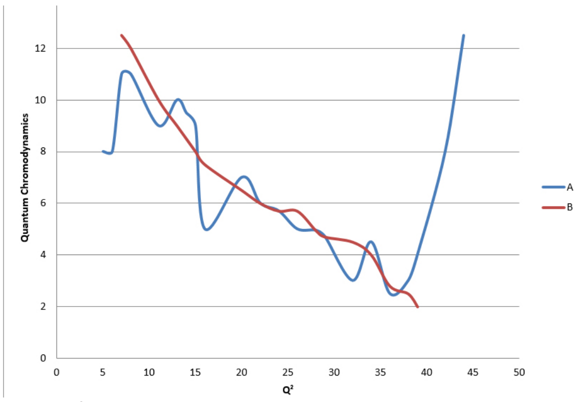

Fig. 3: *Q² against Quantum Chromodynamics (This figure is plotted from results table 3.)*

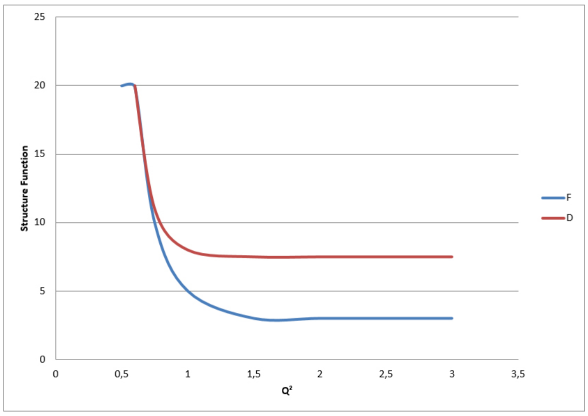

Fig. 4: *Q² against Structure function (This figure is plotted from results obtained in table 4.)*

Fig 1 shows that X and Y are parallel lines that move in opposite lines. Where x represents $x > 0.1$ and Y represents $x \rightarrow 0$. Also, figure 4 indicates a valence correlation achieved for low energy parameters for the quark valence correlation. Proving that the long-range tail was assumed to acquit as $x - \frac{1}{2}$ that is returned by if this lace is cut by a quiet calculation to the rootage which cuts $x >> 0.1$. The $x >> 0.1$ quark valence distribution is checked by distances < *fm*, the correlation function spilling for $Z > \frac{1}{2}$ *fm* and necessary unaltered deportment which obtains the lower curve. The figure is the product of table 1.

Fig 2 shows that g, H, I and J have a meeting point which is at 80 on the w axis. It started at a parallel point that meets the point. Also, the figure indicates infinite nuclear matter so again it is entirely unreliable for $w \leq 40$. It leads to no report of finite size effects and an effort was made to prove the fact that response takes place theoretically. The figure is plotted from the results obtained in table 2.

Fig 3 shows that line A forms a zigzag line which makes it like the letters m and w. While line B indicates a slight slope also similar to the letter m. A represents the equation $\frac{\sigma^{Fe}}{\sigma^{D}}$ and B represents the equation $\frac{\sigma^{D}}{\sigma^{D}}$. This also indicates that there are errors that quantitatively work within. If μ^2 is chosen to be little, then $\frac{\delta\mu^2}{\mu^2}$ that is needed also becomes little. The little value stated in Quantum Chromodynamics signifies that $\delta\mu^2/\delta\mu^2$ is nearly 5%. δ The figure is the product of table 3.

Fig 4 shows F and D lines starting at a point where a slope from 13 points on the structure-function that are separated from each other. Point 13

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indicates that D has a higher structure function than F. D represents Deuterium on the structure function and F represents Fe. Also, the figure indicates the success of the scaling law that is in relation to the deuterium structure-function The heavier can be understood in terms of qualifying the properties of individual nucleons. It is coherent to write the X>0.3 region in terms of individual nucleon donation since it is restrained by lesser distances. The figure is plotted from the results obtained in table 4.

IV. CONCLUSIONS

In nuclei, the quarks correlation functions have a large range. Regarding the origin of the nuclear effect, there is no consensus. When the dust settles, there will be an enhancement at low x, although it may be closer to the bottom than the top. Pion indicates a natural qualitative view of this enhancement. Based on pre-existing nuclear theory without any additional ingredients. However, pions are only effective degrees of freedom, and an inelastic model will not work with a high degree of accuracy. This effect is due to the properties modification of nucleons that are stretched in the nucleus. Structure functions have been understood for individual nucleons. Finite size effects were theoretically proven.

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