

Impact of causality on electromagnetic mass shifts of
baryons *in 2 rows*

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Using the causal Jost-Lehmann-Dyson (JLD) representa-
tion for the contracted virtual photon-nucleon forward
amplitude,

$$M(p, q) \equiv M_{\mu\nu} g^{\mu\nu} = 3q^2 t_1(v, q^2) + (q^2 + 2v^2) t_2(v, q^2) ,$$

which determines the nucleon electromagnetic mass shift,
Rahman and Taha¹⁾ came recently to a rather revolutionary
result that only the invariant amplitude t_2 contributes,
namely,

$$m_p - m_n = - \frac{i}{2\pi} \int \frac{d^4 q}{q^2} v^2 t_2(v, q^2) , \quad v \equiv p \cdot q / m .$$

This causality modified Cottingham formula relies
heavily on a fundamental dynamical assumption: The JLD
spectral function $\psi(u, s)$ is so bounded that $s\psi(u, s) \rightarrow 0$ at
high energies s . Unfortunately, the evaluation of the t_2
contribution in the nucleon case within the scaling frame-
work leads to regularizational difficulties, so that a clear-
cut conclusion is not possible.

We have applied the above ideas to the pion multiplet,
which is more transparent and, as generally believed,
dominated by the GBT contribution. The result we have
obtained

$$\delta(m_\pi)_B = - \frac{i\alpha}{2\pi^3 m_\pi} \int \frac{d^4 q}{q^2} F_\pi(q^2) \frac{p \cdot q}{q^2 - 2p \cdot q} = 0.21 \text{ MeV}$$

is in violent disagreement with the observed value $\delta m_\pi = 4.6$
MeV. This indicates that either the commonly accepted ex-
planation of the pion mass shift is a misleading theoretical
illusion, or the Rahman-Taha model contains an unjustified
hypothesis.

References:

1. A-M.M. Abdel-Rahman and M.O. Taha, Phys.Rev. D 15, 2472
(1977)
2. See, for example, A. Zee, Phys. Rep. 3C, 127 (1972)