An explanation and some experiments of Solving the neutron lifetime puzzle via non standard neutrino interactions.

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Abstract

Neutron lifetime has been observed near 887 seconds in Beams but 879 seconds in magnetic bottle That the inverse quantum Zeno effect may be the solution was been suggested as a reason, but it requires new physics regularly interacting with the neutron. Here we show they exists a background of neutrinos near the experimental materials and neutrino interact via a non standard interaction, it produces a decrease in lifetime of the correct magnitude. We also describe experiments that might determine if this is occurring in nature.

Keywords

Neutron Decay, Quantum Zeno Effect, Neutrino Backgroup

Introduction

A number of neutron decay experiments recently have pinned the neutron lifetime down, but instead of one lifetime, two different lifetimes are observed depending on weather the neutron was observed to decay in a beam or in an ultracold state in a magnetic bottle. For example see [1], where beam has a lifetime of around 887 seconds, while bottles have a lifetime of around 877 seconds.

In 2021 we finally published our theory of a new neutrino interaction [2], a axial charge that reverses its spin if the neutrino spin is reversed, which also predicts a neutrino background new ordinary matter needed to screen out excess charges from Baryons in the new interaction. In general we may place a charge +1 on an electron neutrino, and an interaction strength of α_a, we would assume that no new charge would be found on an electron as the electrons interactions are very well described by the electromagnetic interaction. If the new charge is to be conserved in weak interactions, the neutron must have a charge 1 more than proton $n ß p + e^- + \nu$ then $Q(n) = Q(p) + 1$. Although our previous work assumes anenew force or Axial force charge, is the same for Neutrons with opposite spin, we do not need to assume that here, and it could be either reverses or stays the same under spin flip.

In [3] Giacosa and Pragiara [6], should that the inverse quantum Zeno effect could increase the decay rate of the neutron if some new interaction, interacts with neutrons in bottle with a rate of about a billion times per second. This would have to be new physics as existing interactions would not cause such interactions.

In general if an interaction is to increase the neutron decay rate, it needs to be an interaction which can effectively measure that a neutron is a neutron and some decay products are its decay products, the vast difference in mass /charge ratio of a neutron to a neutrino would do that here.

It would be noted that Axion like particles in a background to an experiment would also increase the neutron decay rate we must be careful however that such particles do not convert to photons (as regular Axions might), on contact with the neutron, as electromagnetic signal would have been observed.

Inverse Quantum Zeno Effect

The he quantum Zeno effect was rigorously describe by Degasperis, Luciano Fonda, and Giancarlo Ghirardi, [4] it shows that when a reacting quantum state is repeatedly measured or interacted with, the act of measuring reduces the speed of the reaction. Related and similarly there is also the watchdog effect by K.Kruss [10]. In general depending on the hamiltonian the slowing of a decay can sometime be an increasing of the decay rate [7] When this happens the effect is known as the inverse quantum zeno effect, and it is the inverse Zeno effect that is needed here. According to [3] the if the neutron is interacted with around a billion times per second in a bottle, it produces an inverse zero effect of the correct magnitude to explain the neutron decay lifetime puzzle.

Neutrinophilic forces and our axial force

In 2005 we started investigating weather neutrino might interact with an in additional force an our paper on the subject was finally published in 2021 [2]. We found a possible neutrino wave equation with additional right handed neutrinos in the keV or MeV masses. I found an earlier paper by L.M. Slad /citeSlad, that showed that an axial force completes the possible Ponicare invariant forces for a particle. We also showed that have a neutrino axial force and a electron vector force (electromagnetism) simultaneously leaves left and right handed weak forces completely separate due to charge conversation, indicating why the known weak force is purely left handed.

In order for the combined summing of proton or neutron charges in matter not to overwhelm the mechanical stability of matter under the electronic magnetic force, we find we needed a background of neutrinos and due to the Fermi energy of the neutrinos many of the background particles would need to be right handed neutrinos with keV energies. It is this background interacting with our axial force and then neutrons that we find here might be cause of the neutron decay anomaly.

Possible models of the neutron decay anomaly

We already have that $Q(n) - Q(p) = 1$ and we must assume the force has range of a least several nanometres, and is conserved at least over intermediate time periods. If when the neutron spin is reversed the new charge reverses, then any net charge of our new force only occurs when many neutrons are polarised in a magnetic field, if on the other hand all neutron have the same charge, any material that the charge density is $q = N_n Q_n + N_p Q_p + X$where X is any the charge on any other new by particles, which we assume are a background of neutrinos. Total neutrality is needed over on average the range of the force, if it is Debye screened or screened by a mass on the gauge particle, and longer range net neutrality is not needed.

Given a cross-section for interaction of sigma and n neutrinos per unit area travelling near light speed as they have low mass, we have the interaction rate I per neutron per second, as

$$I = \rho_\nu r^2 \sigma c$$

which we need to be about a billion times per second.

In our paper [2], we needed for neutrality a neutrino background of around 10ˆ17 neutrinos per cubic meter given a Debye screening distance of 5 nm, for air. This in fact produces an interaction rate of one third of a billion, already near the right amount for explaining the neutron decay rate. Since high speed neutrons are observed to have a slower decay rate, we need them to have a much lower interaction rate with neutrinos, asymptotic screening at high energies which we did observe in our interaction rate on paper, in our section 12.2 on neutrino scattering we found the rate declines approximately as the neutrino energy [2].

Experiments

In order to see if it is a neutrino background that screens out a new force on neutrinos and neutrons, causing the neutron lifetime puzzle, we need to compare the decay rate in the cases of the presence of three kinds of matter, that with high proton to neutron ratio, equal protons and neutrons numbers and that with high amounts of extra neutrons. Ploting the excess proton and neutron density of the nearby material against the neutron decay rate, we would see different rates depending on the isotopic rations of protons to neutrons in the material . In [2] we assumed for simplicity that neutrons had a new (axial) charge of +1/2 and protons -1/2, in such a case they would be no neutrino background for say carbon-12 or oxygen-16 backgrounds, a positive result would be a return of the decay rate to the neutron beam decay rate for such materials. A negative result would be the same decay rate for all isotopic types of nearby material. We need to try the neutron bottle experiment in magnetic bottles, with isotopically different materials.

The Recent UCN (utlta cold neutron)experiments [5], seem to have used aluminium _13 Al 27 coated with a high fluorine Flobium Oil, such materials have a high neutron excess in its material, and since a magnetic bottle is used, the a high magnetic field (in [6] 5 Telsa) where near the experiment potential polarizing nuclei in the material (but at a low amount at room temperature). Since polarisation increases when temperatures are low, we might see increased neutron decay rate (in the case where only net spins on neutrons introduce the new force) at much lower temperatures. Polarisation only matters for the case where opposite spin baryons have opposite charge under our new force.

To use equal amounts of protons and neutrons in the near by material we suggest replace the material with carbon 12 graphite. While water ice would be (at low temperature) the ideal material for a high amount of excess protons.

The Size of the experiment may be a factor. At some distance inside a the trap material in larger bottles the background neutrinos might diminish in density to the background air density (we estimated 10ˆ17 in [2], while in smaller traps more neutrons are present]near material walls, and might interact with high levels of neutrino background at the similar to the density of excess neutrons nside the material, e.g. 10ˆ21 calculated for Pyrex in 2. Interestingly, Tan Wang [5] states that “All the smaller magnetic traps, such as the Ioffe-type NIST trap [12] HOPE [13], and tSPECT [14] [15], have produced very low values for neutron storage lifetime, sometimes more than 100 s lower than “accepted” lifetime values [20].

The experimental cost of such materials is not large, the researchers would of course need access to an ultra cold neutron source.

Conclusions

We observed that our new axial force described in [2] might explain the neutron lifetime puzzle, in the preserve of the standard quantum theory of the inverse quantum Zeno effect. We suggested a lab experiment which could in the time scale of a few years at most determine if our force was truly responsible for neutrons change lifetime depending on the type of experiment measuring it.

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