MEASURING SOLAR NEUTRINO FLUX IN THE SNO+ PURE SCINTILLATOR PHASE

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I did it on my own. Get rekt suckas

Acknowledgements

I did this mostly on my own. Anyone else who helped did so in such an insignificant way that I've by now forgotten about it.

ABSTRACT

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Described here is a measurement of the solar neutrino flux as measured by SNO+.

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Chapter 1

Introduction

1.1 Neutrinos

Neutrinos were first hyptothesized by Wolfgang Pauli in 1930. The motivation for the proposal the apparent violation of energy conservation in β decay (1). Several years after Pauli's somewhat speculative proposal Enrico Fermi offered a more thorough model of beta decay that conserved energy using the neutrino (2). Fermi's model predicted such a small cross-section for the neutrino that some doubted it would ever be observed (3). However, roughly two decades after its initial proposal, Frederick Reines & Clyde Cowan performed an experiment that involved bombarding a tank of cadmium doped water with anti-neutrinos from nuclear reactor. Doing this they were able to observe the rate and energy of inverse β decays that ocurred. The results were consitent with Fermi's model of β decay and were considered a confirmation of the neutrino's existence.

1.1.1 Neutrino Flavor

The first experimental evidence for neutrino flavor came in 1962 from an experiment (4) that observed the interactions of neutrinos that came from muon decay, and the interactions of neutrinos emitted from beta decay. The experiment observed that neutrinos from came from muon decay would produce muons upon interacting in a detector. And neutrinos produced from β decay would create electrons in the detector. This lead to the conclusion that there are two different varieties of neutrino, the ν_e and the ν_μ, and the idea that lepton flavor is conserved. The third lepton generation, the τ and the ν_τ was discovered 13 years later in 1975 (5).

1.1.2 Neutrino Oscillations

Neutrino oscillation is the idea that a neutrino created as a ν_e can be detected and a ν_μ or a ν_τ. Oscillation occurs because the eigenstates of the neutrino's Hamiltonian in a vaccume is different from the weak interaction eigenstates. More succinctly put, the neutrinos mass states are not the same as the weak states. The mathematical description of this is as follows. Starting with the claim that weak states and mass states are related to each other via a rotation matrix.

$$|\nu_i\rangle = U_{i\ell} |\nu_\ell\rangle \tag{1.1}$$

Where $|\nu_\ell\rangle$ represents the neutrino weak states, $|nu_i\rangle$ represents the mass states, and $U_{i\ell}$ describes the mixing of these states. In the simplest case where the weak states and the mass states are the same $U_{i\ell}$ would just be the identity matrix. Additionally $U_{i\ell}$ must be unitary to conserve probability. The mass states are defined such that

$$H |\nu_i\rangle = m_i |\nu_i\rangle \tag{1.2}$$

1.1.3 Solar Neutrinos

1.1.3.1 The MSW Effect

1.1.4 Neutrino Experiments

1.1.4.1 Solar Experiments

1.1.4.2 Terrestrial Experiments

Chapter 2

Conclusion

2.1 Wrapping up...

I rest my case.

Appendices

Appendix A

Some Appendix

A.1 first section

Appendix B

Another Appendix

Glossary

Roman Symbols

M Mass of object, page 8

Greek Symbols

τ Optical depth, page 8

Superscripts

* Conjugate, page 8

Subscripts

$\odot$ relating to the sun (Sol), page 8

Other Symbols

11HUGS 11 Mpc Halpha and Ultraviolet Galaxy Survey, page 8

Acronyms

2MASS Two-Micron All Sky Sruvey, page 8

References

[1] Wolfgang Pauli. **Letter to Tübingen**. 1

[2] Enrico Fermi. **Tentativo di una Teoria Dei Raggi β (Trends to a theory of β radiation)**. *Zeitschrift für Physik*, 1934. 1

[3] 1

[4] Lastname. **Title**. *Journal of Sth*, 2007. 1

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