CERN-TH.4292/85

COMMENTS ON THE
"METHOD FOR OBSERVATION OF NEUTRINOS AND ANTINEUTRINOS"

T.H. Ho^{*)}
CERN - Geneva

A B S T R A C T

It is shown that a mechanism of coherent enhancement of the cross-section of the neutrino scattering in a periodic structure, suggested by Weber could be excluded by the present neutron scattering experiments.

*) On leave from the Institute of Theoretical Physics, Academia Sinica, P.O. Box 2735, Beijing, China.

Recently, Weber gave an interesting proof which shows that neutrinos and antineutrinos may have a large coherent scattering cross-section proportional to the square of the number of particles of the scatter¹⁾. If the neutrinos or the antineutrinos with a low enough energy have a wavelength λ_ν , as large as the dimension of the scatterers, then one would expect a cross-section

$$\sigma_s \propto N^2 \quad (1)$$

Here N is the total number of particles as a result of coherence. However, Weber shows that even if the wavelength λ_ν is small in comparison with the dimension of the scatterer with a periodic structure, "theory" still predicts the same coherent behaviour (1), provided that

$$\lambda_\nu > h / \sqrt{2\mu_s k T_D / (\frac{3}{2} + \frac{\pi^2 T^2}{T_D^2})} \quad (2)$$

where T_D is the Debye temperature, T is the working temperature and μ_s is the mass of the nuclei of the corresponding scatterer. For example, an antineutrino coming from a tritium source, scattered from a 12 gm crystal, as Weber shows, will have a total cross-section of approximately 1.5 cm^2 ¹⁾! This theoretical prediction is quite surprising, since the wavelength of an antineutrino with an energy around 10 keV will be as small as

$$\lambda_\nu \simeq 6.2 \times 10^{-9} \text{ cm} \quad (3)$$

Nevertheless, if such a coherent enhancement of the scattering cross-section does occur in neutrino scattering, then the same mechanism should appear in neutron scattering also, since both of them have a stronger interaction with the nucleus than with the electron, and have a longer absorption length in comparison with the dimension of the scatterer, e.g. $\sim 1 \text{ cm}$. For example, a thermal neutron, on average, will have a wavelength

$$\lambda_n \simeq 1.8 \text{ \AA} \quad (4)$$

i.e., nearly the same wavelength as an antineutrino with energy of 10 keV. Furthermore, the Debye-Waller wavelength of ^{28}Si will be as large as $0.25 \text{ \AA}$, provided that the working temperature is taken to be the ordinary room temperature. Obviously, the condition (2) holds very well. Thus, in a silicon-neutron diffraction experiment, one should observe such a large coherent scattering cross-section! Since such kinds of experiments have been done frequently and no one has found

such coherent enhancement of neutron scattering, it seems that Weber's mechanism could already be excluded by the present neutron diffraction experiment.

REFERENCES

- 1) J. Weber, Phys. Rev. 31C (1985) 1468.