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WATER SPECTRA AND ENERGY EXCHANGE KERNELS

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Many measurements of neutron spectra have been made in water assemblies with B^2 . 0.1 cm^{-2} and with various amounts of 1/v absorber. In these systems a large part of the spectrum is given by an essentially Maxwellian distribution at the moderator temperature which is insensitive to the scattering model since the leakage from the system is small; the shape of this component is unaffected by the 1/v absorption. Hence, the test of the energy exchange scattering kernel is in the difference of the spectrum and the fundamental or Maxwellian component. Using the eigenfunctions[1] of a discrete energy representation the spectrum is written as:

$$N(E) = \sum_{k=0}^{K} a_k N_k(E)$$

The zeroth eigenfunction or fundamental mode is practically a moderator temperature Maxwellian. Therefore normalizing such that $a_0 = 1$, the quantity $\Delta = N(E) - N_0(E)$ contains the model dependent information. Since Δ has a zero, at E' say, the experimental Δ may be written as:

$$\Delta_{exp} = \frac{N_0(E')}{N_{exp}(E')} N_{exp}(E) - N_0(E)$$

The theoretical and experimental Δ are thus directly comparable.

The figure shows the spectrum for the Nelkin model, the corresponding fundamental component and the Δ for the Mass-1 gas and Nelkin models for water for the case of $B^2 = 0.0328\ cm^{-2}$ and $\sigma_a(20^oC) = 3.33$ b/H atom. The solid points give Δ for Burkart and Reichardt's[2] data and $N_o(E)$ based on Nelkins kernel. The open circles are based on the Mass-1 gas model and indicate the insensitivity to the value of E'. The data[2] for $\sigma_a(20^oC) =$ 2.13 and 4.2h b/H atom have also been analyzed in this fashion and show similar characteristics.

Once the fundamental has been subtracted neither theoretical model seems to fit the data extremely well. Below kT the Nelkin model is a closer fit than the gas model but it underestimates the deviation from the Maxwellian whereas in the joining region it overestimates the distortion. The disagreement may be within experimental uncertainty however. This method of analysis also shows the order of accuracy that is necessary to discriminate between different models on the basis of spectrum measurements.

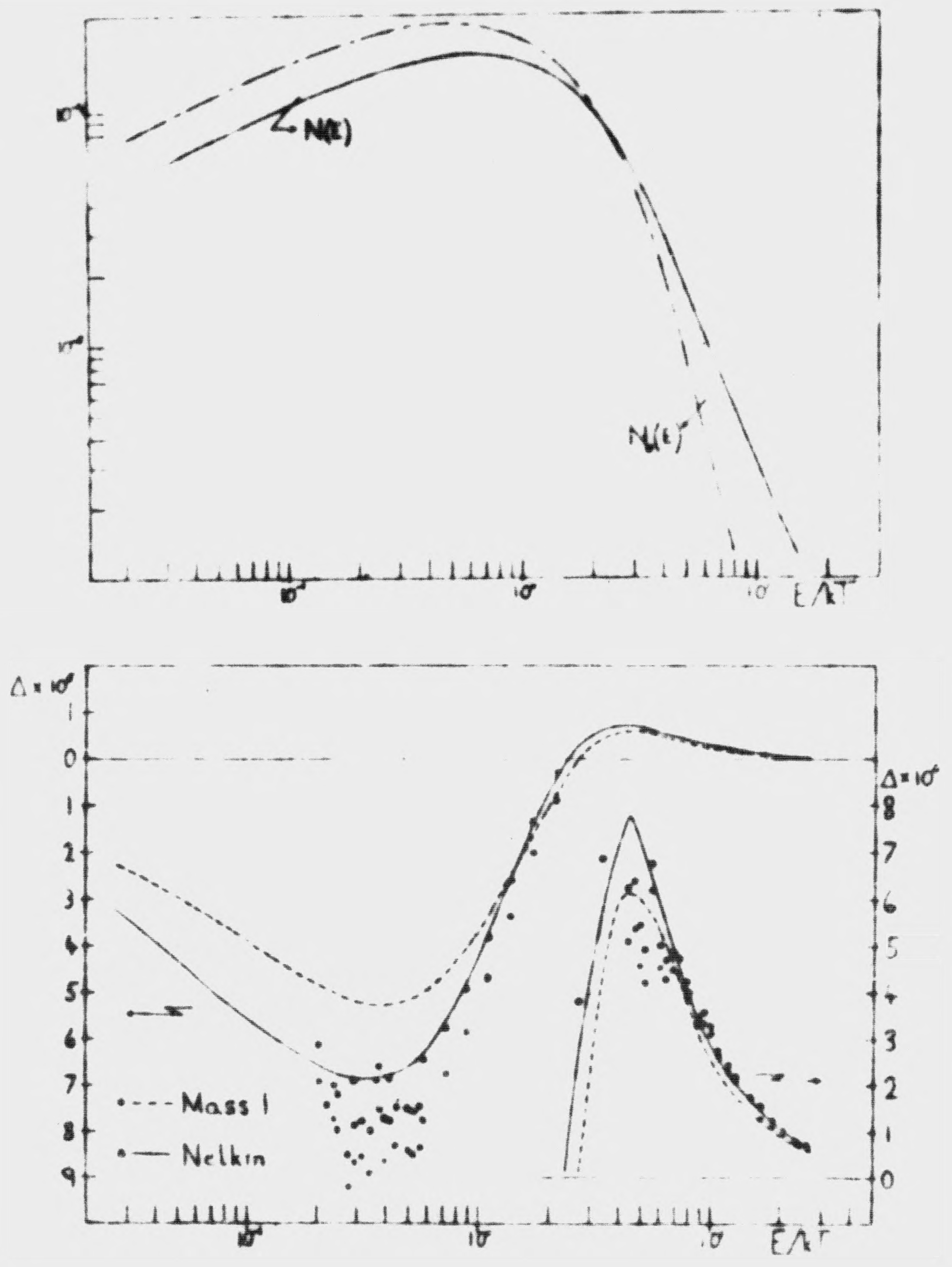
REFERENCES

1. P.B. Datich and M.J. Ohanian, Trans. Am. Nuc. Soc., 6, p.25, (1963)

2. K. Burkart and W. Reichardt, Proc. Intern. Conf. Neutron Thermalization, Brookhaven National Lab., p.318, (1962)

Figure Caption

WATER SPECTRUM AND Δ FOR $\sigma_a(20^{\circ}C) = 3.33$ b/H ATOM
$B^2 = 0.0328\ cm^{-2}$. EXPERIMENTAL DATA FROM REF. 2
(All Ordinates in the Same Arbitrary Units)


N(E)
E/kT
Δ × 10
Mass 1
Nelkin
Δ × 10
E/kT

END