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COLUMBIA UNIVERSITY
DEPARTMENT OF PHYSICS

Contract AT-30-1-GEN-72

HIGHER RESOLUTION NEUTRON VELOCITY SPECTROMETER MEASUREMENTS OF ENRICHED URANIUM

By

W. W. Havens, Jr. and L. J. Rainwater

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COLUMBIA UNIVERSITY
PUPIN PHYSICS LABORATORIES

NUCLEAR PHYSICS INVESTIGATIONS

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W. W. Havens, Jr. and L. J. Rainwater

J. R. Dunning -- Director of Research

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The slow neutron transmission of a sample of enriched uranium containing 3.193 gm/cm^2 has been investigated with a resolution width of 1 microsec/m (1 microsec/m is the full width of the triangular resolution function at the base) and with points spaced 1/3 microsec/m. The results of these transmission measurements are shown in Fig. 1. The solid line represents the new measurements while the dashed line represents the previous measurements (CUD-4) on this sample using a resolution width of 1.4 microsec/m and with points spaced 2/3 microsec/m.

The change of resolution width will not change the area of a transmission dip, but increased resolution will make it deeper and narrower. Also, dips which were previously not resolved and appeared as a single dip are sometimes resolved into two or more separate resonances. Thus, the dip at 6.3 ev now appears to consist of two levels, at 6.3 ev and at 6.9 ev.

The dip at 8.7 ev is sharpened but remains single.

Above 10 ev it is not certain that all resonances are being resolved and many probably are not. (The small spacing of the 6.3 and 6.9 ev dips could

not be resolved if it occurred at much higher energy.) The higher resolution studies show much more structure than before, however, and show many more strong levels or positions of clusters of levels.

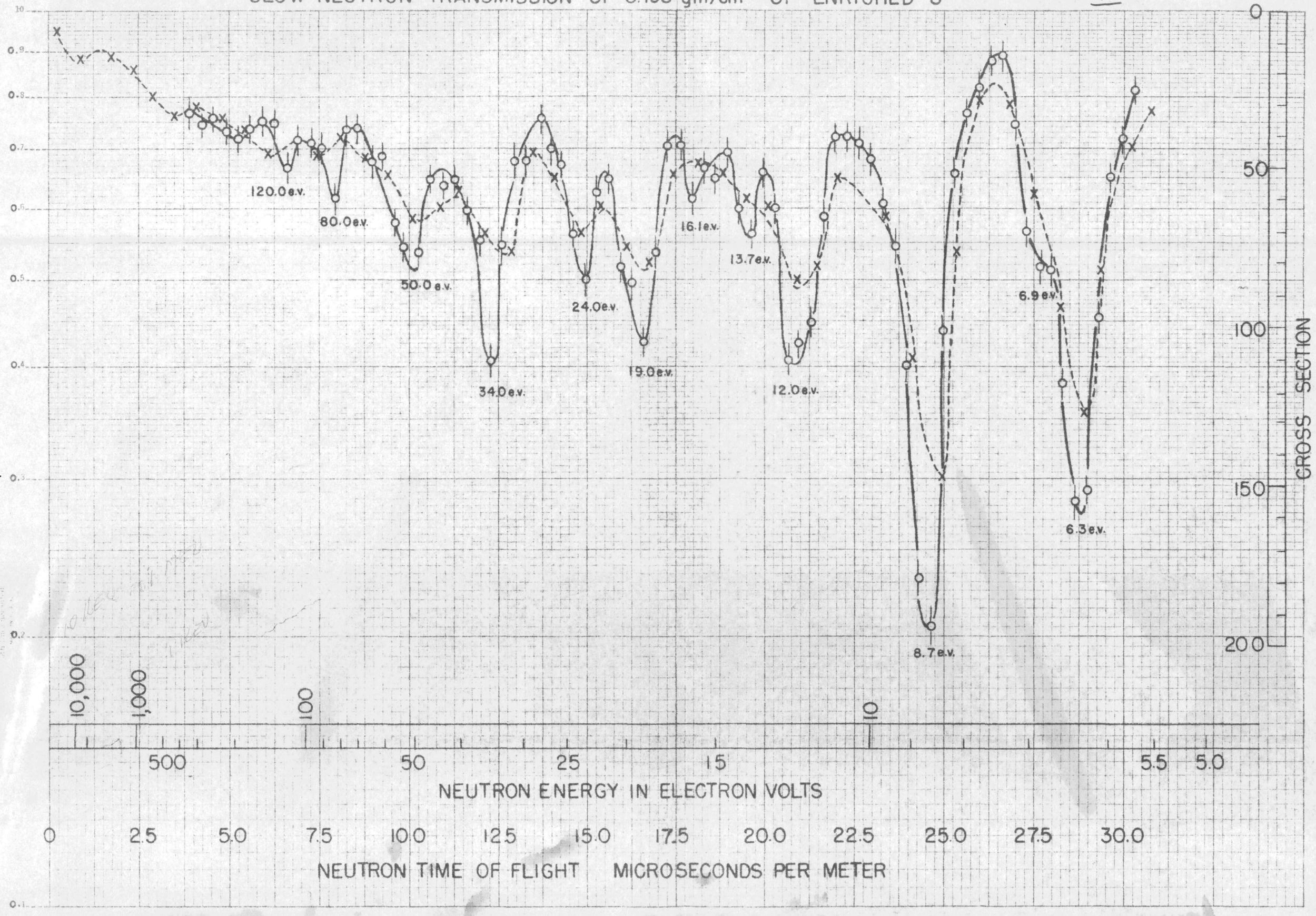
The level previously observed at 12.5 ev has been resolved into two levels at 12.0 and 13.7 ev, and the shape of the dip at 12.0 ev suggests it is multiple. A new weak level appears at 16.1 ev.

The levels at 19, 24, 34, 50, 80, and 120 ev are more clearly defined.

Above 120 ev, the resolution width is many times the level spacing and consequently only fluctuations in level density and an average transmission over a region of several levels can be observed.

Looking at this from the statistical point of view, there are 6 levels in the first 5 ev and 3 levels between 5 and 10 ev, indicating a level spacing of the order of 1 ev. Since the resolution width at 10 ev is about 1 ev, we might expect to distinguish between two approximately equal levels 0.5 apart. This would indicate that the observed transmission dips above 10 ev might be due to more than one level. When the energy is as high as 50 ev the resolution width is approximately 10 ev so that the apparatus should be integrating over several levels. Therefore, if all the levels were equal in strength, no pronounced transmission dips should be observed. Since pronounced transmission dips are observed, this would indicate that there must be large statistical fluctuation in the level spacing or level strengths. There seem to be two types of levels in terms of strength. Thus, the 8.7, 12, 19, 24, and 34 ev levels seem to be of the stronger type.

It should be pointed out that the transmission dip at 120 ev, if due to a single level, would have a $\sigma_0 \Gamma^2 \sim 90$, which is approximately the same strength as for the level at 12 ev. The difference in observed effect is so large because the resolution is so much better at 12 ev than at 120 ev. In the higher energy region (> 100 ev) levels such as those at 13.7 and 16.1 ev would not be observed.

These data are being further investigated by several different methods to determine the nuclear level constants from the experimental data.

SLOW NEUTRON TRANSMISSION OF 3.193 gm/cm^2 OF ENRICHED U