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COO - 1468 - 2

PROGRESS REPORT

January 1967 - December 1967

Submitted by

D. J. Donahue, J. D. McCullen, and L. C. McIntyre

University of Arizona

DISCLAIMER

PROGRESS REPORT

January 1, 1967 - December 31, 1967

A. Doppler-Shift Measurements

1. Determination of Unattenuated Doppler Shifts.

In the past year a good deal of effort has been directed toward improving the measurements and calculations from which mean lives of nuclear states are determined. The experimental information required to obtain a mean life is shown by the equation

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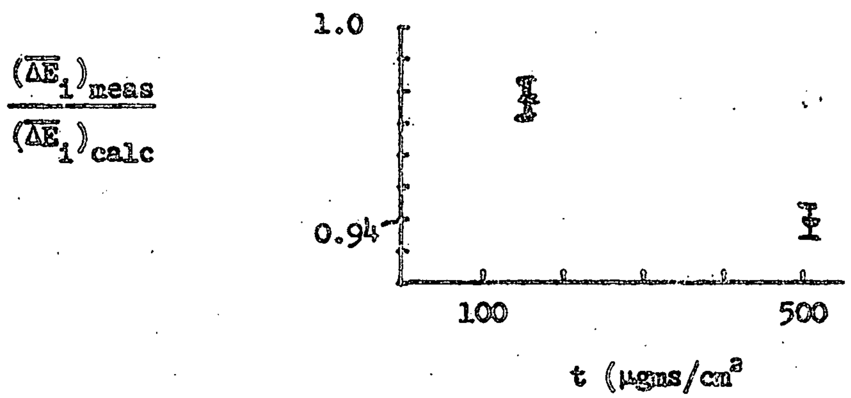
Since most of the measurements done in this laboratory are of the type in which the direction of the recoil nucleus is defined by a coincidence measurement, the calculation of the unattenuated Doppler shift should be a simple kinematics problem. However, because our detectors have finite (and fairly large) solid angles, it is necessary to average over the possible final directions of the recoiling nuclei and over the finite extent of the γ-ray detector. In order to ensure that our calculations of the unattenuated or "full" Doppler shift do not neglect some important factor, we undertook a series of measurements of different full shifts which could be compared with our calculations. These measurements consisted of determining the Doppler shift (that is the numerator of eqn. (1)) of transitions from states whose mean lives are so short (less than about 10^{-14} sec) that no slowing down can occur before the state decays. The transitions used were those from the 4.9 MeV to ground in Si^{29} and the 3.47 and 3.56 MeV to ground in Mg^{27}.

The comparison of these measurements with calculations has led to results which are at present neither certain nor understood. It seems that the full-shift which is measured depends on the properties of the target used. For example, if we plot $(\overline{\Delta E}_1)_{meas}/(\overline{\Delta E}_1)_{calc}$ vs. thickness of the target material the following curve results.



These measurements are rather difficult to make, and the effect we are looking for seems to be only a few percent in magnitude. However, for measurements of Doppler shifts near 100% this effect could be quite important, and at any rate is one which we would like to establish firmly experimentally, and to understand theoretically. At present we are doing more experiments and making some small-angle multiple scattering calculations toward this end. In the meantime publication of some of the results listed below are being held up.

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Doppler shifts of γ-rays and mean lives of states in F^{20} produced by the reaction $F^{19}(d,p\gamma)F^{20}$ are listed in Table II. As mentioned above, all numbers in the table are subject to corrections of perhaps as much as 5%.

Table II. Mean Lives of States in F^{20}

Level	Measured Doppler shifts / Calc. full shift	Mean Life
0.656	0.41 ± 0.03	5.2 ± 0.5 x 10^{-13} sec
0.83	0.0 ± 0.04	> 6 x 10^{-12} sec
0.99	0.07 ± 0.10	> 8 x 10^{-13} sec
1.059	0.97 ± 0.05	< 5 x 10^{-14} sec
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5. Mean Lives of Some Levels in B^{10}.

Work on measurements of the mean lives of the 1.74-, 2.15-, and 3.59-MeV states in B^{10} has been completed. Results will appear in the January 20, 1968, issue of Physical Review.

B. Levels in Sc^{43}.

The energy-level structure of Sc^{43} is of considerable interest, since it is the basis of the shell-model calculations in the $f_{7/2}$ shell. Experimental information on this structure is ambiguous, and it seems that a study of γ-ray decays of the various levels in Sc^{42} could be quite informative. We have tried, on two occasions, to look at these γ-rays, using the $Ca^{40}(He^3,p\gamma)Sc^{42}$ reaction. Initially the Los Alamos cyclotron was used to produce 12 MeV He^3 ions. The background of γ-rays from K^{38} produced in the $Ca^{40}(He^3,\alpha p)K^{38}$ reaction was so bad that conclusive results were not obtained.

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Rough theoretical estimates of the expected branching ratio put it at about 10^{-4}. Thus, the recent experiment by Freeman indicating it to be less than 10^{-3} is not sensitive enough. We propose to look for it by producing Sc^{42} activity in the $K^{39}(\alpha,n)Sc^{42}$ reaction with 8.5 MeV alpha particles. We will need to use doubly ionized helium from the Van de Graaff, most probably requiring the mass analysis unit acquired this year. As a check on the counting and beam chopping system we are going to use, a series of runs have been made on the 2-MeV machine. We have produced Al^{25} (half-life 7 seconds) by the $Mg^{24}(d,n)$ reaction. Al^{25} is a 4.3 MeV β^+ emitter, and approximates the annihilation-in-flight and bremsstrahlung background we can expect to see. The results indicate our techniques are reasonable, and we are now getting ready for the new machine.

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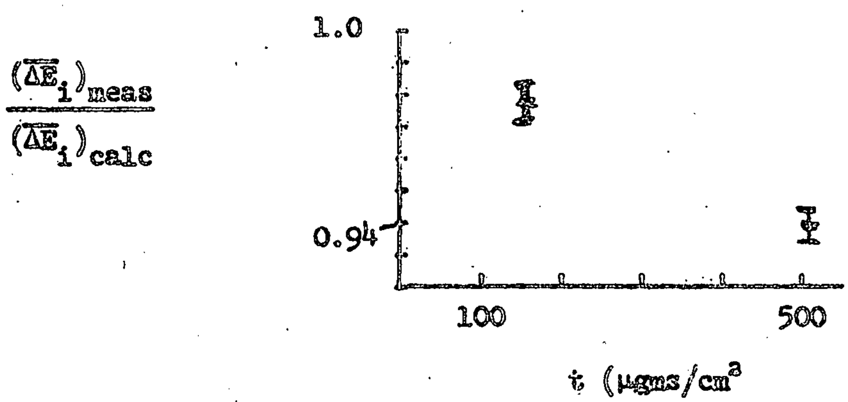

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EQUIPMENT REPORT

For the period March 1967 - March 31, 1968

PURCHASED WITH AEC FUNDS

Equipment Item		Purchase Date	Acquisition Cost
Gun mount for magnet*		Mar 14, 1967	2,000.00
Li-drifted Silicon detector		Mar 15, 1967	900.00
TC 200 amplifier		May 9, 1967	2,255.00
One ion source overhaul		May 25, 1967	105.00
Solenoid valve		May 26, 1967	225.00
Pipe for high pressure gas system*		July 31, 1967	258.20
Tally paper tape perforator		Aug 16, 1967	1,275.00
Interface Nuclear Data 181FM analyzer to Tally perforator		Aug 16, 1967	850.00
Canberra Industries		Aug 17, 1967	1,520.00
1 AEC bin	695.00		
1 Fast Coincidence	450.00		
1 Summing amplifier	350.00		
1 extended cable	25.00		
HeNe gas laser		Sep 5, 1967	200.00
Chart and printer paper		Sep 6, 1967	154.00
3 ion source overhauls		Sep 6, 1967	315.00
ND 161F single 12-bit w/dual singles ADC**		Sep 11, 1967	1,823.59
5 ball valves, 5 thermocouple gauges		Sep 11, 1967	408.00
2 Granville Phillips cold traps		Sep 11, 1967	796.00
5 2" high vacuum gate valves		Sep 11, 1967	450.00
Molecular sieve foreline trap		Sep 11, 1967	230.00
2 2" oil diffusion pumps		Sep 11, 1967	350.00
1 Phillips gauge (3 station) w/3 tubes		Sep 11, 1967	875.00
1 pedestal for support of quadrupole magnet		Oct 5, 1967	250.00
High vacuum plumbing and beam pipes		Dec 19, 1967	461.00

*Portion of expense charged to this contract.

**Our 1024 channel ADC was traded in for this 4096 ADC.

Equipment Report (continued)

PURCHASED WITH UNIVERSITY FUNDS

Item	Purchase Date	Acquisition cost
Pneumatic valve	Mar 13, 1967	700.00
magnet base*	Mar 1967	1,400.00
Cold traps	Jul 18, 1967	1,110.00
He^{++} ion source	Dec 1967	5,000.00
Ge detector and preamp	Jan 1968	6,000.00
Si detectors	Jan 1968	3,000.00

*Fraction paid by University for removal of gun mount from U.S.S. Tucson, and delivery to Tucson.

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