Fig. 1. Coincidence and single absorption in Pb of the gamma-rays of Na²⁴.

Mev β-ray is followed by *either* two 1.38-Mev γ-rays in cascade *or* by a 2.76-Mev γ-ray going directly to the ground state of Mg^{24}. The fact that the intensity ratio is 1, could be accounted for by assuming a branching ratio of 1:2. Both of these level schemes are consistent with the excited levels found in Mg^{24}.

It would be helpful in deciding between these two proposed level systems to know whether the γ-γ coincidences arise from two γ-rays each of 1.38 Mev or from one γ-ray of 1.38 Mev and one of 2.76 Mev.

In order to test this point, γ-γ coincidences were measured as a function of the thickness of Pb absorber interposed between the source and one of a pair of G-M counters. The absorption curve so obtained is to be compared with the absorption of all γ-rays in a single counter, taken at the same time with identical geometry. The results of such an experiment are shown in Fig. 1. Chemically pure NaCl was bombarded by 11-Mev deuterons in the external beam of the cyclotron. After all short periods had disappeared, the source, decaying with the proper 14.8-hr. period, was mounted approximately midway between two counters spaced 11 cm apart. Sufficient aluminum to remove all β-rays was placed on both sides of the source. The data in Fig. 1 have been corrected for decay, background, and chance. The errors indicated are statistical.

Because of the poor geometry (which must be tolerated in such coincidence measurements in order to minimize the statistical errors) no real significance should be attached to the absolute values of the absorption coefficients. However, it does appear significant that both the singles

and coincidence curves have the same slope at higher absorber thicknesses. If the coincidences were caused by two 1.38-Mev rays in cascade, one should expect a slope quite different from that which one gets for the mixture of 1.38-Mev and 2.76-Mev rays. The experimental slopes yield absorption coefficients which correspond theoretically to a γ-ray energy of 3 Mev. The slope corresponding to 1.4 Mev is shown for comparison. Since the 1.38-Mev and 2.76-Mev γ-rays have equal intensities and since their absorption coefficients in Pb are considerably different, one concludes from the curves that both the singles and coincident measurements involve the 2.76-Mev γ-ray as a component, i.e., the 2.76-Mev ray is in cascade with another γ-ray. The data do not warrant further resolution of the curves into components. Coincidence measurements in conjunction with a spectrometer should yield more decisive data.

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Nuclear Magnetic Resonance Absorption in Hydrogen Gas

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WE have recently observed nuclear magnetic resonance absorption[1] in hydrogen gas, at room temperature, and at pressures ranging from 10 to 30 atmospheres. The resonance occurs at the frequency and magnetic field strength corresponding to the g value for the proton, but the process of course involves both protons, in the orthohydrogen molecule only. The r-f coil, excited at 29.1 mc/sec., was enclosed in a small brass cylinder which was filled with tank hydrogen to the desired pressure. The volume of the coil itself was 0.5 cm³, and the volume of gas contributing to the observed effect was perhaps 0.8 cm³.

A single extremely sharp resonance line was observed, the width of which remained constant at 0.25 gauss, over the whole pressure range. This width may well be caused by field inhomogeneity and is to be regarded as an upper limit on the true width. The intensity of the line was directly proportional to the gas pressure. The sensitivity of our apparatus was such that at 10 atmospheres pressure the observed signal arising from nuclear resonance in the gas was roughly 15 times background noise on a voltage basis.

In molecular beam experiments[2] on H_2 the proton resonance is split into six peaks spaced over a region some 90 gauss wide, because of the interaction of the protons in the ortho-H_2 molecule with each other and with the field owing to the molecular rotation. In our experiment, however, a molecule suffers collisions at a rate much higher

than the radiofrequency itself, with the result that these local fields fluctuate rapidly and very nearly average out. The residual mean-square components of these internal fields, in a frequency band $\Delta\nu$, should be inversely proportional to the collision frequency, and the line width hence *inversely* proportional to pressure. A rough calculation of the line width on this basis yields the value 0.04 gauss, considerably smaller than the upper limit found experimentally.

On the other hand the process described is a potent one for thermal relaxation. It should lead to a relaxation time proportional to the pressure. We have measured the relaxation time by observing the onset of saturation as the r-f voltage is increased and find that the relaxation time does in fact *increase* with *increasing* pressure, and in a proportional manner within the accuracy of our measurement, which is not great. At 10 atmospheres the relaxation time is of the order of 10^{-2} sec., which is in fact the order of magnitude to be expected as a result of the process described.

We suggest that a related process may be important in liquids, and perhaps also in non-crystalline solids. The unexpectedly short relaxation time of protons in paraffin, for example, is well established.[3,4] If this view is correct, the rate of local rearrangements and rotations of the molecule and its neighbors may control the relaxation time in such substances, and in such a way that a slow rate, so long as it is greater than the radiofrequency, leads to a short relaxation time.

In any case the extreme sharpness of the H_2 resonance is of interest in connection with precise g value determinations. As was suggested by J. S. Schwinger at the beginning of this investigation, the H_2 absorption might be useful in measuring orthohydrogen concentration. We are interested in the eventual application of the method to He^3; in that case, however, thermal relaxation will presumably have to be brought about by other means, e.g., by admixture of oxygen.

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Long-Life Radio-Iodine *

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A Te target bombarded for 40 hr. with 14.5-Mev deuterons by the MIT cyclotron was received. The radio-iodine was separated in substantially quantitative yield without addition of carrier by oxidizing (heating to 200°C) the target with excess chromic and sulfuric acids, adding water, and reducing to free iodine by heating with phosphorous acid. Addition of a small amount of oxalic acid after the reduction by phosphorous acid served to complete the reduction, but without the usual frothing experienced when oxalic acid is used alone in large quantity. During the reduction, the iodine was distilled in a brisk stream of air into a dilute solution of sodium carbonate and sodium sulfite.

An aliquot of the solution showed considerable activity 6 months later, which was incompatible with the known radio-isotopes.

On addition of iodide as carrier, the bulk of the activity was found to precipitate with silver iodide, and was extractable into carbon tetrachloride after oxidation with iodate Upon injection into rats, large fractions of the carrier free material injected could be found in the excised thyroid glands

The emission of material freshly reseparated by CCl_4 extraction was studied using a mica-window Geiger-counter tube Aluminum, copper, and silver foils were used to determine absorption characteristics, with corrections made for obliquity of the paths through the foils. An x-ray with $\mu = 22.7$ cm^2/g Ag, 15.1 cm^2/g Cu, and 1.51 cm^2/g Al was found. This is equivalent to an energy of 27.0 kev and corresponds to the $K\alpha$-radiation from tellurium, indicating K-electron capture by iodine.

A particle emission of weak energy having an absorption coefficient of about 270 cm^2/g Al, corresponding to a maximum energy of *ca.* 0.1 Mev ocurred once to about every forty K-electron captures. No γ-ray was found.

A half-life of about 56 days was found for the I_2. The total long-life iodine activity of the target 235 days after bombardment was about 930 μCuries. That would amount to the order of 10 milliCuries at bombardment end.

Another activity was found in the iodine solution. It was not removable by boiling. Sodium tellurite was added as a carrier to the mixture, and the tellurium precipitated with SO_2. This was redissolved in KCN, a sample made and counted. The foreign activity was found to have quantitatively followed the tellurium. It decayed with a long half-life (>200 days) by particle emission (no γ-rays observed) with an absorption coefficient of 5.1 cm^2/g Al (*ca.* 1.6 Mev). Its maximum activity was only about 1 disintegration per 1000 K-electron captures.

Two other targets we have examined have furnished radio-iodine with the same properties. It seems probable that the new iodine is the missing I^{129} formed by a (d, n) reaction on the abundant Te^{128} (32.8 percent)[3] or by β-decay of a (d, p) produced Te^{129}. If the I^{129} is the isotope produced as a decay product of the 72-minute half-life Te^{129}, there is present the unique case of isomeric transition through β-decay and subsequent K-electron capture.

The position of the Te* in the scheme is not clear. It may be an impurity; however no such long-lived Te isotope is listed in Seaborg's table.[4] If it were a daughter of the I* which had been building up after the last I_2 separation, it would then have a half-life of about 10 or 400 years depending on the channel responsible for its production. With the activities available, no estimation as to