Pressure and Temperature Measurements in the Upper Atmosphere

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THE October 10 V-2 firing at White Sands, New Mexico, gave interesting atmospheric pressure data in the region from 50 to 90 km above sea level.

The nose-tip of this rocket was made in the form of a cone of 13° apex angle. A ring of holes around the cone afforded connection between the exterior surface and the interior instrument compartment. Additional pressure measurements were made at a point near the tail of the rocket. Experiments by Taylor and Maccoll[1] show that the pressure on the side of a 13° nose cone should be about 1.8 times ambient when the rocket velocity is about 1 mile per second. German wind-tunnel measurements indicate that the tail section gauges should read ambient pressure to within about 10 percent.

Two different types of gauges gave usable data, their readings being transmitted by radio to a telemetering ground station.[2]

Pressures in the lower atmosphere were measured by a sylphon bellows gauge at the tail position. Bellows displacement was transformed into shaft-rotation of a Microtorque potentiometer. This gauge was designed to cover the range from 760 to 15 mm Hg, but broke at a pressure of 150 mm evidently from vibration. Figure 1 A shows the correlation with data computed from Weather Bureau temperature measurements taken over El Paso, Texas, (80 miles distant) at 8:00 A.M. the morning of the flight. Note the deviation when the rocket reached the speed of sound (Mach number = 1).

Tungsten wire Pirani gauges in nose and tail gave satisfactory data. These consisted of 6-watt, 110-volt Mazda pilot lamps with a hole in the bulb tip. The tail gauge measurements are plotted in Fig. 1B. The points determined from the nose gauge lie almost exactly on the same curve. The twofold increase in pressure predicted by Taylor and Maccoll is absent. The discrepancy is unexplained to date, and is most surprising, since on the one hand, some pressure build-up can be predicted from elementary considerations, while on the other hand, a factor of 2 difference in gauge performance is hard to believe. Further studies should clarify the matter.

For comparison with the present observations NACA atmospheric pressure values based on assumed standard temperature[3] are shown by the dashed line in Fig. 1B. The good agreement obtained confirms the essential validity of the assumptions underlying the NACA curve, which is based entirely on indirect evidence. The bend in the solid curve between 60 and 80 km confirms the existence of the negative temperature gradient predicted by the NACA.

Because of the high V-2 velocity and the rapid rate of change of pressure with altitude, it was possible to fix within ±2 sec. the time of maximum altitude by noting the times on the ascent and the descent at which the pressure had a certain value; namely, 0.05 mm Hg. From this, a peak altitude of 108±2 miles was computed.

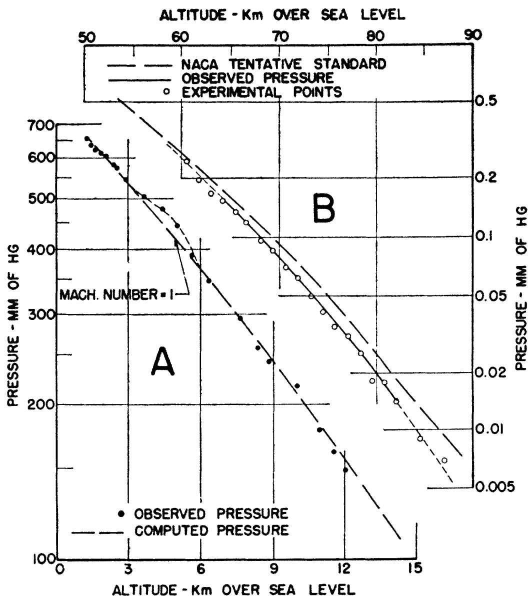

FIG. 1. Pressure measurements in the upper atmosphere. A. Bellows gauge. Use lower and left-hand scales. B. Platinum Pirani gauge. Use upper and right-hand scales.

Eleven platinum resistance and thermistor temperature gauges were installed to measure the adiabatic air temperature and the skin heating. The highest skin temperature observed was 180° C on a 0.3-mm wall section in the control chamber. Further results will not be published at the present time, pending a more complete analysis.

[1] G. I. Taylor and J. W. Maccoll, Proc. Roy Soc. **139**, 278 (1933).
[2] Naval Research Laboratory Report R-2955, Chapter II, Section C, (October 1, 1946).
[3] National Advisory Committee for Aeronautics, *Tentative Tables for the Properties of the Upper Atmosphere* (Prepared by Calvin N. Warfield), Table III—(Sept. 1946).

On the Disintegration Scheme of Na^{24}

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WHAT appear to be the most reliable measurements on the disintegration of Na^{24} suggest a simple beta-particle spectrum with an end point of 1.39 Mev and two gamma-rays of about equal intensity with energies of 1.38 Mev and 2.76 Mev.[1]

Experiments on the inelastic scattering of protons and neutrons[2] by the Mg nucleus indicate excited levels at 1.3 Mev, 2.74 Mev, and 3.88 Mev.

The existence of γ-γ coincidences[3] and the fact that their intensities are equal suggests that the 2.76-Mev and 1.38-Mev rays are in cascade. However, Sachs[4] in a recent letter, has called attention to the fact that such a level system would yield a mass for Na^{24} which would be in disagreement with the value predicted by Barkas.[5] He has, therefore, proposed an alternative scheme, whereby the 1.39

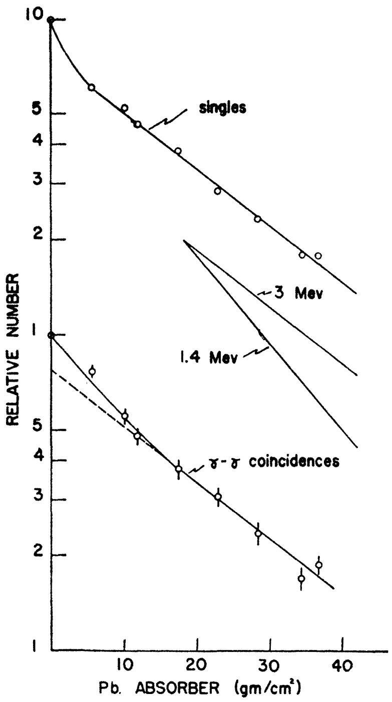

FIG. 1. Coincidence and single absorption in Pb of the gamma-rays of Na^{24}.

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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[2] R. H. Dicke and J. Marshall, Jr., Phys. Rev. **63**, 86 (1943). R. N. Little, R. W. Long, and C. E. Mandeville, Phys. Rev. **69**, 414 (1946).
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[4] R. G. Sachs, Phys. Rev. **70**, 572 (1946).
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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 cm^3, and the volume of gas contributing to the observed effect was perhaps 0.8 cm^3.

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