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Radiation Laboratory

Contract No. W-7405-eng-48

SUMMARY OF THE RESEARCH PROGRESS MEETING

of September 28, 1949

H. P. Kramer

November 14, 1949

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Snow. U. Nakaya.

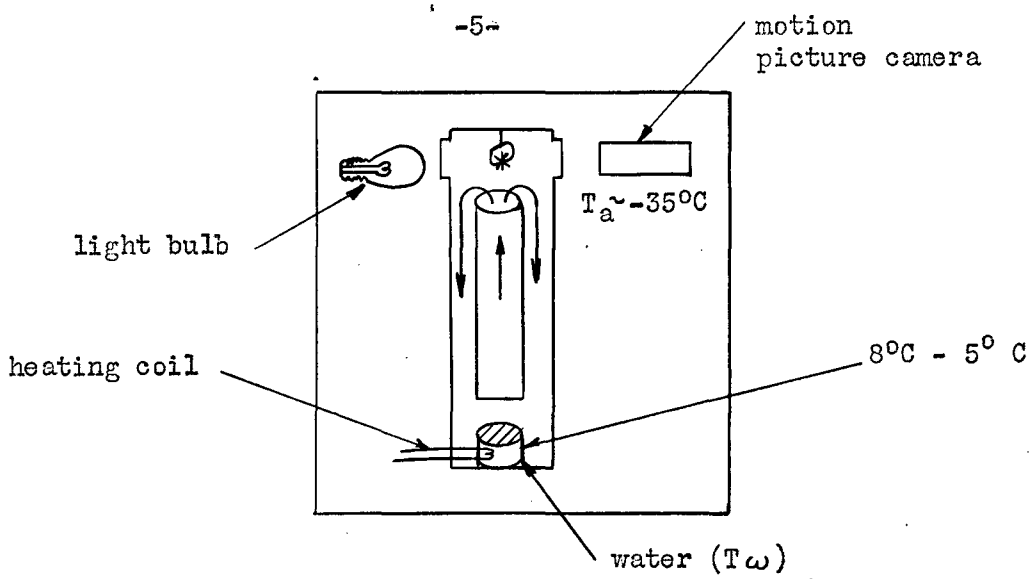
Note: Professor U. Nakaya of the University of Hokkaido, Japan, was a visitor at the Laboratory and in a talk at the Research Progress Meeting described his work on the growth of snow crystals. The presentation was enlivened by motion pictures of growing crystals which were speeded up in order to make the growth apparent.

In the course of twenty years of research about four thousand microphotographs have been taken of snow crystals in the processes of growth. The basic pattern of the crystals is always hexagonal although a large number of variations are found in structure. A correlation is possible between structure and conditions of temperature and water vapor saturation so that every crystal tells the story of its formation and subsequent history. Since snow forms at approximately 3 km. above sea level, the structure of a crystal represents a record of the atmospheric conditions through which it passed on its 2-3 hour descent. During the last war, this information helped in providing the Japanese Air Forces with meteorological data.

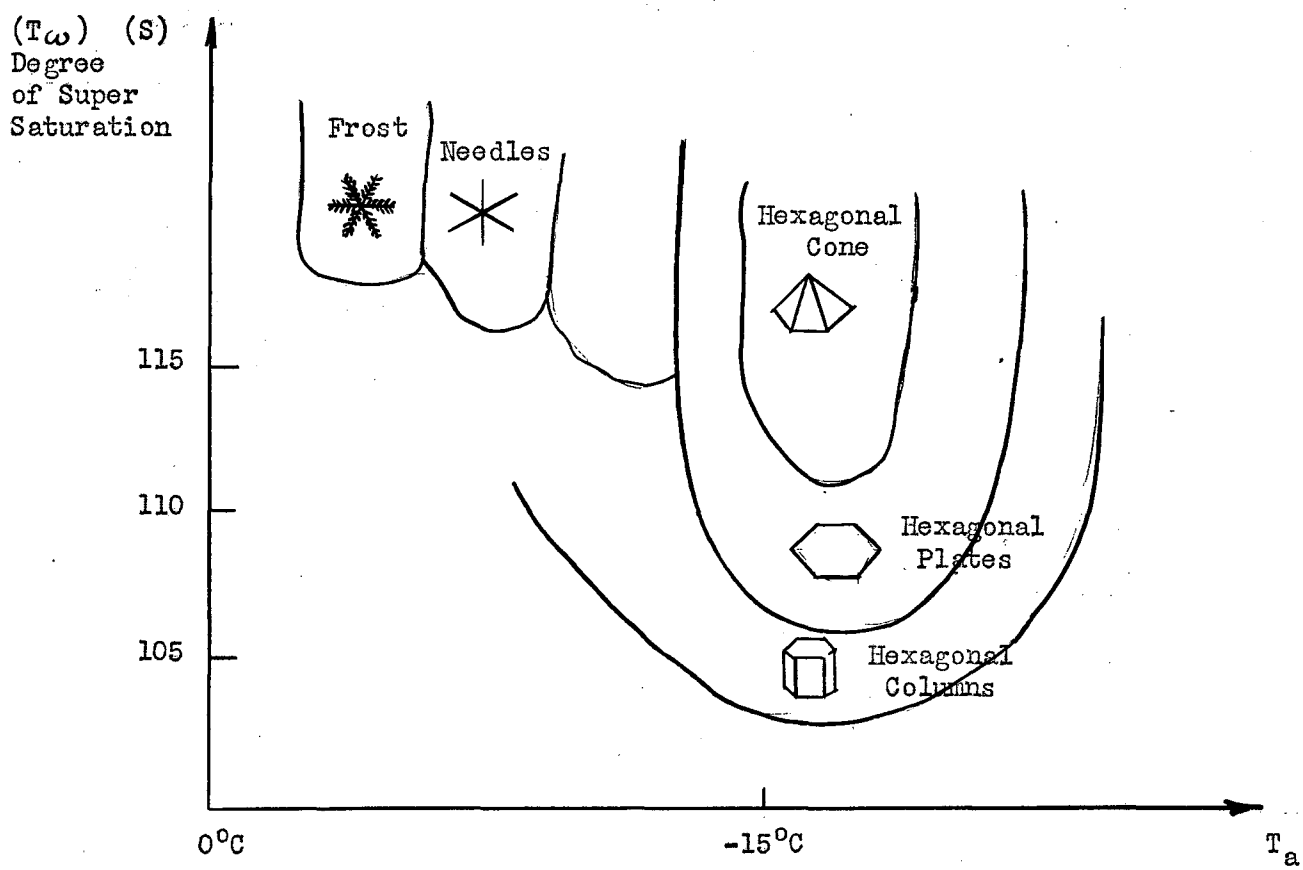
In order to study the formation of snow crystals the chamber shown in Fig. 1 was used to simulate favorable weather conditions in the laboratory. A vertical tube was placed in the chamber whose temperature was maintained at about -35° C. A vessel of water was heated to -8° C - 5° C by a resistance coil. Water vapors rising from the surface of the dish of water are carried

up the inside and down the outside of an open tube of smaller diameter in the convection current set up by the temperature differential. A fine rabbit hair is stretched in a yoke which is suspended from the top of the chamber. Snow crystals form on nuclei of minute bulges in the rabbit hair. Windows in the walls of the chamber make it possible to illuminate and photograph the growing crystals.

Fig. 2 gives an indication of the correlation between crystal shape and condition of formation that has been possible with the afore-described apparatus.



Apparatus for Growing Snow Crystals
Fig. 1



Distribution of Crystal Structures
Fig. 2

Polonium Isotopes. D. Karraker.

In order to produce polonium isotopes, lead was bombarded with α-particles and bismuth with protons. Since tellurium has chemical properties that are analogous to those of polonium, tellurium was added to the target after bombardment to serve as a carrier for polonium. The last step in the separation of carrier-free polonium consisted therefore in the isolation of polonium from tellurium.

A new polonium activity was discovered to result from the bombardment of enriched (27 percent) Pb^{204}. Since polonium isotopes of mass number in excess of 206 are known, and since, moreover, the (α,3n) reaction is the only one which at the bombarding energy of 40 Mev might produce an isotope of mass number less than 206 in good yield, the new activity was assigned to mass number 205. The Geiger decay curve was almost hyperbolic and therefore yielded no useful information. The energy of the α-particle emitted by the new isotope was found on the pulse analyzer to be 5.2 ± 0.1 Mev. A preliminary estimate of the branching ratio of K capture to α-emission is 10^4.

An additional 40 min. polonium activity was discovered which was assigned to mass number 202 on the basis of periodic milkings of the bismuth daughter.

Some work has been done in checking the mass assignments by milking the thallium decay products where assignments are firmly established and they are produced from the only stable gold isotope, Au^{197}. A relation has been demonstrated between the 27 hour Tl isotope and the 4 hour Po activity.

Table I below summarizes the present status of this section of the Table of Isotopes.

Details of the work are reported in UCRL 311 and UCRL 382.

	198	199	200	201	202	203	204	205	206	207	208	209	210
Po					40 m.	37 m.	4 h. 5.35 Mev α	1.5 h. 5.7 Mev α	9 d.	5.7 n.	3 yr.	50-200 yr.	140 d.
Bi		27 m.	33 m.	55 m. / 105 m.	2 h.	12 h.	12 h.		6.4 d.				
Pb	25 m.	20 m.	18 h.	8 h.	long	52 h.	68 m.						
Tl	1.8 h.	7.3 h.	27 h.	75 h.	12 d		3 y.						

Table I

Capture of π^- Mesons in Hydrogenous Material. W. Panofsky.

In photographic plates exposed to mesons produced in the 184 in. cyclotron it has been observed that about 75 percent of mesons produce stars in the emulsion. Such stars are evidence of the capture of a π^- meson by a nucleus, the excitation of the nucleus, and the subsequent emission of charged particles. It is felt that those π^- mesons that end in the emulsion and do not produce stars interact with free protons to produce either a neutron and γ-rays directly or else a neutron and a neutral meson that decays with the emission of two photons. The first mentioned mechanism is the most favored one from a theoretical standpoint but the work of B. Moyer and H. York (UCRL 439) points to the possibility of the existence of neutral mesons from proton nucleon collisions that decay by the emission of two high energy photons.

In order to examine the mechanism of the capture of π^- mesons by hydrogen nuclei, the experiment sketched schematically in Fig. 3 was set up. The 345 Mev proton beam of the 184 in. cyclotron is aimed at a carbon target whose cross-section for the production of π^- mesons is known. A block of CH_2 or LiH placed at a larger radial distance from the center of the cyclotron than the carbon target serves for a medium in which π^- mesons can be captured by hydrogen nuclei. The γ-rays that are emitted in consequence of this capture are analyzed and counted by a pair spectrometer of the type that has been employed by B. Moyer and H. York.

Assurance that γ-rays that are observed by means of the pair spectrometer do not originate from the action of protons in the carbon target is gained by running the apparatus without the block of CH_2 or LiH and moving the target until the pair counter is shielded from the carbon target and the number of γ-ray photons counted does not exceed the background.

Some calculations were carried out to determine the expected number of counts of γ-ray photons from the capture of π^--mesons by protons in CH_2 and LiH. One must take into account the probability f of capture by C and Li nuclei. The expected number of counts together with the preliminary results obtained are displayed in Table I.

Secondary Target	γ-Energy	Counts/hr.		
		From Geometry	$\sigma_{\pi^0} = 1/3\ \sigma_{\pi^-}$	Observation
CH_2	135 Mev	5100 f	6700 f	0 $\pm$ 2
LiH	135 Mev	1500 f	1400 f	.5 $\pm$ 2
LiH	65 Mev	1500 f	1400 f	-1 $\pm$ 4

Table I

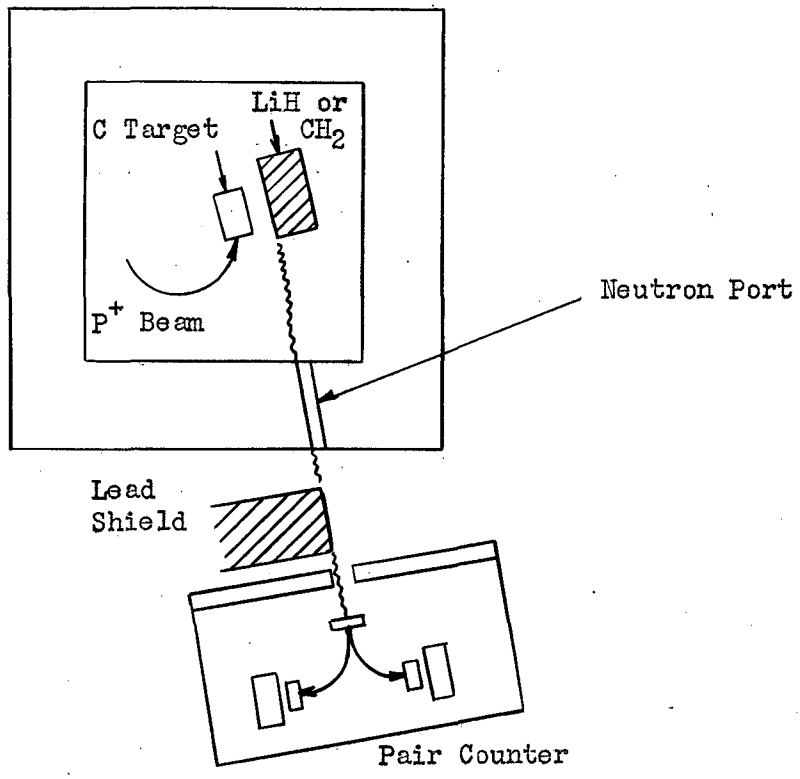

LiH or
CH_2
C Target
P^+ Beam
Neutron Port
Lead
Shield
Pair Counter

Fig. 3

Here, the column headed "From Geometry" gives the expected number of counts per hour calculated on the basis of the above described geometry, and the column headed by "$\sigma_{\pi^0} = 1/3\,\sigma_{\pi^-}$" gives the expected number of counts of decay γ-photons on the assumption that the γ-photons from neutral mesons have not been eliminated by shielding.

The negative results may be due either to a low value of the fraction f ($f < 10^{-3}$) or else to the lack of validity of the theory that predicts γ-rays to be emitted in conjunction with the capture of π^--mesons by protons. It is thought that it will be worthwhile to test the theory under more favorable circumstances. For this purpose, compressed hydrogen (f=1) will be used at p = 200 atm., T = -75° C and hence with a density of $\rho = .04$ gm/cm^3 instead of hydrogenous compounds in the secondary target. Since it is necessary to perform the experiment in the internal beam of the cyclotron because of the low inherent counting rates, a pressure chamber will be constructed to prevent leakage of H_2 into the vacuum tank of the 184-in. cyclotron.

Plans for the Full-Scale Bevatron. W. Brobeck.

Tests on the one-quarter scale model have crystallized the design by settling several problems that had been unanswered questions. The arrangement that divides the machine into four quadrants is satisfactory. An aperture of two feet in height and six feet in width will be sufficient for a beam of good intensity. The magnet is constructed in 2 1/2° sections of laminated steel plates. The steel plates will be individually grounded. A sample section has been completed and is available for tests. The design of the magnet calls for 9000 tons of steel. 1000 feet of the cable for the magnet coils has been manufactured. Construction on the building started on September 1. It is

expected to be complete June 1, 1950. It is expected that the machine will have been completed by the end of 1951. Although the present design of the magnet provides for a two-foot aperture, it is hoped that after the machine is completed the intensity can be increased still further by reducing the aperture to one foot.

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ead/11-14-49