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UCRL-1798

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

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MONTHLY PROGRESS REPORT
No. 108

March 15, 1952 to April 15, 1952

May 2, 1952

CLASSIFICATION CANCELLED
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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

March 15, 1952 to April 15, 1952

MONTHLY PROGRESS REPORT No. 108*

May 2, 1952

1. BEVATRON
(A.E.C. Program No. 9500) UNCLASSIFIED

General

Initial tests at Brookhaven have resulted in a 30 Mev beam and indicate that the UCRL 1 ft. x 4 ft. aperture will be quite adequate.

Coil Winding

There has been no coil winding during this period because the supply of vendor-furnished coil spacers has been exhausted. Due to the unreliable delivery and quality of the vendor-furnished spacers (molded of asbestos filled phenolic bakelite), the 1400 remaining spacers will be machined from masonite "Benelex 70" in the UCRL shop. Seven weeks are required to complete the winding after the spacers become available.

Magnet

Preparations are being made for the magnet tests (without pole-pieces) scheduled for this summer. The possibility of trouble from residual magnetism and transient ripples in the current as it approaches zero is being investigated. Tests have indicated that every pole tip plate instead of alternate plates should be enameled. Magnet model tests are continuing to determine the final pole plate outline necessary to obtain the desired shape and useful radial depth of the field. Earliest possible delivery of steel plate for the pole bases and tips is during the third quarter of 1952.

Bearing protection for the motor-generators is being investigated. The latest suggestion by the manufacturer is that a belt-driven oil pump be connected to the motor-generator shaft to provide bearing lubrication while the machine is coasting in case of power failure.

Vacuum System

For the curved tanks, fabrication of the drilling jigs has been completed and all other major parts are in various stages of procurement or fabrication except for the Corner Bars (specifications about to be started), the Curve Tank

* Previous report UCRL-1746 (No. 107)

SECRET

Filler Frame (design just completed), and the Handling and Assembly Fixtures (50 percent designed).

The transition tanks will be fabricated by the Atlas Pacific Engineering Company. The promised delivery is two tanks by July 1 and the other six tanks by September, if material is delivered on schedule.

Design is in progress on the refrigeration piping and almost completed on the forevac oil system.

Accelerator Tube

It has been decided to use a single drift-tube and to increase the operating voltage from 22 kv to 30 to 40 kv. As a result, additional Ferroxcube cores are being ordered for the self-tracking amplifiers.

Linac

The tank is now vacuum tight. The drift tubes have been installed in the liner and alignment and gap adjustments are being made.

2. 184-INCH CYCLOTRON OPERATION (A.E.C. Program No. 5741) UNCLASSIFIED

The cyclotron was used for research experiments approximately 96 percent of the 586 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	566.00 hours	96.6 percent
Routine maintenance	2.75	0.5
Electrical troubles	12.50	2.1
Other	4.75	0.8
Totals	586.00 hours	100.0 percent

3. 60-INCH CYCLOTRON OPERATION (Operated by the University of California) UNCLASSIFIED

Operation during this period was as usual, being at an efficiency level of about 80 percent. The only deficiency was a recurrence of the east U-house water leak. Repair was made, providing for a shield around the errant gasket. The machine has been operating since the repair without recurrence of the difficulty.

4. SYNCHROTRON OPERATION
(A.E.C. Program No. 5731)

Operation

The synchrotron operated satisfactorily until the end of March. At this time a crack developed in one quartz section, ruining the vacuum. Two days were spent in trying to patch the crack with araldite coating resin. At first this was successful, but failed after running the synchrotron a few hours.

The only recourse, then, was disassembly of the magnet and replacement of the cracked vacuum donut segment. Disassembly and assembly was accomplished in two days. As is always the case when the machine is disassembled, a complete retuning of the synchrotron, betatron cycle is necessary. A beam was found quickly after assembly but has not yet been of high enough intensity to be usable for the majority of experiments. The cloud chamber group has been using the beam during this adjusting period.

Search for the set of conditions that will increase beam intensities has been conducted at near the 200 Mev energy level. This is lower than peak magnet energizing voltage with a proportionately lower rate of rise of magnetic flux in the magnet circuit. The tuning controls are not so critical at this level and it is easier to change modes of compensation. When the intensity increases to a reasonable value, it is planned to continue the adjustments and bring the energy of the beam up to its normal 322 Mev.

Statistics

Operating statistics are as follows:

Operation for customers	256.95 hours	67.98 percent
Tests with synchrotron	53.50	14.15
Maintenance	67.55	17.87
Totals	378.00 hours	100.00 percent

5. LINEAR ACCELERATOR AND VAN DE GRAAFF OPERATION
(A.E.C. Program No. 5751)

UNCLASSIFIED

Operation

The preliminary converter and oscillator for the proposed Van de Graaff regulation system are built. Delivery on the Collins FM - IF amplifiers is expected within the next week, at which time the work will be continued on the integration of these units into a working system, giving a control signal which is a function of the rf phase of the linear accelerator and the output current phase of the buncher.

A continuous non-interrupting linear accelerator beam current monitor has been built which is now ready for preliminary installation. It consists of two, 10,000 turn toroids in series, enclosed by a triple magnetic shield. At present it will allow visual observation of the current waveform. Work is in progress to integrate this pulse for direct measurement.

The presentation of a scope "picture" representing the gradient vs. length of the linear accelerator as seen by diode loops is being held up while further work is done to make the input signal to the radial beam unit similar in its characteristics to the "slideback voltmeter."

Statistics

Running time	63 percent
Maintenance	12 percent
Repair	25 percent

6. EXPERIMENTAL PHYSICS (A.E.C. Program No. 5211)

UNCLASSIFIED

Film Program

Studies of Meson Production by Nucleon-Nucleon Collisions. An experiment to test the charge symmetry hypothesis is under way.

Mu Meson Interaction with Matter. Work is continuing on separating by grain counting the π meson contamination from the μ mesons. This is necessary to establish whether negative μ mesons ever produce multiple-prong stars.

Meson Masses and the Energy Balance in Meson Decay. An experiment has been carried out to determine the distribution of meson production through the volume of the target used in the meson mass experiments. This information is necessary because the target is finite in size. It was found that the activity of the target was uniform throughout its radial dimension of 0.040 inch. A number of such auxiliary experiments will be necessary to establish the magnitude of small corrections to the data thus far obtained.

Large Angle Meson Scattering. Scanning of C_2 emulsion detectors is continuing to obtain the large angle scattering cross section of π^- mesons in Al, Cu, and Pb.

Meson Spectrometer. Studies are being made of the vertical focusing and the resolution of the spiral orbit type spectrometer.

High Energy Beta Spectra. For study of such beta spectra as that of N^{12} the position of the stable orbit and the momentum resolution of the existing spiral orbit spectrometer are being investigated.

High Energy Electron Processes. Study of nuclear scattering of high energy electrons in emulsion as well as pair production and high energy electron-electron collisions are continuing. Study of the grain density of tracks beyond the ionization minimum is also being attempted.

Diffraction and Coulomb Scattering of 340 Mev Protons in Lead. No new results have been obtained on this experiment. The present plates can be analyzed, but another experiment is planned to improve the quality of the plates before undertaking an extensive scanning program.

Spall Analysis. Plates suitable for analysis have now been obtained of the mass-charge spectrum of disintegration products of Be, C, Al, Cu, Sn, Au, and U. Fragments in three momentum intervals are being studied. In each case the proton beam at 79 inches in the 184-inch cyclotron was used to bombard thin targets of the elements being investigated.

Cloud Chamber

Work on 90 Mev neutron-induced stars in helium has been completed and a report is now being prepared for project distribution.

Film reading and data tabulation is being done on the following problems: n-p scattering by 90 Mev neutrons, meson scattering in aluminum, 270 Mev neutron induced stars in oxygen, 270 Mev neutron induced stars in helium, and 90 Mev neutron-induced stars in carbon.

The pantagraph cloud chamber was prepared for a run in the proton beam, for three different experiments to be done in succession: a determination of the μ-electron decay spectrum, an investigation of the origin of electrons which were detected with counters, and a measurement of the binding energy of protons in beryllium by the bombardment of a beryllium target with protons and the observation of the three protons coming out.

The Triton Reaction $p + d \longrightarrow \pi^+ + t$

The effort this month was spent in calculating time of flight correlations and in constructing a new scattering table for an improved geometry and in developing improved instrumentation for an expected two day run on the cyclotron.

The Photoproduction of Negative Pions from Deuterium

Calculations have been made on the absorber thicknesses and time of flight correlations for an angular distribution. Also, improved triple coincidence circuits were constructed for the expected run on the synchrotron.

Neutral Meson Gamma Ray Spectra

The absolute cross section for the production of neutral meson gamma ray has been measured in the external 340 Mev proton beam. The gamma ray spectrum emitted at 90° to the incident proton beam is measured with a pair spectrometer, while the incident proton beam is monitored with a calibrated ionization chamber. This measurement, correlated with the relative gamma ray yields from carbon targets bombarded by the internal beam, makes it possible to determine the spectra for all angles on an absolute basis, and, therefore, to calculate the cross section for production of neutral mesons for 340 Mev proton bombardment of carbon.

Cross Sections for Products of 90 Mev Neutrons on Carbon

Another run of the spinning disc method has been made to separate Li^8 and He^6 activities by selective beta absorption. The results indicate that both are present, although more detailed calculation must be done to determine the exact amounts present. More data is being gathered on the production of Be^7. Preliminary results indicate a cross section of about 10 millibarns.

The cross sections obtained by beta activity are: B^{12} 5 ± 1 mb, Li^8 2 ± 1 mb, He^6 1 ± 0.5 mb, C^{10} 2 ± 1 mb, and Be^7 10 ± 5 mb. (Cloud chamber measurements indicate a minimum value of 4 ± 1 mb).

Low Energy Pair Spectrometer

The design has been completed for proportional counters for the low energy pair spectrometer and submitted to the accelerator technicians for building. The wire method is being used for measuring orbits in low energy pair spectrometer.

A Study of the Pick-up Process in Proton Deuteron Scattering

The results of experiments under this heading are in the process of analysis and will be written up in the form of a thesis and circulated as a UCRL report. It is expected that this will be completed about the first of June.

Magnetic Particle Spectrometer

The spectrometer method for determining momentum distribution in nuclei is being modified. Previously the spectra obtained represented integrals over a momentum distribution; using the new method the momentum distribution will be obtained directly. To do this two protons are counted from a single collision, both the incident and struck particles. This is done by placing a scintillation counter telescope at 90° to the direction of the particle entering the spectrometer and requiring coincidences between the two protons. The energy resolution of this modified spectrometer is being calculated. Also, the relation between

the energy of the particle entering the spectrometer and the energy of the struck nucleon has been calculated. To improve the energy resolution of the spectrometer narrower GM tubes are being constructed. To make use of the line character of the scattered deflected beam of the 184-inch cyclotron, a stand is being built to elevate the spectrometer magnet such that the line will be perpendicular to the pole faces of the magnet. This will allow use of the full length of the beam and will give an intensity gain of a factor of 4.

High Energy Electrons Produced by 340 Mev Protons on Carbon

Several experiments are in progress to determine if the production of electrons and positrons of high energy from carbon is compatible with the shower electrons expected from neutral meson decay gamma rays. The apparatus consists of a magnetic channel for energy resolution and time of flight detectors to identify the electrons.

Nuclear Elastic Scattering of 300 Mev Neutrons

The most recent run with the neutron elastic scattering setup indicates the angular distribution of the elastically scattered 300 Mev neutrons on copper and lead correspond roughly to diffraction patterns from spheres. However, the intensities of the patterns obtained are substantially below those predicted by the theory of the opaque nucleus.

Pi^- Meson Capture in Hydrogen and Deuterium

Computation of electron orbits based on the magnetic field measurements and a study of the theoretical resolving power of the pair spectrometer was begun. Analysis of the data from the deuterium reaction was essentially completed.

Neutron Time of Flight Experiments

An electronic synchronizing unit to synchronize the electrostatic deflection of the 184-inch cyclotron with the radio frequency has been developed and is almost completed. Investigations on the accuracy of photographic techniques involved in this method are continuing. Equipment is being constructed for a preliminary experiment on n-p scattering at low neutron scattering angles at 90 Mev.

$p + p \rightarrow \pi + d$

A. Proton-proton scattering has been used to check instrumentation to be used on the absolute cross section of the reaction $p + p \rightarrow \pi + d$ for center of mass angles greater than 45°. At these angles the separation of the deuteron from the proton beam is about five degrees, and it is hoped to be able to dispense

with the magnetic field used at smaller angles to separate the reaction products from the proton beam, reduce other charged background, and aid in identification. The magnetic field complicates the solid angle calculation, since the photomultipliers must be placed outside the region of strong field. The instrumentation tested consists of scintillation counters, 10^{-8} sec electronic resolution, and 3×10^{-9} sec oscilloscope resolution. Pulse height and time of flight are used to help bias out fast proton background in the deuteron and aid in identifying the reaction products. The tests indicate the electronics to be satisfactory. However, large fluctuations in scintillation counter pulse heights make it difficult to plateau the real event without bringing in excessive accidentals from fast protons, at desired beam levels. Present efforts are directed to reducing pulse height fluctuations by increasing the light gathered.

B. Some tests were made on the effect of magnetic fields on the operation of RCA 5819 photomultipliers, using Helmholz coils which gave a fairly uniform field over the critical region. It was found that a transverse field of 0.5 gauss could change output pulse height by 20 to 30 percent, increasing or decreasing it depending on relative orientation of tube, field, and the earth's field. A longitudinal field of 1.5 gauss, of either sign, reduced output pulse height by about 30 percent.

Photoproduction of Pi^{o} Mesons

Little progress has been made this month due to a shutdown of the synchrotron.

Elastic Proton-Deuteron Scattering Using 345 Mev Protons.

A preliminary trial using specific ionization measurements (pulse height from thin stilbene crystal) and total energy measurements (pulse height from thick sodium iodide crystal) to identify deuterons in the presence of many protons has been unsatisfactory. Several refinements have become obvious, and will be tried.

Proton-Proton Scattering at Reduced Energies (160 to 250 Mev).

Fabrication of the liquid hydrogen vessel with a thin aluminum or stainless steel wall is still not successful, although there is yet hope that the target may soon be finished, based on partial success with various designs.

Total Proton-Proton Scattering Cross Section (345 Mev).

A different liquid hydrogen target has been designed and submitted for construction, for the purpose of measuring the total proton-proton scattering cross section by attenuation of the proton beam. Primarily the experiment will be designed to resolve discrepancies between work here and work at other laboratories. The proton beam will be passed through a cylinder 8 inches in diameter and 20 inches long containing liquid hydrogen. The beam will move along the axis of the cylinder. Attenuation of the beam by scattering through more than 8 degrees will be measured using a large liquid scintillation counter constructed in connection with another experiment.

Synchrotron Studies.

About the first of April the synchrotron developed a leak in the tubulation on one of the sections of the quartz donut. Attempts to repair it failed, and so the machine had to be dismantled, the quartz replaced. As has too often happened in the past, it is taking a long time to get the beam back to full intensity at full energy.

Before the shut down, the excitation function measurements of photo-neutron production were completed. Measurements have been made at maximum beam energies of 40, 80, 120, 160, 200, 240, 280, and 320 Mev. The results show appreciable yields above 140 Mev for all substances measured. The exact shape of the yield versus energy curve above the "dipole resonance" is not certain, but the yield in the region of 150 Mev may be connected with virtual meson production.

Some further measurements have been made on the annihilation of fast positrons in Be. The results obtained agree with the theory of annihilation of positrons in flight.

The production of $\pi+$ mesons at small angles to the γ-ray beam from H and D is to be investigated. It is planned to use the pair spectrometer magnet to bend the mesons into the counter system. Preliminary runs with the pair magnet close to the collimator have given satisfactory γ-ray intensities, so the experiment seems quite feasible, provided the meson yield is not too small.

Several days were also spent in making measurements of the magnetic field around the synchrotron orbit. These measurements showed a fairly uniform field with four sharp dips in it. No satisfactory "explanation" of this field distribution has been found. Taking such measurements is a time consuming process and at present it does not seem worthwhile to try to make adjustments until a similar field plot can be obtained, especially when it is still uncertain how small a change in field may cause an appreciable loss in intensity.

7. THEORETICAL PHYSICS
(A.E.C. Program No. 5211)

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Work is continuing on the meson exchange contributions to the deuteron photo effect.

Investigation of the effect of a singular tensor potential on high energy p-p scattering and calculations of polarization effects is continuing.

The program of fitting nuclear force parameters with ps-ps meson theoretical potentials is essentially completed for the low energy data. The high energy scattering will be investigated.

Effects of binding and multiple scattering in nucleon-nuclei interaction are being investigated.

Work continues on non-linear pseudoscalar meson theory.

The calculation of the π^0 meson production by photons from deuterium has been completed for the elastic and inelastic production. It is found that to determine the algebraic sign for the nuclear coupling constant it is necessary to perform experiments in the elastic case, i.e., where the deuteron is not disrupted in the process of meson production.

8. THE M.T.A. PROGRAM (A.E.C. Program No. 9200)

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Mark I Operation

The goal for the present operation of Mark I is to obtain a gradient sufficient for acceleration of protons to 15 Mev. This requires an end to end tank potential of 22.5 megavolts. Twice this voltage is needed for the acceleration of deuterons to 30 Mev. The rf voltage will first be applied to the cavity without exciting the drift tube magnets and later with all magnets excited. At the present time the rate of rf voltage build-up in the tank is 1/3 megavolt per hour of "on time". After the cavity has attained the correct voltage and the injector has been tested, a low current proton beam will be accelerated. A Faraday cup will be used to measure the beam current.

All the drift tube magnets, with the exception of No. 8, are presently being tested while rf voltage is fed into the tank. The beam precessor and the injector have been assembled and are ready for operation in the near future.

Some sparking that occurred between drift tubes No. 0 and No. 1 has been eliminated by removing all the bolts on the No. 1 drift tube and soldering a copper strip over the holes. Since the sparking caused some pitting of the surfaces, both drift tubes have been recleaned and electro polished. To prevent sparking after the tank voltage has reached peak voltage the tank will be discharged by the crow bar method. An x-ray detector unit has been added to determine the frequency of sparking.

In the first series of trials the top voltage was in the range 19 to 19.5 Mev.

A-12 Accelerator Design

The possibility is being considered of sectionalizing the A-12 cavity into several smaller series cavities. This proposal stems from the fact that RCA is now able to produce a shielded grid oscillator tube, RCA A-2332 which has the required power and design circuitry. The split tank system would involve a series of independent cavities excited by one master oscillator which would

connect through common transmission lines to amplifiers at each cavity section. In this case tuning the individual cavities would effect only the phase. The oscillation frequency of Mark I will be measured as a function of time to determine its stability and the information used in further studies of this A-12 design. The advantages of sectionalizing on an rf basis are a reduction in bake-in time, easier detection of vacuum leaks, less stored energy liberated per spark, simplification of mode and flatness problems, and phase adjustment possibility between tanks if accumulative tuning errors have been made.

A-12 Target Design

Some experimental work has been done at Columbia University using the Nevis cyclotron in measurements of the neutron production from the bombardment of uranium with 384 Mev protons. This is similar to work done with the University of Chicago cyclotron and with the UCRL 184-inch cyclotron. A scattered beam from the cyclotron passes through the concrete shielding, is collimated, and enters a 40-inch tank filled with a solution of $MnSO_4$. A uranium billet is used as the target. The beam current on the target is about 5×10^{-14} amperes, which is approximately half the current used in the similar Chicago measurements. A yield figure of $7.5^{+1}_{-0.5}$ neutrons per proton was found. The results at UCRL for 340 Mev protons on uranium give 8.3 neutrons per proton, which may be extrapolated to 9.0 for 384 Mev protons. The experimenters at Columbia feel that their results are a rough confirmation of the order of magnitude of the results obtained at UCRL. In the Columbia experiments the background was high, which would help to explain the difference in the results.

The target presently being studied consists of 1/16 inch uranium plates with a 1/10 inch water layer. Since this layer is only 1/3 of a mean-free-path for resonance neutrons in water, the question has arisen about the applicability of the usual methods of calculating the resonance escape probability. The usual formula for the effective uranium cross section is considerably different for normal lattices and for the MTA primary. By an examination of the variations of the affects with geometry and with energy is hoped to be able to evaluate the resonance escape probability for the MTA system. A method of measurement has also been suggested and will be examined.

It has been calculated that infinite reflectors may be ranked in order of decreasing effectiveness: deuterium oxide, carbon, beryllium oxide, beryllium, iron and water. Since the first two substances must be 750 centimeters thick in order to approximate infinite reflectors it has been found at the Argonne Laboratory that beryllium is superior to all other reflectors for small reflector thickness. For the MTA target however, cost is a more important factor than physical size and therefore carbon is probably the best choice.

The water tank measurements described in previous reports are being continued.

J-16 Program

Since the shape of the magnetic field is extremely important in a Thomas type cyclotron, considerable time has been spent with the one-tenth scale electron model cyclotron in obtaining data for the design of new magnetic pole faces which will provide a magnetic field accurate to 1/10 percent. This information has been obtained and the new electron model group has designed and is building two magnet pole faces which will provide a magnetic field of the desired accuracy. The new model will be a 1/8 scale model of the full 300 Mev deuteron accelerator.

Another important investigation being done by this group involves the design of the dee structure. Three pairs of wedge shaped dee tips which graduate into simple pipe stems are currently being used. The minimum rf voltage on the dees required for complete acceleration is also being studied. The threshold dee voltage is now 200 volts to ground. Methods and procedures are being studied for extracting the circulating beam from the cyclotron.

The 20-inch cyclotron group using the quarter scale bevatron injector cyclotron is studying starting source conditions, servomechanisms for three phase operation, and capacitance interaction between the dees. This machine accelerates protons to 0.9 Mev. To date, an off-center calutron ion source (a low voltage d.c. arc source with a graphite exit slit) has produced sufficient protons to give more than a 5 milliampere beam. Sufficient rf power is not now available to produce beam currents in excess of this. A servomechanism has been designed which will adjust the phase shift with good efficiency. The capacitance between dees has been eliminated by the use of a set of transmission lines between each pair of dees.

The theoretical group has developed the Thomas cyclotron theory and calculated the magnetic field up to sixth order terms. Calculations have also been made on shaping the magnetic field to allow the beam to be removed. The orbital trajectory of the first few turns has been obtained graphically.

For the full scale J-16 accelerator serious consideration is being given to the use of a horizontal magnetic field. Since in this case the pole faces are vertical, dust will not settle by gravity on the pole faces and the elimination of dust sparking will be facilitated. Furthermore, the magnet pole pieces will provide additional shielding, and the mechanical structure is simplified if the dees may be suspended in a vertical position.

9. CHEMISTRY
Part A
(A.E.C. Program No. 5311)

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Isomeric States of Bi^{210}

Bi^{210} occurs in nature as the 5 day beta emitter known as RaE. A second isomeric state of very long half-life was discovered by neutron irradiation of Bi^{209}. Its half-life for alpha decay (estimated from the activity and

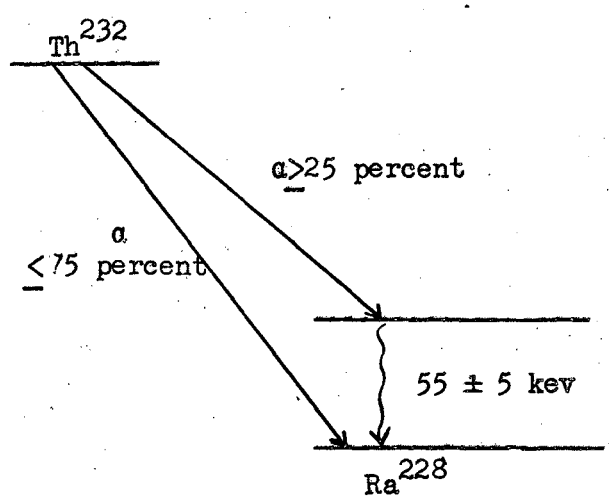
cross section for formation) is 10^6 years. In a recent experiment it was shown that Po^{210} grows in at a rate of 3×10^{-3} that of the alpha decay. Thus isomeric transition or beta decay (whichever is faster) takes place with a 3×10^8 year half-life. This long-lived Bi^{210} has not been detected in nature, but it is being searched for in uranium ores.

Decay of Pu^{239}

The alpha spectrograph shows three alpha groups for Pu^{239}, with the largest interval 51 Kev. Electrons of about 100 Kev have been observed here and elsewhere in intensity corresponding to about 0.5 percent of the transitions. A corresponding alpha group has not yet been detected.

Decay of Th^{232}

Electron-alpha coincidences in photographic emulsions indicate that the decay scheme of Th^{232} is:



Properties of Em^{221} and Po^{217}

Proton bombardment of Th^{232} has produced the new isotope Em^{221}. It decays via both beta emission and alpha emission and has a half-life of 24 minutes. Alpha decay gives rise to the previously missing polonium isotope, Po^{217}, which decays by emission of 6.5 Mev alpha particles. The mass assignments are based on the properties of other daughters, which are well known radioactivities. The radiations of Em^{221} itself have not been observed, because of interfering radiations.

Crystal Structure of Am_2O_3

Some time ago Am_2O_3 was observed to have the cubic sesquioxide structure like most of the rare earth oxides. A sample prepared recently at a lower temperature was found to have the hexagonal structure like La_2O_3.

CHEMISTRY
Part B
(A.E.C. Program No. 5311)

Metals and High Temperature Thermodynamics

Work is in progress on the following problems:

1. Gaseous hydroxides.
2. Thermal conductivity of gases at high temperatures.
3. Refractories.
4. Gaseous molecules.
5. Gaseous oxides.

Basic Chemistry

The following problems are under investigation:

1. Thermodynamics of rhenium.
2. The hydrolytic polymerization of zirconium.
3. Germanium chemistry.
4. Electron exchange rate between Fe^{2+} and Fe^{3+} work has been terminated.
5. Thermodynamics of indium.
6. Thermodynamics of thiosulfate.
7. Solubility of rare earth fluorides.
8. Chemistry of ruthenium.

CHEMISTRY
Part C
(A.E.C. Program No. 6400)

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Organic Chemistry

Fundamental studies on isotope effects, rearrangement mechanisms, rates of reactions, and organic synthesis of labeled compounds are studies under this heading. During the past month research projects under each of these different sub-classifications have been continued.

Animal Biochemistry

In cooperation with organizations such as the Donner Laboratory of Medical Physics, the Division of Pharmacy and Experimental Therapeutics, and the College of Agriculture a number of biochemical problems have been studied. These include the following: (1) the excretion of morphine in normal and drug-addicted humans; (2) the metabolism of simple carbon-14 labeled organic compounds in man and animals; (3) the chemical role of cholesterol and other steroids in heart disease; (4) the rate of metabolic oxidation to CO_2 of organic compounds in small animals, and the use of these living systems as possible bio-assay tools for drugs, hormones, and enzymes.

Plant Biochemistry

Many of the chemical steps by which carbon dioxide is converted to useful products in the growth of green plants have been elucidated in the last several years. Most of these experiments have been aided by the use of tracers, particularly carbon-14. In the work of the group studying plant biochemistry, these intermediates and the sequence of reactions that occur in the plants are being investigated. Rate studies, degradation studies, microbiological assays, and unknown compound identification make up the bulk of the outward physical problems being studied by this group. The interpretation of the results and the evolution of adequate theories to correlate the data are, of course, simultaneously necessary.

10. MEDICAL PHYSICS UNCLASSIFIED
Part A
(A.E.C. Program No. 6000)

Tracer Studies

The distribution of I^{131} in the tissues of rats is being compared to that observed with At^{211}. Studies upon the metabolism of fission products in rats and monkeys are being continued.

Radioautography

The series of radioautographs of Pu lung sections, using stripping emulsion, has been completed. Work on monkey tissues with mixed fission products has been started; to date only the rib sections appear to give satisfactory radioautographs.

Radiation Chemistry

Studies of the effects induced by radiation in oxygen-saturated aqueous solutions of acetic acid and hydrogen-saturated aqueous solutions of formic acid have continued. The silicic acid gel column and paper chromatograms have been the principal devices used to detect and identify the products from these studies. One irradiation of unlabelled propionic acid has been made.

MEDICAL PHYSICS UNCLASSIFIED
Part B
(A.E.C. Program No. 6000)

The Biological Effects of Radiation with the 184-inch Cyclotron

Dosimetry. Assay of the radioactivity of irradiated tissues and phantoms is being used for measurement of the dose delivered by high energy deuterons. The principal activities induced in tissue are O^{14}, O^{15}, and C^{11}. One thousand reps to a single drosophila fly mass 1 mg gave rise to approximately 250 disintegrations of C^{11} per minute. This method is furnishing information concerning the recombination of ions in the ionization chamber at high dose rates.

Animal Experimentation. Animal experimentation was continued concerning lethal effects of partial body irradiation, particularly irradiation of various regions in the head of the mouse. Some brain irradiations were also made on hamsters in collaboration with the University of Minnesota.

Biological Effects of Radiation with Yeast Cells

Additional evidence was obtained for the existence of triploid and tetraploid yeast cells by mating illegitimate diploids with haploids and diploids. The experiment is controlled by biochemcial genetic markers. One criterion used is the x-ray survival curve.

Instrumentation

The multiple scintillation counter apparatus for *in vivo* scanning of a patient is in the initial testing stage. The apparatus consists of ten 1P21 tubes arranged in a straight line and connected to a cathode ray oscilloscope with a long persistence screen. To scan the object the phototubes are moved in a direction perpendicular to the line along which they are arranged. Each scintillation picked up by a phototube is recorded as a momentary spot of light at an appropriate location on the cathode ray tube. A radioactive test object containing approximately 1/10 of a mc/cm^2 of I^{131} gives rise to a visible image on the long persistent screen of the cathode ray tube. Work has started on additional equipment which will allow exposing a photographic plate by means of ten neon bulbs, each of which will flash when a scintillation is seen by the phototube to which it is connected. The object will be scanned more slowly with this apparatus and greater sensitivity should result.

The Life Span of the Red Blood Cell

Studies have been initiated on the life span of the red blood cell in hypophysectomized rats. It is too early to state whether any difference in the life span of the red cells will be seen.

Studies with C^{14} Labeled Stilbamidine

As reported earlier, a patient with multiple myeloma was given a tracer dose of C^{14} labeled stilbamidine followed by a treatment course of ACTH. The urinary and fecal excretion of radioactivity was not different from that occuring in patients with multiple myeloma who have not received ACTH.

Determination of the Blood Volume and Plasma Volume with Fe^{59} Globulin

The "non-hematocrit" method for determination of the blood volume and plasma volume with Fe^{59} globulin injected in iron turnover studies has been used for about two years. It depends on the separate measurement and plotting of c/m/ml in whole blood and in plasma from each sample. In all cases centrifugated Wintrobe tube hematocrits were also run on each of the serial samples.

The method provides interesting comparisons in the "computed hematocrit" $\left(1-\frac{\text{c/m/ml in whole blood}}{\text{c/m/ml in plasma}}\right)$ and the centrifugated one.

Protection after Irradiation by a Tissue Extract that Stimulates Tissue Proliferation

Formation of desoxypentose nucleic acid (DNA) in tissue as measured by P^{32} labeling of DNA has been used as a measure of tissue proliferation. This relationship has been substantiated by measuring DNA formation in the same tissues which were measured for mitotic activity. Irradiation either directly or indirectly depresses DNA formation; the presence of growing tissue (embryo or tumor) within an animal stimulates DNA formation. Saline extracts of embryo tissue mashes (cell free) can stimulate DNA formation even in the irradiated animal. The material in tissue extracts, that is capable of stimulus of cell division and DNA formation in normal or irradiated tissues, is roughly identified as crude saline soluable, alcohol insoluable nucleoprotein. Preliminary results (based upon the fact that radiation depresses tissue proliferation and these extracts can stimulate or partly restore this process) on protection of irradiated animals by this tissue extract after irradiation has been achieved. Twenty-four irradiated mice (800 r whole body) were given saline extract of 0.7 grams of homologous embryo per mouse in 10 injections (twice a day for 2 days and once a day for 6 days). Twenty-four irradiated control mice were given saline injections of the same schedule. A significant difference has been maintained between the two groups over 18 days post irradiation time, indicating a protection by the embryo extract.

11. HEALTH CHEMISTRY
(A.E.C. Program No. 5311)

UNCLASSIFIED

Work in progress in the Equipment Development group includes:

1. Preparation for the receival of two highly active Canadian pile-bombarded samples to be received in May; p partial description of the equipment was given in the progress report for December 15, 1951, to January 15, 1952.
2. Equipment for "cows" for the miling of americium from plutonium was completed and the operations are successfully under way.
3. Completion steps are being made on the new decontamination chamber, and improved setup based on a design made after trial use of a pilot model over a period of a year. These last steps include lining the chamber and auxiliary equipment with polyethylene.
4. On April 4, 1952, 109 drums containing active waste in cement, a decontamination chamber and its dolly (see No. 3 above), and eight calutron parts were dumped at sea.
5. Six gloved boxes were completed plus the usual repair, reassembling, etc., of boxes, centrifuges and auxiliary box equipment.

12. PLANT AND EQUIPMENT

Bevatron Instrument. (Program No. 9500. 5-424-9001) Magnet winding is approximately 81 percent complete and the steel erection is still approximately 60 percent complete.

Animal House. (Program No. 9600. 6-424-9007) Paving adjacent to the Animal House is approximately 75 percent complete.

Radiological Laboratory at the U.C. Medical Center. (Program No. 9600. 6-424-9008) Sound level measurements are to be made the week of the 21st, after which acoustical treatment of the accelerator room will be designed and installed.

MAN-MONTHS EFFORT REPORT
Scientific Personnel

PROGRAM NO.	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
9200 M.T.A. - Mark I	Construction	1.50	
9500 Bevatron	Miscellaneous	2.95	
Operations			
2000 M.T.A.	Design and Development	72.16	
3000 Weapons Research	General	12.54	
5211 Physics Research			
Experimental Physics	Cloud Chamber	12.00	
	General Physics Research	43.86	
	Instrument for General Use	3.14	
	Magnetic Measuring	2.74	
Theoretical Physics	General	11.16	
Photographic Film Detectors	General	12.94	
5261 Applied Physics Research			
Mark III Cyclotron	Electron and X-C Models	14.04	
Chemistry Research			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	2.83	
	Nuclear Properties of Heavy Element Isotopes	9.30	
	Transmutations with 184-inch and 60-inch Cyclotrons	7.28	
	Analytical and Services	22.16	
	Special Chemistry Development	1.00	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.00	

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MAN-MONTHS EFFORT REPORT
Scientific Personnel

PROGRAM NO.	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
Chemistry Research (cont.)			
5311 Basic Chemistry Research, Part A	Instrument Development and Services	5.00	
	X-Ray Crystallographic Measurements	2.83	
	Health Chemistry Research	9.54	
Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics		
	Basic Chemistry, including Metal Chelates	7.00	
	General		
5361 Applied Chemistry Research	Process Chemistry	7.84	
Reactor and Accelerator Operation			
5731 Electron Synchrotron	Operation	9.19	
5741 184-inch Cyclotron	Operation	13.22	
5751 Linear Accelerator	Operation	9.83	
6300 Medical Research and Other	Internal Irradiation and Hematological Response	4.47	.50 Consultant Man-Months
	Health Medicine	6.31	-

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MAN-MONTHS EFFORT REPORT
Scientific Personnel

PROGRAM NO.	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
6400 Biological Research	Instrumentation for Quantitative Measurements of Radiation	1.73	.90
	C^{14} Metabolism	1.81	.75
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	12.32	6.45
	Trace Elements and Irradiation Studies	5.23	2.40
	Radiation and Mutation Rate	1.70	.25
	Physical Biochemistry	12.58	4.40
	Biochemical Response to Irradiation	3.23	.47
	Miscellaneous	4.32	2.75
	Metabolism of Lipo Protein and Lipids	5.73	12.10
	Iron Metabolism Hematopoiesis	3.49	.50
	Synthetic and Experimental Organic Chemistry	22.35	-
	Metabolism of Fission Products	17.41	-
6500 Biophysics Research	Biological Effects of Cosmic Radiation	2.60	.25
	Health Physics	.67	-

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