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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

MONTHLY PROGRESS REPORT

No. 85

April 15 to May 15, 1950

May 31, 1950

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Berkeley, California

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

April 15 to May 15, 1950

MONTHLY PROGRESS REPORT No. 84

1. BevatronUNCLASSIFIED

Magnet. Forty-eight percent of the leg slabs and 17 percent of the yoke slabs have been assembled. The order for sample pole plates has been held up by investigation of various painting methods of which vitreous enamel now seems the best. The order for punching and machining is about to be placed while the decision is being reached on painting.

Coil winding previously scheduled for August 15 may be delayed due to the fire which burned out the mechanical engineering office. About one month will be required to replace the drawings destroyed many of which were on the coils.

Building. Excavation for the magnet foundation is complete and placing the reinforcing steel has started. Siding is being installed and the floor is being poured in the office section.

2. 184-inch Cyclotron OperationUNCLASSIFIED

The cyclotron was used for research experiments approximately ninety-three percent of the 460 hours that the crew was on duty.

The cyclotron lost essentially one shift's operation because of the fire in Building 8. The Ilco water pumps had to be shut off until the valves in the basement of Building 8 could be shut off.

Following are operating statistics for the period:

Research Operating Time	425-3/4 hours	92.5 percent
Maintenance	18-1/2	4.0
Repairs	5-3/4	1.3
Visitors and Fire in Building 8	10-1/4	2.2

3. 60-inch Cyclotron OperationUNCLASSIFIED

Operation of the 60-inch cyclotron has been very smooth with comparatively no difficulty occurring. External alpha beams of 35 microamperes were obtained and an average operation efficiency of 78 percent.

4. Synchrotron OperationUNCLASSIFIED

Operation of the synchrotron has been consistently good this past month. Average beam intensity has been 600 R/hr at 1 meter from the target, measured with an ionization chamber behind 1/8 inch of Pb. Peak intensities

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of 8000 R/hr have been held for several days operation.

Motion of the upper pole tip segments was eliminated by shimming between the upper yoke and the pole tips. This operation has also resulted in a reduced noise level while the machine is running.

The inside surface of the quartz vacuum chamber, with the exception of the resonator quartz, was sprayed with air drying silver paint. This procedure tends to correct any breaks in the electrical conducting coating and minimizes the buildup of static charges inside the quartz vacuum chamber. The conducting coating is connected to a grounding network for bleeding off charges.

The r.f. voltage modulator has been perfected and installed. This device provides a 3 millisecond beam duration, extending over the period from 1-1/2 milliseconds before peak field to 1-1/2 milliseconds after peak field. (There is a maximum of 5 percent decrease in peak energy at the beginning and end of the beam pulse). The use of this long duration beam has resulted in an increase in the ratio of real counts to accidental counts in crystal scintillation counting circuits.

Following are operating statistics for the period:

Research Operating Time	249.4 hours	67.2 percent
Tests of Synchrotron	52.9	14.3
Maintenance	68.7	18.5

5. Linear Accelerator and Van de Graaff Operation UNCLASSIFIED

During this month it was found that belts which have been constructed to be static proof are of no value for use in the Van de Graaff. The accelerator with its 60 kv difference across the V belts cause too much current drain through the belts.

No new equipment was installed during this month. The Van de Graaff was opened several times for broken V belts and once to remove a piece of material from the outer gap; aside from these openings the machine gave very little trouble.

Operating time was as follows:

Running Time	263.25 hours	83 percent
Repair	42.25	13.2
Bake-in	4.5	1.4
Lost Time due to Power Failures	8.5	2.7

6. Experimental Physics UNCLASSIFIED

Film Program. Di-protons. At the suggestion of L. W. Alvarez a study is being made on the possibility of doubly charged protons (proton and π^+ meson in bound state) being released from a target under high-energy proton bombardment. Photographic plates are arranged to receive particles emitted in the

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forward direction. The particles will be identified by range in the emulsion and by grain count.

Since the lifetime of this particle might be very short, an exposure will be made using the emulsion as target. In this case, particles of short lifetime ejected from the disintegrated nuclei will be recorded.

Uranium secondary production. Study is continuing on the possible production of mesons from uranium nuclei which fission after π^- meson capture.

Cloud Chamber. The experiment to determine the energy spectrum of the electrons from the decay of the μ -meson was continued. This work was done at the synchrotron.

Losses sustained by this Group in the fire in Building 8 on April 23, 1950 included one 22 in. cloud chamber and five 16 in. cloud chambers destroyed, and one 10 in. cloud chamber and one 8 in. cloud chamber destroyed. Efforts are being made to replace the lost equipment. Three projectors were burned; however most of the parts have been recovered and the equipment will be usable.

The Neutral Meson Program on the 184-inch Cyclotron. The efforts during the past month in the study of photons from neutral mesons produced in the 184-inch cyclotron have been directed toward a study of yield versus proton energy, and also the yield versus angle for constant proton energy. The evaluation of these effects has been nearly completed so far as methods employing internal targets in the cyclotron allow.

Development of Pair Spectrometers. The magnet and vacuum tank for the 200 Mev pair spectrometer have been assembled and tested. The magnetic field was found usable without shims. The 350 Mev spectrometer magnet has been assembled and now awaits completion of blower brackets and mounting truck which are being finished in the shop. Bench tests with 200 megacycle amplifiers and a prototype coincidence circuit, working with magnetically shielded photomultipliers separated from the detecting crystal by a 30 in. lucite light pipe, have given satisfactory performance and provided enough information to order the electronic apparatus and design the light pipes for the spectrometers.

Magnetic Particle Spectrometer. Further measurements of the energy distribution of the neutron beam resulting from bombardment of a beryllium target by 340 Mev protons in the 184-inch cyclotron have been made, and are found to confirm previous results.

Some preliminary measurements of the momentum distribution of charged particles ejected from carbon, copper and lead nuclei by the above neutron beam have been made.

Preparations are being made for a program of neutron-deuteron scattering using this equipment.

Hi-Speed Oscilloscope. The oscilloscope originally referred to in UCRL-617 has been recently modified to further facilitate the development and construction of short time counting apparatus. The modifications have consisted in

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the use of new DuMont cathode ray tube type 1056-P11, in place of the early experimental model type K1017-P11. The new tube emits about 10 times the light intensity as compared to the old model. Both tubes have coaxial cable fittings to the deflecting plates. Total accelerating potentials up to 35 kilovolts are used. A further modification has been to use vacuum tubes to generate the sweep voltage in place of the rather unreliable gas tube. A positive pulse of about 5 volts will trigger the sweep with good accuracy. The shortest sweep length is about 10^{-8} sec. per inch of tube face at a deflection sensitivity of 200 volts per inch. The pulse initiating the sweep can be fed directly or through a distributed amplifier to the vertical deflection plates. On the 10^{-8} sec. per inch sweep the pulse jitter is in the order of 10^{-10} sec. for a rise time of 10^{-9} seconds. Sweep speeds down to 10^{-5} sec. per inch are also available.

Proton-Proton Scattering. The scattering cross section at 345 Mev has been obtained with the apparatus described in the last Quarterly Physics Report, UCRL-627. The differential scattering cross section between 20° and 90° in the center of mass system is 4 millibarns, probably correct to about 5 percent. The disagreement with the gas counter results is being investigated.

The cyclotron beam was reduced in energy to 249 Mev and 167 Mev by passing it through a lithium absorber. The proton-proton cross section was remeasured at these two energies at an angle of 90° , resulting in a measurement of approximately 4 millibarns.

Deuteron-Proton Scattering. Using the same apparatus as for proton-proton scattering, the elastic deuteron-proton scattering cross section is being measured for angles of deflection θ of the deuteron varying between 40° and 160° in the center of mass system.

Mean Life of the μ^+ Meson. The mean life of the μ^+ meson has been measured with a system of crystals and distributed amplifiers. The result is

$$\tau = (2.65 \pm 0.12) \times 10^{-8} \text{ sec.}$$

Production of Neutral Mesons in the Synchrotron Beam. γ - γ coincidences have been observed arising from various materials bombarded in the synchrotron beam. These coincidences show a strong angular correlation which corresponds precisely to the correlation computed from the kinematics of a neutral meson disintegrating in flight into two γ -rays. The γ -rays have been positively identified by transition curves and also by the range of the conversion electrons produced by the γ -rays in lead. Thus far the following data pertaining to this problem have been taken: 1. Angular distribution. The direction of the emitted mesons must lie in the plane defined by the two γ -ray counters and the target. It is thus possible to measure an angular distribution of the π^0 meson by rotating the normal to the plane about in a plane containing the beam. These curves have been taken on carbon and show an angular distribution considerably more forward than the corresponding curves as observed for the photo production of charged mesons. 2. Z Dependence. Yields of neutral mesons have been measured as a function of Z for six elements. A cross section for hydrogen was obtained by C-CH₂ differences. The results show a small

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decrease per nucleon for increasing Z . However, the yield for hydrogen is not anomalously large as was observed in the case of charged meson production. This experiment definitely establishes the reality of the neutral meson.

Proton-Proton Scattering as a Function of Energy. It has been possible to modify the field distribution in the linear accelerator cavity such that a small beam of variable energy can be produced. After magnetic analysis such a beam is then useful for studying nuclear processes as a function of energy. Using this beam the absolute cross section of proton-proton scattering at 45° laboratory angle has been studied using a gas scatterer and two proportional counter telescopes in 90° coincidence. The results join smoothly onto the low energy points. The results are fully compatible with pure S scattering in the entire range from low energies to 32 Mev.

Inelastic Scattering. Experiments are in progress investigating the level structure of helium by inelastic scattering of protons. This is being done both with photographic plates and counter techniques.

In the former inelastic scattering experiments with protons, there has been some evidence for inelastic scattering in heavy elements corresponding to an energy lower than the barrier height. Some questions were raised as to whether this anomalous effect is due to either low atomic number impurities in the target or due to low energy contamination of the beam. Both of these points are being investigated in detail in order to verify the existence or non-existence of the effect.

Observation of Fast Neutrons Produced by π^- Capture. When a π^- meson is captured in materials other than hydrogen, star formation is likely to result. It is known from photographic plate evidence that only 75 percent of the stars result in visible ionizing radiation. The remaining 25 percent are expected to be processes in which one or more fast neutrons are emitted. This process is being investigated by observing a secondary target exposed to π^- mesons produced in a primary target in the 184-inch cyclotron. The fast neutrons from this secondary target are being permitted to multiply in a uranium block and are then moderated in a water tank and counted with BF_3 counters. Preliminary experiments have shown this effect to be present despite the problem of considerable background. More accurate measurements are in progress and in particular it is being planned to look for the neutrons produced by π^- absorption in deuterium. This experiment will give essential qualitative information on the nature of the π^- meson. A deuterium high pressure gas handling system is under construction to aid in this experiment and also to produce high pressure targets for the observation of γ -rays from deuterium targets after π^- absorption.

Analysis of Photographic Plates Exposed to Mesons from Proton-Proton Collisions. A new exposure has been made using the liquid hydrogen target for the analysis of π^+ mesons produced in proton-proton collisions. The technique has been considerably improved by the use of an analyzing magnet which eliminates the background produced by elastically scattered protons. Analysis of these plates has confirmed the former conclusion that the meson energy distribution is peaked towards the high energy end. This peak presumably has to do with the

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attractive forces between the final neutron and proton resulting possibly in the formation of a deuteron. The energy resolution is at present insufficient to ascertain whether a real deuteron is formed or not. Evidence has appeared for an asymmetry in the direction of the emission of the μ -meson in the π - μ decay. This asymmetry is at present statistically significant by three times standard deviation and therefore will bear further investigation. If this asymmetry is real, the results will be very interesting from the point of view of spin and magnetic moment of the meson.

Meson Studies. Three experimental programs are currently being pursued; namely, the meson production cross section from proton-proton collisions, scattering cross sections for mesons on protons and finally the electronic counting of positive and negative mesons in flight. The production cross section was reported at the Washington meeting of the American Physical Society and possible fine-structure in the spectrum is being further investigated. The other two programs are in process of instrumentation.

Synchrotron Studies. The synchrotron beam has been used to further the investigation in the search for neutral mesons using the double γ coincidence method, of the occurrence of Compton protons, and the study of the π - μ mesons half-life.

7. Theoretical Physics

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Scattering Experiments. A number of suggestions for explaining p-p scattering have been made by people at the Institute for Advanced Study, whose principal aim was to find forces which maintained charged symmetry. These have been looked into to some extent, but we have not been able to find any improvement over our own conclusions.

Meson Theory. Calculation of meson processes involving deuterons have been carried out. The effects of the strong distortion of the nucleon wave-functions by nuclear forces, and particularly the possibility of deuteron formation in meson production has been investigated, and has been shown to radically alter the expected energy distribution of the produced mesons. The modified spectrum, which is much more concentrated to high energies, is in good agreement with the observations. A systematic survey of the predictions of the various meson theories shows that pseudoscalar theory with pseudovector coupling most nearly accounts for the observed facts. One outstanding discrepancy is the large photo production cross section for neutral mesons.

Other Studies. Investigations are being carried out on various points concerning shower theory such as the lateral spread of air showers. These are of interest both for cosmic ray and synchrotron problems. A study is also being made of the penetration of high energy particles through matter, in the attempt to answer such questions as the fraction of their energy lost in nuclear events rather than in ionization, the number of neutrons made, and similar problems.

8. M.T.A. Program~~SECRET~~

During the period of this report no important changes were made in the design of the vacuum tank. The length of the tank for the initial section will be 62 feet, which will allow one foot at each end for adjustment of the liner length. Bids for this tank have been received. The drift tubes will have a positioning leeway of ± 1 foot. The only substantial uncertainty in the drift tube placement is at the low energy end and model tests should give the answer.

Cost estimates have been worked out for vacuum pumping systems of various speeds. It was decided that a system involving 48 300 cfm Kinney pumps for roughing 5 KS-5000 oil booster pumps for roughing, and 48 32 in. diffusion pumps for finishing would be satisfactory. This system would pump down in 4 hours to 10^{-4} mm. The present plan is to secure the Kinney and 32 in. diffusion pumps from the Y-12 plant at Oak Ridge. In connection with the vacuum system, attention is being given the matter of radiation loss through the pumping slots or holes in the tank liner. The radiation loss must be balanced against the loss of pumping speed. The vacuum system was let out for bids early in May.

Considerable thought is being given to the question of what becomes of the portion of the injected beam that is lost before reaching the target. Some of it will strike the drift tubes and give rise to neutrons. To keep the neutron production at a minimum and to avoid the creation of undesirable activities by the neutrons that are liberated, graphite liners will be used in all drift tubes save the first two which will have copper liners. The amount of shielding that will be required on the basis of a one-half tolerance dose outside the shielding for 8 hour shift is approximately 6 feet of concrete. Foundations are being provided for 7 feet of shielding.

Measurements on the 800 mc model have shown that some of the drift tubes are smaller than originally thought. This means that some of the focussing magnets must be redesigned for the smaller space, which can only be done at the expense of higher current densities and higher power consumption. At the low energy end it is possible to compromise on the model tests and increase the diameter of the first drift tubes with a considerable saving in magnet power. It is not possible to use magnets without iron since the increased stray field would probably give rise to discharges in the regions of high electric field.

Work on the ion source was interrupted by the fire in Building 8. Before the fire an ion source developed from a modified piece of calutron equipment was operated and modulated at 12 megacycles with a beam of 12 ma. During a portion of the rf cycle the modulation was at least 50 percent. The advantage of modulating the source lies in the fact that the energy of the stray beam does not have to be dissipated. The apparatus is now being rebuilt.

The 120 mc, 1/10 scale model of the 60 foot section with all the drift tubes will be ready by the end of May. It is being set up so that very accurate frequency measurements may be made. Field plots will be made and the drift tubes located after which a field plot will be made along the axis and a determination of the magnetic field throughout the entire tank. A 1/20th scale model is also under design for the acceleration of electrons. It will be used in accurate measurements of the beam loss on the drift tubes, space charge effects, etc.

9. Chemistry

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Part A

Isomerism of Am²⁴². The two isomers of Am²⁴², produced by neutron irradiation of Am²⁴¹, have been studied with a double focusing beta spectrometer. The end points of the beta spectra, determined by extrapolation of Kurie plots, are 633 ± 3 Kev for the 16 hr. isomer, and about 580 Kev for the long lived isomer. Conversion electrons corresponding to L conversion of a 50 Kev γ -ray are also observed with a 16 hr. half-life. The γ -ray has been observed directly in absorption measurements. These data suggest that the γ -ray corresponds to an isomeric transition in Am²⁴². The abundance is about one gamma per β -decay, and an alternate possibility is that the 16 hr. isomer is about 100 Kev above the ground state and decays entirely by β -emission to a 50 Kev level of Cm²⁴². Experiments are planned which will distinguish between the two decay schemes. If the first is correct, previous cross section calculations for the production of the isomers are in error.

Decay of At²¹⁰, At²¹¹, and Po²¹¹. Some time ago it was observed that 6.4 day Bi²⁰⁶ is produced by decay of 8-hr. At²¹⁰, which is known to decay mainly by electron capture. The amount formed corresponds to an α/K ratio for At²¹⁰ of a few tenths of a percent or less, depending on how the counting efficiency of Bi²⁰⁶ is estimated. A search for α -particles due to At²¹⁰ detected none, but set a limit of 0.1 percent if their energy is greater than 5.3 Mev. An abundance of 0.3 percent would have escaped detection if at 5.3 Mev, because of Po²¹⁰ interference. In this experiment, the branching fraction of At²¹¹ was redetermined, and was found to be 40.8 ± 0.5 percent α -decay, in excellent agreement with the accepted value of 40 percent. Careful pulse analyses of the mixture showed two new peaks at 6.6 and 6.9 Mev which are interpreted as fine structure from the decay of Po²¹¹, with abundances of 0.5 percent and 0.6 percent, respectively, compared to the main group at 7.43 Mev.

Other Astatine Isotopes. Work continues on the study of astatine isotopes produced by high energy transmutation. The assignment of a 2.0-hr. activity to At²⁰⁷ has been confirmed by showing that it decays to 5.7-hr. Po²⁰⁷. Previous work showed that it decays by α -emission to Bi²⁰³, identified by means of its Pb²⁰³ daughter, the 2-day lead.

Separation of polonium from astatine at regular time intervals, followed by separation of bismuth from the polonium, yielded both 14-day Bi²⁰⁵ and 12-hr. bismuth in amounts corresponding to a 24-minute astatine parent. The 12-hr. activity is probably Bi²⁰⁴ rather than Bi²⁰³, because no Pb²⁰³ was observed in the decay curve. Thus two astatine isotopes, 205 and 204 or 203, have half-lives of about 24 minutes. An α -activity of this half-life had been previously tentatively assigned to At²⁰⁵.

Use of the rabbit on the 184-inch cyclotron allowed observation of a new 43-second astatine α -activity. The α -particles had an energy of 6.45 Mev.

New Polonium Isotopes. Bombardment of bismuth with deuterons and with protons in the 184-inch cyclotron has produced polonium α -activity of 17 min. and 11 min. half-life. The 17-min. period has α -particles of 5.67 Mev and is believed

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to have mass number ~ 201 . The 11 min. period has two groups of alphas at 5.84 and 5.76 Mev, with intensity ratio about 8:1. The mass assignment of this activity is believed to be about 200. Other shorter lived α -activities probably due to even lighter polonium isotopes, have been observed in experiments using the "rabbit" of the 184-inch cyclotron, but these have not yet been studied carefully.

Magnetic Susceptibilities of the Trifluorides of Americium and Curium.

Curium Trifluoride. The magnetic susceptibility of a 25 μg sample of CmF_3 was determined at room temperature by a modification of the Farady method, using a permanent magnet and a delicate torsion balance to measure the pull. A value of $X_m = 18,700 \pm 4000 \times 10^{-6}$ was found for this sample. Within experimental error the value agrees fairly well with that expected on the basis of a ground state assignment of $^8S_{7/2}$ for the Cm^{+3} ion. The temperature dependence of the susceptibility has not been investigated, however.

Americium Trifluoride. The magnetic susceptibility of 220 μg of Am as Am^{+3} was measured at room temperature in the apparatus described above. A X_m value of $1200 \times 10^{-6} \pm 300$ was found for this sample, in reasonable agreement with that previously reported for the aqueous Am^{+3} ion by Howland and Calvin. The temperature dependence of the fluoride susceptibility has not been investigated.

Preparation of Curium Metal. A few micrograms of CmF_3 were prepared by precipitation of Cm^{+3} in aqueous solution with aqueous hydrofluoric acid. The fluoride was dried in air at about 110°C for one hour. A piece of the dried fluoride was reduced in a beryllia crucible with Ba vapor at 1275°C . A globule of curium metal of about 1 μg estimated mass was produced. The globule was smooth and silvery in appearance, and showed no evidence of reaction in a dry nitrogen atmosphere in two hours.

Chemistry

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Part B

Synthetic and Experimental Chemistry. The Strecker synthesis of alpha amino acids using labeled cyanide is being investigated as an easy procedure to prepare a number of carboxyl-labeled amino acids. Two runs on alanine have been completed with fairly low yields, but the data are incomplete.

Two preparations of labeled formic acid have been completed with yields of 35 percent and 90 percent, respectively, depending on the catalyst used.

A low activity preparation has been made of cyclohexanone-2- C^{14} and the product analyzed by isotope dilution methods, showing 91 percent the desired product and the impurity identified as diethyl-ether by index of refraction measurements. A high specific activity preparation of this compound will be made as soon as the total amount of carbon to be used can be determined.

The work on the direct reduction to alcohols of cadmium-nickel fatty acid salts in the presence of copper chromite has proceeded satisfactorily.

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A new method for the preparation of vinyl acetic acid, namely, carbonating the allyl Grignard, has been tried.

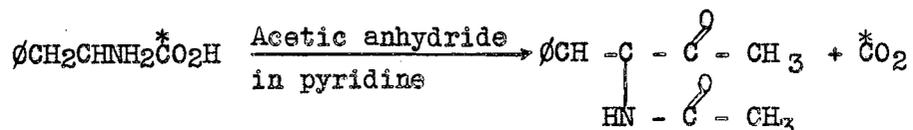
A high specific activity preparation of carboxyl-labeled malic, succinic and fumaric acids is underway. A previous preparation of this material had become attacked by microorganisms and resulted in a contaminated product that could not be purified. This activity will, however, be recovered.

Work on the synthesis of a number of labeled purines has been completed except for the cleaning up of certain residues. Previously, guanine and guanazolo were prepared. In the last month adenine has been prepared in 15-17 percent yield based on the cyanide used to start the synthesis, and 7-amino-1v-triazolo pyrimidine (8-azoadenine) has been obtained in 20 percent yield, also based on cyanide.

One more run on the preparation of tritiated cholesterol has been carried out with slightly improved recovery. This material is being used in certain phases of the heart disease work of the Medical Physics Group.

The preparation of malonic acid derivatives for the study of isotope effects in rate reactions has been attempted in several ways.

A study of one phase of the Dakin-West reaction is in progress:



By use of carboxyl-labeled phenylacetic acid it is hoped to establish the exact source of the carbon dioxide produced in this reaction.

Several preparations on the decomposition of oxalic acid have been made in the study of isotope effects in this reaction. Some difficulty has been encountered in equipment design and in obtaining material balances, but as soon as these difficulties have been overcome a warm run will be made.

Biological Chemistry. Work on the identification of acid constituents from in vitro liver slice experiments has continued. Two phases, the paper chromatography and the synthesis of suspected materials have been studied.

In connection with the biological studies on the metabolism of fatty acids, paper chromatography of these materials has been studied. Compounds up to C₇ have been satisfactorily separated using either of the following two solvents: (a) 60 parts pyridine, 20 parts concentrated ammonium hydroxide solution and 10 parts water; or (b) 60 parts pyridine, 30 parts concentrated ammonium hydroxide solution and 10 parts water. The pyridine gives a little better separation of the higher molecular weight acids, but is more objectionable due to odors. The separation of palmitic acid from stearic acid has been studied but satisfactory results have not yet been obtained. In the solvents mentioned streaking results.

The detection of tritium on paper chromatograms has been accomplished by the use of a windowless flow counter placed directly over the paper.

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Experiments on the paper chromatography of tritiated cholesterol have continued. Various coated papers, among which Quilon treated papers show the greatest promise, have been tested. First attempts to obtain a radioautograph of a paper chromatogram gave no spot after fifteen days contact.

The degradation of labeled cholesterol produced and isolated from a rat fed labeled isobutyric acid is in progress. By oxidation of the side chain it is hoped to get a rough estimate of the distribution of the C^{14} .

Work on the chemical nature of the S13 factor (atherosclerotic significant peak) has continued, but no material as such is available yet. S13 enriched serum and normal serum have been lyophilized and extracted with acetone. Work is in progress at present to separate the lipids, cholesterol, cholesterol esters, to identify the fatty acids and to determine the degree of saturation of the two fractions.

In collaboration with the Poultry Husbandry Department 9.6 millicuries of sodium acetate- $l-C^{14}$ has been fed over a ten-day period to a laying hen. The bird was sacrificed and the various organs isolated. The seven eggs collected have now all been separated into yolk, white and shell, lyophilized and the combustion of this material is in progress to determine the activity accurately. Direct plates of this material gave erratic results, but the hottest egg seemed to have from 200-300 μc of activity in which the C^{14} was distributed roughly as follows: 200-250 μc in the yolk and 50-100 μc in the white.

Photosynthesis Chemistry. The investigations on the mechanism of CO_2 reduction are being directed towards the reactions resulting in production of the two carbon compounds related to the C_2 acceptor of CO_2 .

The chemical degradation of some of the products of four seconds of steady-state photosynthesis by barley leaves in $C^{14}O_2$ has been partially completed. It is found that the α and β carbon atoms of phosphoglyceric acid have equal specific activities. The glycolic acid obtained from the same experiment has corresponding equal radioactivity in both carbon atoms. This indicates that a symmetrical intermediate is involved.

Enzymatic hydrolysis of the phosphorylated compounds involved in sucrose synthesis has been used for their identification. The only source of free hexoses in plant extracts from short C^{14} photosynthesis experiments is such compounds. In the four second experiment no glucose phosphates are observed. Fructose and a relatively larger amount of an unknown sugar are observed in addition to glyceric acid and the trioses.

Experiments on non-steady state photosynthesis have been performed in an attempt to understand the well known induction phenomena. Preliminary results indicate that the reactions are inhibited after the primary carboxylation reactions.

The glycolic acid feeding experiments are being extended to include the assimilation of C^{14} -labeled formate by Scenedesmus.

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The radioactive acids formed in a number of microorganisms after $C^{14}O_2$ fixation are being identified. These include the tricarboxylic acid cycle intermediates.

An attempt is being made to determine the locus of CO_2 reduction by rapidly separating the cellular parts after short $C^{14}O_2$ photosynthesis in spinach leaves.

Chemistry~~SECRET~~

Part C - Project 48B

Metals and High Temperature Thermodynamics. Work is in progress on the following problems:

1. Gaseous hydroxide species.
2. Liquid metal systems and heats of formation of intermetallic compounds.
3. Theory of refractory behavior.
4. Thermal conductivity of gases.
5. Heat Transfer in forced convection film boiling.

Basic Chemistry. Solvent Extraction. The following problems are under investigation:

1. The chelate complex of lanthanum with TTA.
2. Thermodynamic studies on rhenium.
3. $Fe^{3+}-Fe^{2+}$ electron exchange rate.

Ore Reduction. The following subjects are under investigation:

1. Solvent extraction using chelate process. A study of phosphate complexing.
2. A study of equilibrium in uranyl phosphate precipitation.

10. Medical Physics~~FOR OFFICIAL
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Part A

Tracer Studies. The metabolism of tantalum after intramuscular and intrapulmonary administration in rats, is being continued.

The fate of various carrier-free isotopes of rhenium in rats is being investigated. The effect of sub-lethal doses of x-ray radiation upon the intracellular sodium space of rats is being studied.

Studies of the total body distribution of astatine as At^0 and At^- is being continued.

Chelating Experiments. Plutonium and Cerium. The in vivo experiment has been terminated, the animals have been sacrificed and assay of the excreta and tissues is being carried out.

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Calcium. Preliminary results of the experiments on the effect of EDTA on calcium excretion show a factor of 20 to 30 times greater excretion in the treated animals over the untreated animals. Experiments with various dosage and time schedules are continuing.

Iron. The animals treated with Fe^{59} showed ten times as much urinary excretion of a dose of tracer iron as did the untreated animals after 24 hours. Experiments with various dosage and time schedules are being continued.

Radiation Studies. Equipment is now available for metabolic studies on irradiated rats and an experiment using around the LD 80/30 days has been initiated. The effects of 100 r total body radiation on the resistance of mice to inoxia have been studied. Preliminary observations suggest that 24 hours after irradiation, there is a depression of general cellular metabolic level with a bounce over the norm at 48 hours and a return to the normal level at 72 hours. These studies are being continued.

Decontamination and Bone Metabolism Studies. Prompt treatment with zirconium citrate was found to increase the urinary excretion of radioyttrium five fold within 5 minutes after injection. There was also a significant effect on the distribution in liver and kidney.

Administration of the calcium complex of versene (ethylenediamine tetra acetic acid) was found to effectively increase the excretion of radiocalcium and radiostrontium and to reduce the deposition of these elements in the skeleton.

Studies of the calcification mechanism, using radiocalcium, are being continued, but the work on alkaline bone phosphatase has been temporarily suspended.

Radioautographic Studies. Radioautographic work on the study of radiation damage produced by astatine in the rat is still continuing.

Astatine 211 - Thyroid Uptake Study. Thirty-five Curtis-Dunning rats were injected with 5 microcuries each of At^{211} in the -1 valence state. Five animals were sacrificed at the following intervals: 1 hour, 4 hours, 12 hours, 24 hours, 48 hours, and 72 hours. The animals that were given At in the -1 state were sacrificed at 24 hours. At the time of the injection of the At each animal was given 5 microcuries of I^{131} intraperitoneally. When the animals were sacrificed blood samples were taken and the cells and plasma separated by centrifugation. The thyroids were mascerated with a solution of dilute NaOH and Na_2SO_3 .

A thorough tracer study on At^{211} is now in the planning stage and will be well underway within the next week.

Radiochemistry. Two millicuries of carrier-free $\text{Re}^{183,184}$ and 200 microcuries of Os^{185} have been isolated from a wolfram exit strip using a previously reported procedure. A carrier-free method has been developed for the isolation of Ta^{182} from alpha bombarded hafnium. A more rapid distillation procedure has been developed for the isolation of astatine from bismuth. Millicure

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amounts of astatine have been prepared for animal injection. Studies have continued on the exchange of At^0 with organic iodides.

Medical Physics

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Part B

Lipoproteins. A summary of lipoprotein analyses of serum has been presented this month in the Quarterly Progress Report. These studies classify the so-called β_1 lipoprotein fraction of man and of the rabbit according to their density. The differences in the densities of the giant molecules of the β_1 series are measured in the analytical ultracentrifuge. Some 10 different types of these molecules have been observed. They contain cholesterol, fats, phospholipids and protein. Current investigations have emphasized the role of atypical types of these lipids in atherosclerosis. Studies are in progress to observe the effects of radiation on the serum lipoproteins.

The metabolism of serum lipoproteins has been labeled in the rabbit, (1) by administration of tritium labeled water, (2) by the administration of tritium labeled or C-14 labeled cholesterol, and (3) by the administration of radioactive phosphate. Preliminary results suggest a similar metabolic turnover rate for both the normal β_1 lipoproteins and for the atypical lipoproteins.

Biological Effects of Radiation. The tetraploid strain of yeast that was recently isolated from the diploid strain shows more tolerance to irradiation than the parent diploid strain. The relative LD₅₀ x-irradiation dosages are 1, 5, and 20 for haploid, diploid and tetraploid yeast respectively.

There is now evidence that the incidence of double-nucleated lymphocytes is increased in a group of 10 employees whose exposure to radiation of any source approached 0.3 r/week. These individuals were measured within a week of the radiation exposure.

Carbon Labeled Glycine. Quantitative analysis of the C-14 excretion of the first patient to receive C-14 labeled glycine reveals that 95 percent of the administered radioactivity has been accounted for in the CO_2 excretion and in the feces during the first month.

Iron Metabolism. Completed studies on the rate of radioactive iron incorporation into red blood cells indicates that iron metabolism and red cell formation may be slightly affected by doses as little as 5 r and that there is a linear relationship between irradiation dose and depression of red cell formation up to 250 r which was the highest level studied. (These studies have been done cooperatively with the Naval Radiological Laboratory, Hunter's Point, San Francisco, California.)

Nucleic Acid Metabolism. Studies of the indirect effect of radiation on nucleic acid metabolism are being summarized. It is apparent that these

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effects can be detected, against the background variability of fluctuations in nucleic acid formation, at doses as little as 30 r. In these studies the livers and spleens of mice were selectively irradiated and the formation rate of desoxyribose nucleic acids were noted in tumor transplants and normal tissues of the same animal.

11. Health Physics and ChemistryUNCLASSIFIED

Projects Completed by the Research and Development Group. The activities of the Research and Development Group during this period include:

1. Bldg. 5A, Decontamination Annex: equipment for decontamination chamber undergoing test runs as it is completed in the shops.
2. Equipment for movement of Hanford dissolver solutions from Hanford containers: equipment completed and successful transfer executed.
3. Equipment for sample bombarded at Hanford, received April 26, for S. G. Thompson: equipment completed and sample processed successfully throughout all steps.
4. Berkeley Box Section: 5 boxes completed and delivered.

12. Plant and EquipmentUNCLASSIFIED

Bevatron. The building is approximately 70 percent complete. The shop and office wing is being completed first. The siding is being installed; the fenestration is about 90 percent complete. The sheetmetal people started work on the heating and ventilation in the shop and office wing. Painting is in progress on the steel structure and the roofing. The reinforcing steel and the magnet foundation footing are about 40 percent complete.

Construction of Cafeteria. Construction is 84 percent complete and is on schedule after time allowance is granted for weather and other unavoidable delays. Masonry, lathing, plastering and carpentry are nearly complete; pouring of top layer of slab about to begin; painting begun and continuing.

Construction of Animal House. Preliminary plans and scale model have been submitted and working drawings will be begun upon approval of preliminaries and authorization.

Construction of Sheetmetal and Salvage Shop. Design not started.

Warehouse. The warehouse is essentially complete.

Radiological Laboratory at the University of California Medical School. Bids have been received; starting of construction is pending.

Miscellaneous Construction. Power Distribution. Work on the 12 kv line to the hill switching station has been completed. Work on the other sections is continuing.

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Fire Protection. The first phase is completed; work on the second phase has been suspended.

Alterations to Synchrotron Building. The directive is pending on the counting room.

Cyclotron Improvements. The motor generator house for the increased magnet excitation is 50 percent complete.

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Information Division

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MAN-MONTH EFFORT REPORT

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	9.8	
60-inch Cyclotron	- -	-	Non-Project
Synchrotron	Operation	6.0	
Linear Accelerator	Linear Accelerator - General	4.0	
	Van de Graaff - General	4.0	
	Development	.8	
Bevatron	Building	.1	
	Injector	1.4	
	Magnet	1.7	
	Vacuum System	-	
	Miscellaneous	.1	
Experimental Physics	Cloud Chamber	3.0	
	Film Program	9.8	
	Ionization Chamber and Crystal Counter	3.6	
	Neutron-proton Scattering	.5	
	Proton-proton Scattering	1.4	
	Absolute Cross Section Measurements	1.2	
	General Physics Research	7.2	
	Meson Experiments with Synchrotron	4.0	
	Scintillation Counters -Research Experiments	.8	
	Pair Counter Experiments	5.8	
	Particle Momentum and Energy Analysis	1.2	
	Proton Elastic Scattering	.8	
	Magnetic Measuring Equipment	1.8	
	Meson Counting at the Synchrotron	1.2	
	Cryostat-Preparation of Liquid Targets	1.5	
	Instruments for General Use	-	
	Theoretical Physics	Bevatron	-
General Physics Research		12.3	
Isotope Separation	Nier Spectrometer	.2	
Radioactivity Physics	General	2.4	
	Crystal Program	.3	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Chemistry, Part A	Chemistry of Transuranic Elements	4.5	
	Nuclear Properties of Transuranium Elements	4.9	
	Transmutations with the 184" Cyclotron	12.7	
	Analytical and Service	15.6	
	Process Chemistry	9.9	
Chemistry, Part B	Synthetic and Experimental Chemistry	5.6	
	Biological Chemistry	8.0	
	Photosynthesis Chemistry	5.9	
Chemistry, Part C	Metals and High Temperature Thermodynamics	3.5	
	Basic Chemistry, including Metal Chelates	2.0	
	General	3.0	
	Ore Reduction	.5	
Biology and Medicine Part A	Metabolism of Plutonium and Allied Materials	12.0	
	Decontamination Studies	7.0	
	Radiochemistry	4.0	
	Radioautography	2.0	
Biology and Medicine Part B	Tumor Metabolism	.6	.2 Consultant
	Special X-ray Studies, Radioactive Measurements etc.	6.7	2.3 Man Months
	Radioactive Carbon Studies	1.6	.1
	Fundamental Medical Research	7.7	1.6
	Hematology	.4	.1
	Medical Work with the 184" Cyclotron	1.1	.8
	Fly Genetics	2.2	.1
	60" Cyclotron Bombardments	.2	.1
	Physical Chemistry	11.2	.4
	Specific Irradiation	2.5	1.4
Donner Animal Colony Expense	1.5	-	
Biology and Medicine, Part C	Synthetic and Experimental Organic Chemistry	20.9	
Health Chemistry, Physics	Monitoring and Disposal	5.6	
	Research and Development	15.2	
	Film Badge Program	4.5	
	Medical Examination Time	2.3	
Measurements Project Development	General	4.2	
M.T.A. Program	Design and Development	19.1	

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