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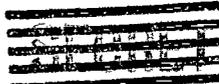
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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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PROGRESS REPORT No. 76

July 15 to August 15, 1949

August 29, 1949

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Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

July 15 to August 15, 1949

PROGRESS REPORT No. 76

1. BevatronUNCLASSIFIED

Quarter Scale Model. The principal cause of fluctuations in the accelerated beam was found to be variation in the oscillator frequency with respect to magnet current. Most of this variation has been removed by changes in shielding and grounding of the units so that the beam, with large aperture, ordinarily varies less than twenty percent from pulse to pulse. The frequency tracking has been improved to the extent that a beam has been accelerated as long as 200 milliseconds; however, the rate of decrease with time is still greater than predicted for gas scattering and there is good evidence that tracking errors still cause a loss of beam. It has been decided not to proceed with the conversion of the model to higher energy at this time.

Full Scale Bevatron. As suggested by a similar study from Brookhaven the possibility of accelerating electrons in the bevatron has been investigated somewhat. The accelerating voltage required to overcome radiation loss sets the limit to the energy obtainable. An electron energy of 2 Bev which would require 100,000 volts on the accelerating electrode appears attainable without difficulty. Injection would no doubt, require a linear accelerator of the order of 10 Mev energy to avoid too low a magnetic field at injection. A separate injector and r.f. accelerating system would be required if electrons as well as protons were to be accelerated.

Construction Progress. The plates for the first sample magnet sector are coming through the fabricator's shop. The assembly fixture for the yoke slabs will be finished in the shop in a few days and the leg slab fixture is being built. Agreement has been reached on leasing half of the fabricator's shop building for the assembly work which is to be done by the laboratory. Grading of the site is proceeding on a two shift basis with completion scheduled for the end of the month.

Full Scale Injector. Development of an r.f. Cockroft-Walton high voltage supply for the 500 KV ion gun is proceeding. Thirteen stages each using two 8013A tubes and two .02 mfd. condensers is planned. The filaments will be heated by r.f. transformers and the assembly will consist of 13 cylindrical sections each 5-1/2 inches thick by 12 inches in diameter filled with oil or freon. The rating is to be 2 Ma. DC output current. The oscillator frequency is 200 KC. Model tests of the drift tubes for the 10 Mev Linac have started.

2. 184-Inch Cyclotron Progress OperationsUNCLASSIFIED

The cyclotron was used for research experiments ninety-two percent of the 490 hours that the crew was on duty.

Because of school vacation, the members of the Chemistry Group still use about

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twenty-five percent of the cyclotron time.

A device to focus the deflected beam is under design and construction.

3. 60-Inch Cyclotron

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The 60-inch cyclotron is still undergoing reconstruction. The electrical circuit changes have been completed and certain parts are still in the process of fabrication.

4. Synchrotron Operation

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A one-week shutdown has occurred during the past month to replace a cracked injector quartz. Since reassembly of the machine, the output has not been as great as prior to the shutdown. Most runs have been made with a beam intensity of 500 to 700 R/hour.

Temporary installation of a regulator in the injector high voltage supply has been effected. No improvement in the machine performance has resulted from its installation, but studies of timing jitter can now be made with greater precision because of the absence of amplitude jitter.

A procedure has been instituted to determine the percentage of the elapsed time during which the synchrotron is available for experimental work. These percentages will be reported as the data become available.

5. Linear Accelerator and Van de Graaff

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The Van de Graaff generator gave a good deal of trouble during the month, after several months of very reliable operation. It was concluded that a real overhaul was necessary to restore the machine to good operation. A one-week shut-down allowed the overhaul to be completed, and the whole machine is now operating well again.

The new magnet chamber for the 90 degree magnet between the Van de Graaff and the Linear Accelerator is almost ready for vacuum testing. The new design should eliminate trouble with beam spreading caused by the beam passing through a non-uniform residual field when magnet is off. It has always been necessary, in the past, to de-gauss the 90 degree magnet carefully after making an energy measurement because of this trouble.

Advantage was taken of a recent Van de Graaff opening to make a few small improvements in the machine. New type, heavier needles are being tried out in the corona gaps to cut down the casualty rate in needles, the light beam system was modified, reducing the amount of light necessary. One tube was removed from the pressure vessel and put outside at atmospheric pressure. The light beam pre-amplifier circuit was changed to improve its output and stability and to decrease susceptibility to sparking. A filter was installed in the lead of the meter which increases the corona current received by the high voltage electrode to prevent the lead from radiating spark interference into the shell wiring.

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A motor-generator set is being readied for use as the beam analyzer magnet supply in order to improve magnet regulation over the present system using a relatively high impedance rectifier supply.

6. Experimental PhysicsRESTRICTED

Film Program. Data are being worked up on the ratio of positive to negative mesons of 50-80 Mev energy emitted at 90° to the 350 Mev proton beam from a series of targets. The only information which is complete enough so that the statistics mean very much is on carbon and aluminum. In these two cases, the ratio is $5.2 \pm .5$ and $5.1 \pm .5$, respectively. A total of 76 tracks in copper give a value of 4.3 ± 1.5 . A total of 32 tracks in beryllium yields a ratio of 7 ± 4 . Although none of the data are yet good enough to rule out the expected plus to minus ratio of approximately three, it seems unlikely that it will be lower than 4.

New holders have been completed and preliminary runs have been made for a measurement of meson masses to greatly increased accuracy.

A study is being made by L. Germain on stars produced in NTB3 emulsions by 350 Mev protons. Preliminary data show 5 percent of the stars to have a high energy proton deviated by less than 2° from the original proton.

E. Grimwald has made a study of the frequency and energy distribution of stars from π^- mesons as seen in NTB3 plates. No star prongs were seen with energy so high that they would have been missed in the previously reported star studies made with C2 plates.

Meson Production with 350 Mev Protons. The absorption method of detecting mesons has been developed further. It has been established that if one is detecting π^+ mesons by means of observing the μ decays in the plate, one should use a rather sensitive plate like a C3 rather than a C2. Our past work with C2's must be considered as giving too low a positive to negative ratio because of this effect. We have also rearranged our plates so that we can follow Wentzel's suggestion on detecting a possible asymmetry in the angular distribution of the μ decays. So far, from a total of 48 π^+ mesons of 30-70 Mev, no asymmetry has been observed.

Cloud Chamber. All of the data has now been taken in the experiment to determine the energy distribution of the synchrotron x-rays. About 1000 pairs have been measured and the results agree well with the theoretical curve. Runs are now in progress to get cloud chamber pictures of mesons made at the synchrotron.

A cloud chamber has also been operated in the deflected proton beam of the cyclotron. The object was to study the background that will be present in the study of high energy γ -rays.

Cerenkov Radiation. Calculations were performed on the magnitude of errors in the Cerenkov angle due to multiple scattering. This was larger than hoped for but it will still allow a good determination of proton beam energy. Delivery of the proper glass has been delayed.

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High-Energy Photons from Target. Experiments have been performed with a cloud chamber in the deflected proton beam. These were devised to give information on the background of charged particles one must contend with in searching for the pairs of electron pairs which may arise from simultaneous emission of two photons as is expected from neutral meson decay. The tests indicate that it is possible to observe tracks with minimum ionization in the presence of the background in the chamber.

Proton-proton Scattering at 30 Mev. The counting of 19,500 tracks of the plates exposed at 30 Mev has been completed. The results are in essential agreement with those reported previously, except for improved statistics.

Proton-proton Scattering at 340 Mev. Several measurements of the proton-proton scattering at 340 Mev using the coincidence technique (counting both protons involved in a scattering process) have been made. The differential scattering cross section in the center of mass system appears to be constant to 20 percent from 43 degrees to 90 degrees in the center of mass system, with value 5 ± 1 millibarns per steradian. Means of reaching 20° (center of mass) are under careful consideration, but so far they involve either a liquid hydrogen target or a large electronic rebuilding operation to use fast scintillation counters.

Total Cross Sections. Measurements of cross sections for production of Li^8 on C, N, Ne, A, Kr, Xe are being completed. Cross sections with protons at 340 Mev and excitation functions with deuterons up to 190 Mev have been measured. A report on this work is expected soon.

Life Time of the Neutron. Counts have been observed which show a storage effect in the magnetic field. To be sure that they are due to neutron decays, it will be necessary to show that they behave in the proper manner, as function of pressure and time delay.

Types of Reactions Produced by Particles and X-rays at Various Energies. The study of the excitation functions of Mn, Fe, Co, Ni, Cu and Zn isotopes from the 190 Mev deuteron bombardment of copper is about complete, and will soon be reported.

The study of the absorption in Pb of the radiation from the synchrotron producing (γ, n) and $(\gamma, 2n)$ reactions is being compared with shower theory; the agreement seems good.

Some preliminary experiments have been undertaken to determine the relative production of neutrons by various elements under x-ray bombardment from the synchrotron.

Study of Radioactive Isotopes Formed and Their Decay Properties. The decay of Zn^{62} seems to be partly by low energy β^+ emission, partly by K capture. A low energy γ -ray is emitted, and partly converted. The upper limit of the $\text{Cu}^{62} \beta^+$ spectrum is about 2.9 Mev.

Excitation functions for the production of Po^{206} , Po^{207} and Po^{208} by bombardment of Bi with protons of 10 to 30 Mev are being measured. Studies are also being made of products of bombardment of Bi by α -particles up to 390 Mev.

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The program to measure the fission excitation functions of U^{238} , U^{235} , Th^{232} , Bi^{209} and Au^{197} using protons to 340 Mev, deuterons to 190 Mev and α -particles to 390 Mev is nearing completion. A report giving these results is expected within a short time.

Magnetic Particle and Energy Discriminator. All of the equipment associated with the G.M. tubes to be used in this experiment is either built or about to be built. As soon as finished, this part of the apparatus will be employed in experiments which do not require the use of an associated pulse height analyzer, such as a determination of the energy spectrum of the neutron beam produced by protons in the 184-inch cyclotron.

The possibility of using a cathode-ray type pulse height analyzer, which offers the advantages of simplicity and great stability of channel width, is considered very promising. The design and construction of such an analyzer will commence at once.

In experiments using magnetic energy resolution, an error may be introduced through particles entering, and being scattered in the pole tips of the magnet, thus losing energy and being deflected from their proper path. Theoretical investigations of this matter are being made, and may later be checked by experiment. If it is found that the error introduced here may be serious, thin walled proportional counters will be made for use between the pole tips, to better define the paths of the particles passing through.

Scattering Deflector for 184-inch Cyclotron. The present electrostatic deflector provides a pulse of deflected protons about 10^{-7} seconds in length. By placing a thin scattering target at the electrostatic deflector position the deflected proton pulse has been lengthened to about 5×10^{-5} seconds making it much more suitable for counting experiments. A 0.060 in. thick thorium scattering target has been found to provide 5 to 10 percent of the deflected beam current available with the electrostatic deflector. The scattering in the target is multiple Rutherford scattering as given by Williams's scattering formula.

Measurements to determine the efficiency of a scattering deflector utilizing 360° magnetic field focussing has shown that using a 0.010 in. thorium scattering foil about 4 percent of the circulating beam can be concentrated on a 1/2 in. high by 1/4 in. wide aperture 2 in. below the scatterer. This is comparable with the efficiency of the present deflector system.

Measurement of Total Cross Sections of Nuclei for 40 Mev Neutrons. A measurement was made of the lithium total cross section with the result $\sigma_t = (0.684 \pm 0.011) \times 10^{-24} \text{ cm}^2$. Equipment was completed for measuring total cross sections of gases as described in the Quarterly Report of May-July. The principal use of this equipment will be with helium but oxygen and nitrogen will also be used as a check of the method. Other gases which may be used are hydrogen and argon.

As a preliminary experiment for poor geometry absorption cross section measurements a test was made of the uniformity of the neutron beam. A special target was used in order to shift the center of the 40 Mev neutron beam into the thin aluminum window on the south-east side of the cyclotron tank and an array of carbon detectors was placed just outside of this window. The varying activity of these detectors indicated that the beam was not sufficiently uniform to be well suited for poor geometry experiments.

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Neutron Activities from High Energy Fission in Heavy Nuclei. Apparatus is being constructed for the detection of short lived (.1 to 10 seconds) neutron activities which are produced by high energy fission in heavy nuclei. A systematic search for isotopes of this type, other than the six already known, will be conducted. It is thought that by measuring the yield of one of these isotopes as a function of the energy of the bombarding protons in the 184-inch cyclotron we can determine the excitation function for fission.

Neutron Measurements with Bismuth Fission Chamber. The angular distribution of neutrons knocked out of Be by 350 Mev protons had been previously measured from 0° to 27° inside the cyclotron shielding with bismuth fission chambers. The angular region was extended to 85° by measurements from a target placed in the deflected proton beam. A lead absorber between the target and the fission chamber prevented scattered protons from entering the chamber.

Measurements of the ratio of the neutron fission cross section in bismuth to the $C^{12}(n,2n)C^{11}$ cross section as a function of neutron energy, indicated that the fission cross section increases by about a factor of three relative to the $n,2n$ cross section in carbon as the neutron energy is increased from 90 Mev to 270 Mev.

The Determination of Absorption Coefficients of Various Materials for High Energy X-rays. Work on the transition curves for 300 Mev x-rays striking C, Al, Cu, and Pb is continuing.

Work on the use of radioactivities as detectors for γ -rays and the measurements of what are essentially shower curves, that is, numbers of quanta of a given energy versus thickness in lead, is continuing. The results have been compared with the theory for the approximately 30 Mev γ -rays producing $C^{12}(\gamma,n)C^{11}$ and the agreement is good.

Meson Experiments. Experiments are continuing on the determination with counters of mesons produced in various materials placed in the deflected proton beam of the 184-inch cyclotron, and the technique is being improved continuously. It should be possible to measure differential and total meson production cross-sections as functions of Z and E, with high accuracy and great rapidity, compared to the photographic method.

A rough energy spectrum of mesons produced in carbon using 300 Mev x-rays is near completion and an approximate cross section has been computed. An improved experimental set-up has been completed and will be used soon.

7. Theoretical Physics

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Neutron-proton Scattering. The paper on 40 and 90 Mev results is nearing completion. Calculations on 280 Mev scattering are in progress.

Proton-proton Scattering. An attempt is being made to explain the results by supposing a tension force is effective. This looks promising, however, it would mean that nuclear forces are not charge independent.

Scattering of Protons and Neutrons on Deuterons. An experiment has been proposed

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by Chew (and is being instrumented by the Cloud Chamber Group) which, it is hoped, will allow conclusions to be drawn concerning the n-n scattering.

Production of Mesons by 390 Mev Alpha Particles, 350 Mev Protons, and 300 Mev X-rays. Considerable progress has been made in understanding the negative-positive ratio observed in the x-rays. The expected ratio is $\pi^-/\pi^+ = 1/[1 - E/MC^2 (1 - v/c \cos \theta)]^2$ which gives an effect of the right magnitude. Production cross section measurements with both x-rays and protons agree within a factor of three with our calculated cross sections.

Types of Reactions Produced by Particles and X-rays at Various Energies. Work on spallation reactions, such as (p,6n), has been fairly successful.

Energy Dependence of Reactions. The excitation functions of the above reactions have been calculated. They are in reasonably good agreement with the measurements.

Total Cross Sections for Neutrons and Charged Particles for Various Elements. Success in understanding the 280 Mev neutron cross sections has not been achieved as yet. Our model is being developed so that it can be checked against the 14 Mev experiments.

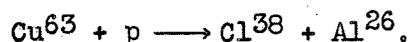
8. Chemistry

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Part A

"Fission" of Copper. Cl^{34} and Cl^{38} were found some time ago in copper targets which had been irradiated with high energy protons. A series of experiments has shown that Cl^{38} is formed from copper with protons of all energies above 75 Mev, and perhaps with 70 Mev. It is not detectable at lower energies, and its presence at 75 Mev cannot be explained by impurities in the target. The Cl^{34} , however, is produced at least in part from sulfur impurity on the surface of the copper.

For the reaction $Cu^{63}(p, pn6\alpha)Cl^{38}$ the threshold is calculated as 95-100 Mev, if the alphas emerge with energy corresponding to two-thirds the electrostatic barrier (which decreases as charge is lost). Spallation of individual protons and neutrons requires more energy because of the binding energy of alphas. The only explanation of the reaction is a "fission" yielding two large fragments, such as



For this reaction the thermodynamic threshold is 35 Mev. If 40 Mev is required for the potential barrier, the experimental threshold is 75 ± 10 Mev. The calculation does not exclude reactions leading to two large fragments plus a small number of protons or neutrons.

Mass Assignment of 13-second Krypton. The 13-second krypton formerly listed as 79 or 81 has been assigned to mass 81 by noting its growth from 5-hours Rb^{81} . Using the crude beta-spectrograph, growth of electrons with about this half-life

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was noted immediately after heating the rubidium sample in a flame. The Rb^{81} has been assigned with the mass spectrograph.

A New Lanthanum Isotope. Cesium bombarded with high energy helium ions has yielded a new 4-hour lanthanum positron emitter, as well as the previously known 19-hour La^{135} . The new activity has been assigned to La^{133} by the mass spectrograph using the transfer technique, with the plates showing clearly stable La^{139} and radioactive La^{135} and La^{133} .

Gamma-Rays of Bismuth. The conversion electrons of 14-day Bi^{205} and 6.4-day Bi^{206} have been examined with the new beta-spectrograph. Previous work with absorption methods showed a 1.7 Mev gamma for Bi^{205} and a 1.1 Mev gamma for Bi^{206} . Softer gamma-rays were not well resolved. Many electrons of lower energy were present, but on the crude spectrograph looked like a continuous beta-spectrum.

With the new instrument about 20 electron lines were resolved. These have been tentatively correlated with gamma-rays as follows:

<u>Bi^{205}</u>	<u>Bi^{206}</u>
0.431 Mev	0.183 Mev
.527	.350
.550	.370
.746	.570
1.84	.850
	.650?

There are also some electrons near 1 Mev, which may be due to more than one gamma-ray of about 1.1 Mev for Bi^{206} . There are not enough data to yield unique decay schemes.

Properties of Francium and Astatine Isotopes. The values reported last month have been revised as follows. Fr^{212} has a half-life of 19 minutes and decays 45 percent by alpha-decay and 55 percent by electron capture. Its daughter At^{208} (1.68 hours) decays 0.5 percent with alpha-particles of 5.65 Mev, and 99.5 percent by electron capture. Another isomer of At^{208} appears to exist with 7-hour half-life, because Po^{208} has been milked from such a parent.

Other astatine isotopes are now characterized as follows:

<u>Isotope</u>	<u>Half-life</u>	<u>Mode of Decay</u>
At^{209}	5.5 hours	K; 5.65 Mev α
At^{207}	1.8 hours	5.76 Mev α
$\text{At}^{205?}$	25 minutes	5.9 Mev α
$\text{At}^{204?}$	10 minutes	6.1 Mev α

Magnetic Susceptibility of Vitamin B-12. The magnetic susceptibility of a sample of vitamin B-12 obtained from Professor Calvin has been measured with a microbalance and a permanent magnet. This vitamin is an organic compound which contains cobalt. The apparatus was standardized with $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$,

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using the value of $\chi = 29.6 \times 10^{-6}$ given by Pauling. The molar susceptibility, based on molecular weight of 1490, was $\chi_M = 8.4 \times 10^{-3}$, corresponding to $\mu_{\text{eff}} = 4.5$ Bohr magnetons. This value is close to that found for many organic compounds of cobaltous ion.

Crystal Structures of GdF₃ and NaGdF₄. Treatment of GdF₃ with metallic sodium at high temperature resulted in a dark substance which magnetic measurements indicated to contain trivalent gadolinium. Analysis showed the presence of sodium. The x-ray diffraction patterns showed two phases which were interpreted as follows:

GdF₃: hexagonal, UCl₃ structure

a = 6.05 A

c = 3.59 A

NaGdF₄: cubic, CaF₂ structure

a = 5.29 A

This is the first trifluoride reported with the UCl₃ structure, although many such chlorides, bromides, and hydroxides are known. All previous samples of GdF₃ examined in this laboratory had a complicated pattern not yet solved, but isomorphous with YF₃, EuF₃, and other heavy rare earth trifluorides. The UCl₃ structure for GdF₃ may be made stable by the presence of Na, or it may depend on the heat treatment.

Other Experiments. Work continues on preparation and properties of isotopes of Cl, Kr, Rb, Sr, Y, Sn, I, Xe, Cs, Ba, La, all the rare earths, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Em, Fr, and the rest of the heavy elements. Gold fission yields are being investigated. Experiments are in progress on measurement of rates, recoil ranges, and recoil energies, for spontaneous, low energy, and high energy fission of uranium and thorium induced by high energy particles. Work continues on chemical separations and radioactivity measurements of the material from the recent neutron bombardment of plutonium. Some short-lived alpha-activities have now been found among the rare earth elements. Anion exchange resins are being tested for separating americium, curium, and higher elements from each other and from the rare earths. A new calorimeter is under construction

ChemistryUNCLASSIFIED

Part B

Synthetic and Experimental Chemistry. The preparation of the following compounds labeled with C¹⁴ is being studied: ethanol-1 or 2-C¹⁴, ethyl bromide-1 or 2-C¹⁴, propanol-1 or 2-C¹⁴, valine- α -C¹⁴, leucine- α -C¹⁴, lactic acid-2-C¹⁴, lactic acid-3-C¹⁴, isopropyl bromide-methyl-C¹⁴, oxalacetic acid-C¹⁴, malic acid-C¹⁴, fumaric acid-C¹⁴, succinic acid-C¹⁴, tartaric acid-C¹⁴, pyruvic acid-C¹⁴, cyclohexanone-C¹⁴, and isocaproic acid- α -C¹⁴. In the last month 8.5 millicuries of lactic acid-1-C¹⁴, 0.28 mc. of phenylalanine- β -C¹⁴, 2.1 millicuries of methyl-C¹⁴ iodide and 4.0 millicuries of glycine-2-C¹⁴ have been sent to the

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Isotopes Division, U.S. Atomic Energy Commission, Oak Ridge for distribution.

Some difficulties were encountered in the past month in the synthesis of methanol by catalytic hydrogenation. It was found that a great deal of the carbon dioxide was being absorbed as carbonate on the old catalyst but a new batch of catalyst corrected the difficulty and the yields are now back up to as high as 91 percent for methyl iodide, or over 95 percent for methanol based on CO₂.

After earlier discouraging work on the synthesis of isopropanol-methyl-C¹⁴ by the reaction of methyl magnesium iodide and acetaldehyde some good results have finally been obtained by the following process. Labeled methyl magnesium iodide in hexyl ether is condensed with acetaldehyde which is added dropwise in a hexyl ether solution. The Grignard complex is then decomposed with stearic acid and the isopropanol together with various other impurities is distilled out. This was then fractionally distilled in a micro apparatus to give approximately 90 percent yield on a 50 mmole scale. Additional runs will be made on a smaller scale in anticipation of a high specific activity preparation.

In the study of purine and pyrimidine metabolism preliminary synthetic work on the preparation of 2,6-diaminothiazolo purine has been started. Malononitrile is being prepared by the following reaction sequence:



This compound will then be condensed with guanidine hydrochloride to make the first cyclic intermediate in the preparation. The C¹⁴ will be introduced later in the synthesis. Experiments are also underway on the preparation of intermediates for the synthesis of other purines and pyrimidines including adenine, guanidine and guanazolo.

An apparatus for the preparation of cyanide (see R. B. Loftfield, *Nucleonics*, 1, No. 3, 54, (1947)) from radioactive carbon dioxide has been set up and an 80-90 percent yield on a 1 mmole scale was consistently obtained. The final crystallization of Demerol-N-methyl-C¹⁴ is in progress. A tentative yield of 74 percent for all the fractions has been obtained. The purification of amino acids by fractional elution from an ion exchange resin is being studied. Preliminary experiments with a glycine-valine mixture have given encouraging results.

A major problem in the preparation of glucose-1-C¹⁴ and mannose-1-C¹⁴ has been the purification of the product on a small scale (10-20 mmoles). Paper chromatography is successful but the capacity of the papers is very small and the procedure tedious. A chromatopile (stack of filter papers) is being investigated; although preliminary work was discouraging some later data indicate that this method may yet be applicable.

The attempted preparation of α -labeled valine and leucine through the aldehyde in the Strecker synthesis has been postponed; yields were so low that it was deemed necessary to find another way of making these compounds. Malonic ester synthesis or bromination and amination of the α -labeled acid are now both under investigation as means of preparation of leucine and valine.

This work on the preparation of naphthylmalonic acid to be used in the reaction mechanism study of decarboxylation of the free acid has continued. Some

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difficulty has been encountered in obtaining α -naphthylglycolic acid (an intermediate in the synthesis) in good yield but it is hoped that this will be solved shortly.

Biological Chemistry. The immunization of rabbits to A and B blood substances has continued in the study of certain rate constants for the production of proteins in the body and something about the precursors at the sites of formation. Highly concentrated antibodies to human A and B cells have been demonstrated and these rabbits are now almost ready to be given the radioactive amino acid in a continuation of the experiment.

Previous work by Witebsky and co-workers has demonstrated the presence of Rh antigen in amniotic fluid. This fact has been confirmed and chemical steps are in progress to isolate and characterize the antigen that was thus measured.

The in vitro studies of the metabolism of propionic acid- l - C^{14} in normal and neoplastic tissues have shown that the radioactivity thus introduced is found in a variety of different compounds. Labeled alanine from the propionic acid has definitely been identified and it is probable that some of the higher amino acids are also present. There seems to be some radioactive glucose present and there is also evidence for a number of other compounds with clearly defined chemical properties which are not amino acids. Experiments are underway to identify these later compounds as well as to characterize some of the more complex substances formed.

The work on the metabolism of labeled stilbamidine has continued with a number of mice being dissected after varying periods of time following the injection of radioactive material.

Photosynthetic Chemistry. The path of carbon in photosynthesis by algae and barley seedling leaves is being investigated in this laboratory. It is possible to deduce the sequence and type of reactions involved by determining the C^{14} content in each carbon atom of the intermediate of photosynthesis as a function of the duration of the synthesis in radio carbon dioxide. Initial work demonstrated the early predominancy of activity in carboxyl groups and the 3,4-carbon atoms of the hexoses. Recent results now verify these findings and render them more general.

Glyceric acid, derived from 3-phosphoglyceric acid in hexose synthesis by barley, has been degraded and found to have the following distribution: 60-second photosynthesis - 44 percent carboxyl, 31 percent α -carbon, 25 percent β -carbon; 15-second photosynthesis - 55 percent carboxyl, 29 percent α -carbon, 13 percent β -carbon. In the green algae Scenedesmus which had photosynthesized for 5 seconds 95 percent of the activity was in the carboxyl group while 2.5 percent and 1 percent were in the α - and β -carbons, respectively.

From the 60 second and 15 second photosynthetic barley experiments sucrose was shown to have 37 percent and 52 percent of the activity respectively in the 3,4-carbon atoms. The distribution of activity in alanine, glycine and serine is also being investigated; preliminary results are similar to the above analyses.

Radioactive glycines have been fed to the algae Scenedesmus in the presence

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of light and carbon dioxide. Only a small amount of activity is fixed in the case of carboxyl-labeled glycine while glycine-2-C¹⁴ is largely converted to serine. This serine will be degraded and should be labeled largely in the α -carbon with some activity in the β -carbon and no activity in the carboxyl carbon. Other labeled compounds found in this experiment include alanine, malic acid, sucrose and hexose phosphates in small amount.

The path of the photolysis of water during photosynthesis is being investigated with H₂O¹⁸. The universal association of carotenoids with chlorophyll suggested the possibility of carotenols being involved. Ten grams of Chlorella has been allowed to photosynthesize in 4 percent O¹⁸ water. The separation of the pigments and their analysis is in progress.

Hexose monophosphate has been successfully separated from inorganic phosphate by elution from Dowex 1 anion exchange resin columns with 0.2 N sodium chloride. The product obtained from hydrolysis of "Bios" brand fructose diphosphate is approximately half fructose-6-phosphate and half glucose-6-phosphate. Very pure fructose-1,6-diphosphate has been obtained by the same technique.

ChemistrySECRET

Part C Project 48 B

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

1. Studies of refractory carbides, borides, and silicides.
2. Thermodynamics of CN and N₂.
3. Absorption coefficients of CN and C₂.
4. Thermodynamics of molybdenum halides and oxides.
5. Thermodynamics of gaseous aluminum and iron oxides and hydroxides.
6. Low melting metal systems.
7. Theory of bonding in solid and gaseous oxides.
8. Construction of high temperature calorimeter and theory of its use.
9. Apparatus for the measurement of thermal conductivities of gases.
10. Design of equipment to extend work on film boiling to the case of forced convection.

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

1. The exchange of iodine atoms between iodate ion and iodine.
2. The chelate complex of lanthanum with TTA.
3. Thermodynamic studies on rhenium.

Engineering Development of Plutonium Separation. The following subjects are being investigated:

1. Solvent extraction using chelate process.
2. Pilot plant design for TTA synthesis.

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Ore Reduction. The following subjects are under investigation:

1. The dropping Hg electrode is being used to investigate phosphate complexing of U^{III} as ground work for a method of determining the oxidation state of uranium.

2. The construction of a photomultiplier has been completed and is now being used in fluorimetric determination of micro amounts of uranium. A Photovolt Model 512 Fluorimeter is being used for uranium analysis in conjunction with the solvent extraction using chelate process.

3. Solvent extraction using chelate process.

9. Medical Physics

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Part A

Tracer Studies. Tracer studies have been initiated using Rh¹⁰⁵ and Sm¹⁵³. Work is being continued using Se⁷⁵ and columbium.

Decontamination and Bone Metabolism Studies. Decontamination. Simultaneous administration of massive doses of zirconium citrate resulted in a marked decrease in the radiocolumbium (Cb⁹⁵), carrier-free, left in the skeleton and soft tissues after 3 days. The femur contained 0.5 percent of the dose in the controls and 0.07 percent in the treated group; the liver decreased from 6 percent in the controls to 0.3 percent in the experimental animals. Values for urine and carcass are unfortunately not available at this time.

A study was made of the rate of deposition of radio-cerium (Ce¹⁴⁴ carrier-free) in the adult female rat. Animals were sacrificed at 5, 10, 15, 30, and 60 minutes following intravenous administration of 8 microcuries of Ce¹⁴⁴. Treatment with massive doses of zirconium citrate (40 mg. Zr.) decreased the deposition of radiocerium in soft tissues, blood and skeleton, and increased the urinary excretion up to 15 fold.

Bone Metabolism. A comparison was made of the deposition of radiophosphorus in the skeleton of rachitic and control rats. Uptake by bone was much less in the rachitic animals, and there was an increase in urinary excretion. Radioautographs showed no P³² in the broadened epiphyseal cartilage of the rachitic rats, and very little in the epiphyseal region as compared to the normal animals in which this was the site of most active deposition of the phosphorus.

Injections of massive doses of estrogens in immature pigeons failed to produce any significant effect on the skeletal deposition of radiostrontium.

Radioautographic Studies. Radioautographic studies using radio-phosphorus were set up to study the effect of growth hormone under different physiological conditions. They were not completed due to insufficient radioactivity present at the time of cutting.

The uptake of radio-calcium in the femur and costochondral junction of 150 gm. rats, at 1 and 24 hour intervals has been partially completed. Preliminary studies

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showed surface deposition on the cortical bone of the rib, and deposition throughout the calcified cartilage. The femur experiments are still in progress.

A series of experiments using growth hormone under conditions of phosphorus deficiency have been set up with radio-calcium, but are still in progress.

The uptake of element 61 in the costochondral junction and femur was studied at intervals of 1 and 24 hours after intraperitoneal injection. 150 gm. rats were used. In the femur at 1 hour, promethium was present in a spotty pattern in the shaft, and present on the shaft surfaces. In the costochondral junction, at 1 hour, surface deposition on the cortical bone occurred. This element was also present at the border between the calcified and non-calcified cartilage of the chondral segment of the rib. Small amounts of promethium outlined part of the muscle surface. At 24 hours, the same pattern was noted as in the 1 hour experiment with the exception of the activity associated with muscle surface.

Radiochemical Isolation. One millicurie of $\text{Co}^{56,57}$ was separated carrier-free from milligram amounts of chromium, aluminum, cadmium, and zinc. The isolation is based on the observation that carrier-free radio-cobalt does not carry on $\text{Fe}(\text{OH})_3$ precipitated from $\text{NH}_4\text{Cl} - \text{NH}_4\text{OH}$ solution but is carried if $\text{Fe}(\text{OH})_3$ is precipitated with NaOH .

One millicurie of Rh^{105} was isolated carrier-free from neutron irradiated RuO_2 . The RuO_2 contains both Rh^{105} and Tc^{97} . The Ru and Tc^{97} were removed by distillation from $\text{H}_2\text{SO}_4 - \text{NaBrO}_3$ solution. The Rh^{105} in the residue was separated from remaining sulfate by precipitation with $\text{Fe}(\text{OH})_3$ carrier. Fe was removed by ether extraction from 6NHCl .

A process has been developed for the recovery of Np^{227} from animal ash. The ash is digested with $\text{HNO}_3 - \text{H}_2\text{SO}_4$. Np is carried down on the CaSO_4 which forms. This is washed and redissolved in NH_4Cl solution. Np is then carried down on $\text{Fe}(\text{OH})_3$ precipitated with NH_4OH . Ten millicuries of Cb^{95} have been separated from Cb-Zr mixture using a procedure previously recorded.

Medical PhysicsUNCLASSIFIED

Part B

Biological Effects of High Energy Neutrons. Detailed hematological data are being gathered on the 184-inch cyclotron crew for possible effects of low-level irradiation.

Use of Large Animals in Long Range Studies of Biological Effects of High Energy Neutrons. Arrangements are under negotiation for the temporary housing of large animals pending the completion of the animal house.

Biological Effects of High Energy Particles. The lethal effects of high energy deuterons from the 184-inch cyclotron are being studied with *Aspergillus* and yeasts. Arrangements are being made to use the proton beam from the linear accelerator.

Biological Effects of Radiation on Nucleoprotein Metabolism and Protein Metabolism. Studies of nucleoproteins and protein metabolism are continuing. The emphasis

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of the work has been shifted temporarily from biological effects of radiation to effects of neoplastic tissue on the nucleoprotein metabolism of host tissues. Studies are in progress to work with labeled nitrogenous bases in nucleic acid metabolism and to separate and identify the nitrogenous bases in nucleic acids.

Effects of Radiation on the Reticuloendothelia System and Related Effects with Regard to Immunity Mechanisms. Work related to selective irradiation of the lymphatic system and radioactive colloids of various elements is being carried on.

Microchemical Assay of Tissue Components by Induced Radioactivity. Elemental assays have been successful for copper. Work is progressing with iron, zinc, and titanium. Both normal and tumorous mouse tissue has been used.

Study of Genetic Effects of Radiation. Sex-linked lethals, *Drosophila* induced by high energy deuterons continue under investigation.

Metabolic Studies on Normal and Leukemic Cells. This work is continuing with particular attention being given to improvement in the methods for collecting leukocytes in small quantities rapidly, so that metabolic studies can be initiated as soon as possible after withdrawal of the cells.

Physical Chemistry (on the Arteriosclerosis Problem). Ultracentrifugal and chemical studies continue on the lipids and lipoproteins bearing cholesterol, which appear in the serum of rabbits developing atherosclerosis. It takes three months to produce the disease by cholesterol feeding, so that this study still has another month to run. Of note is the fact that not only do the ultracentrifugal lipoprotein components seen initially increase tremendously in quantity, but that also there are at least 2 new lipoprotein components developing as the rabbits become increasingly hypercholesterolemic. From the sedimentation constants for these new components it appears possible that they may represent dimers or trimers of the original molecule.

A similar lipoprotein of higher sedimentation constant than the usual B₁-lipoprotein is seen ultracentrifugally in the serum of certain humans. It is too early to say anything concerning special significance of this component in disease.

The preparations for the use of tritium in the study of the cholesterol problem in atherosclerosis have continued.

10. Health Physics and ChemistryUNCLASSIFIED

Radiation Field Studies. Surveys have been made of the fast neutron field of the Linear Accelerator since their recent improvements in output and shielding.

Relative measurements of high energy neutron intensity inside the cyclotron shielding in various azimuths have been made.

Other Studies. A new model air alarm counter has been built and is now in the

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process of testing.

A tungsten shielded container has been fabricated and is awaiting test.

The installation of a one-inch lead shield and viewing window has been completed.

A target carrying box, which is a modified lead target carrying box designed to decrease radiation exposure to target carrying personnel, plus a probe for extracting target material, is under construction.

The frame-work for the decontamination chamber has arrived and construction will begin the latter part of August.

Processing of a special sample from Hanford, which arrived late in May, is essentially completed as far as use of the straight-type cave is involved; the remaining material remains to be salvaged after which the cave and its equipment will be decontaminated and prepared for the coming December run.

11. Plant and Equipment

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Bevatron Building and Equipment. Grading operations have progressed on schedule during the month and probably will make the September 1, 1949 deadline. Another troublesome slide has developed but should not prove serious. The building contractor is making preparations to begin his work as soon as the grading is completed. The contract has been negotiated with a steel fabricated firm, Gilmore Fabricators, for the rental of space in their shop to work our assembly crews. The personnel for this work is being hired at present.

Central Research Laboratory Building. This project is in the finishing stages. The painting is nearing completion and the laying of floor covering is progressing nicely, as is the installation of laboratory furniture. It is anticipated that the building will be partially occupied by the middle of September.

Construction of Animal House and Cafeteria. Laboratory personnel and the architects are working out the details for the working drawings for the cafeteria. Preliminary discussions are now being held on the animal house, with the view of obtaining some rough preliminary drawings in 30 to 60 days.

Construction of Shops - plumbing, electrical, sheetmetal and salvage. The work has progressed rapidly on the forming for the first story of the building to house the electricians, plumbers and maintenance machinists. The pouring of concrete for the first story walls is in progress. No further work has been done on the plans for the sheetmetal and salvage shop.

Miscellaneous Construction. Warehouse. The contractor has been working for the past month on placing and pouring concrete for the warehouse foundations.

Alterations to Laboratory Buildings. Approval has just been received for alterations to Room 203E of the Chemistry Laboratory Building. This work will be started as soon as possible.

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Power Distribution. Work has been progressing nicely on the installation of the 12 kv power line from the campus substation to the hill switching area. Pouring of concrete around the conduit has progressed about 2/3 of the distance from the campus to the hill. The leg from the hill substation to the bevatron area has received considerable attention in that most of the trenching has been completed and some of the conduit and concrete have been laid.

Fire Protection. All phases of this project have been progressing according to schedule. The new section of the water line from the storage tank to the Bevatron area is nearing completion.

University of California Hospital Radiological Laboratory. Laboratory personnel and architects' personnel have been working out details for preparation of the working drawings.

Alterations to Synchrotron Building. Approval has recently been received for the alterations on the synchrotron building. This work is just getting underway.

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Information Division

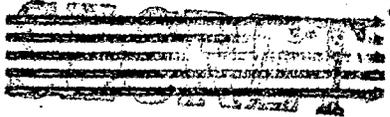
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APPROXIMATE DISTRIBUTION OF EFFORT

<u>PROGRAM</u>	<u>SUBDIVISION</u>	<u>MAN-MONTHS EFFORT</u>	<u>COMMENTS</u>
Bevatron	Injector	3.0	
	Magnet	2.8	
	General	.1	
	1/4 Scale Model Development	13.5	
184-inch Cyclotron	Operation	9.9	
60-inch Cyclotron	-	-	Non-Project
Synchrotron	R.f. System	-	
	General	.5	
	Injection	1.4	
	Magnet Tests and Operation	6.0	
	Vacuum Chamber	-	
Linear Accelerator	Linear Accelerator - General	4.1	
	Van de Graaff - General	4.2	
	Development	.8	
Experimental Physics	Cloud Chamber	3.6	
	Film Program	9.1	
	Ionization Chamber and Crystal Counter	1.4	
	Neutron-proton Scattering	1.5	
	Proton-proton Scattering	4.4	
	Neutron Diffraction	1.1	
	Meson Range and Decay Measurement	.8	
	Absolute Cross Section Measurements	2.9	
	General Physics Research	14.5	
	Magnetic Measuring Equipment	1.5	
	Instruments for General Use	2.0	
	Meson Experiments with Synchrotron	3.9	
	Scintillation Counters-Research Experiments	1.1	
	Pair Counter Experiments	4.6	
Compton Scattering Experiments with Synchrotron	1.9		
Theoretical Physics	Synchrotron	-	
	Bevatron	2.0	
	Cyclotron	-	
	General Physics Research	15.0	
Isotope Separation	Nier Spectrometer	1.2	
	Low Mass Spectrograph	.2	

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<u>PROGRAM</u>	<u>SUBDIVISION</u>	<u>MAN MONTHS</u>	<u>EFFORT</u>	<u>COMMENTS</u>
Chemistry, Part A	Chemistry of Transuranic Elements	12.3		
	Nuclear Properties of Transuranium Elements	5.8		
	Transmutations with the 184-inch Cyclotron	23.5		
	Analytical and Service	16.0		
Chemistry, Part B	Synthetic and Experimental Organic Chemistry	7.0		
	Biological Chemistry	5.7		
	Photosynthetic Chemistry	8.0		
Chemistry, Part C	Metals and High Temperature Thermodynamics	8.0		
	Basic Chemistry, including Metal Chelates	2.0		
	Engineering Development of Plutonium Separation	4.5		
	Ore Reduction	4.0		
	General	4.5		
Medical Physics, Part A, Div. I	Metabolism of Fission Products	11.0		
	Decontamination Studies	7.0		
	Radiochemistry	3.0		
	Radioautography	2.0		
Medical Physics, Part B, Div. II	Tumor Metabolism	1.4	1.1	Consultant
	Special X-Ray Studies, Radioactive Measurements, etc.	7.1	2.3	Man-Months
	Radioactive Carbon Studies	.7	.8	
	Fundamental Medical Research	1.9	3.5	
	Hematology	.4	1.3	
	Medical Work with the 184-inch Cyclotron	3.1	1.3	
	Fly Genetics	2.0	.6	
	60-inch Cyclotron Bombardments	.4	-	
	Physical Chemistry	7.5	.5	
	Specific Irradiation	5.1	.2	
Health Physics, Chemistry and Medicine	Monitoring and Disposal	4.7		
	Salvage, Decontamination, etc.	-		
	Research and Development	16.7		
	Film Badge Program	3.5		
	Medical Examination Time	3.3		



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