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Radiation Laboratory

Contract No. W-7405-eng-48

MONTHLY PROGRESS REPORT
No. 82

January 15, 1950 to February 15, 1950

February 27, 1950

Classification changed to **DECLASSIFIED**
 by authority of J J Blum + E J Shurin, L.R.L.
 on April 1961 B. J. Sobell
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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

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1. Bevatron

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Magnet Model Tests. A preliminary test with poles for the 1 x 4 ft. aperture gave a field of 16,000 gauss (6.4 Bev) with the coils in the position required by the 2 x 6 ft. aperture. If verified by later tests this means that rewinding the coils for 6 Bev in the 1 x 4 ft. aperture will not be necessary. Tests to determine the best shape of the pole tips for the 2 x 6 ft. aperture are starting.

Building. Steel erection started February 10, 1950.

Magnet. 1400 tons or approximately 17 percent of the total steel plates have been machined. Assembly into stacks is expected to start February 27. Machining difficulties have been overcome.

Injector. Testing of low voltage units of the ion gun is proceeding. The high voltage rectifier is still in the shop.

2. 184-inch Cyclotron Operation

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The cyclotron was used for research experiments approximately ninety-two percent of the 487 hours that the crew was on duty.

Most of the difficulties experienced with the new probe have now been solved. The probe has been used consistently by the Film Program Group.

3. 60-inch Cyclotron

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The machine has been operating at the highest efficiency yet recorded. The first week of February the overall operating efficiency was 86.5 percent and that of the second week was 90.8 percent. In general, the machine is running considerably better since the overhaul than before.

4. High Current Cyclotron

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The necessary building alterations and the magnet oil cooling system have been completed. The main transformer pad is about 80 percent completed. The vacuum chamber pole pieces have been installed and tested. Work on the target pump is proceeding according to schedule.

5. Synchrotron Operation

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No higher intensity beams have been attained than those already reported. The stability of the machine has increased, however, to an approximate average output of 1500 R/hr at one meter from the target, measured with an ionization chamber behind 1/8 inch of Pb.

Studies of the magnetic field have yielded additional information on the amount of magnet compensation required. Of the 16 compensating loops (8 octant pairs) only 7 are now in use; the other 9 are open circuited for simplification. The rate of rise of compensating current at injection time is under investigation with a view toward obtaining more effective compensation early in the betatron injection period.

Much trouble has been experienced from glass puncture of the injector stems during baking out or shortly after. Ten injectors were placed in the machine in January with only three producing beams without puncture. For a time this trouble was thought to be remedied but has recurred and is being attacked by increasing the thickness of the glass.

6. Linear Accelerator and Van de Graaff

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During this month there was considerable lost time due to failures of equipment in the Van de Graaff high voltage end. The pulser gave trouble several times and the probe shorted once. A light bulb exploded and was blown through-out the tank causing 3 days of lost running time. Bake in time is very long and consumes as much as 21 percent of the total available time.

The following steps are being taken to alleviate these difficulties:

1. A dual pulser channel is being constructed to be installed during the next month. With this system it will be possible to have a failure in one pulse chassis channel and switch to another workable one from the outside of the machine without stopping operation.

2. A shield has been placed over the probe insulator to stop ion bombardment of the insulator and subsequent failure.

3. It is expected that bake in time will be shortened by sandblasting and painting the main Van de Graaff shell inside so that rust no longer forms and is transferred. A new 350 CFM Kinney pump is being installed in the gap house and will provide a much higher overall pumping speed than the present system. With the coated tank and better pump it is hoped that bake in time will be cut to a maximum of 2 hours.

The time distribution for machine operation was as follows:

| | | |
|------------------|--------|--------------|
| Total hours | 372 | |
| Bake in time | 78.5 | 21 percent |
| Operating time | 182.75 | 49.2 percent |
| Repair time | 104.75 | 28.2 percent |
| Machine research | 6 | 1.6 percent |

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It is of interest to note that although a diffusion pump is not necessary in the high voltage end it is impossible to run without a charcoal trap. This conclusion may be applicable only to the present column.

7. Experimental PhysicsUNCLASSIFIED

Film Program. Positive-Negative Ratio for π Mesons Produced by Neutrons. In previous experimentation¹ the ratio of positive to negative π mesons has been measured for mesons produced by 345 Mev protons. The ratio of positives to negatives is found to be about 5.

A similar experiment has now been performed to find the positive-negative ratio for π mesons produced by the beam of neutrons from the cyclotron. In this measurement it is found that there are more negatives than positives. The ratio of negatives to positives is 12.6 ± 1.5 .

Cloud Chamber. Measurements have continued in the experiment on the scattering of 90 Mev neutrons by deuterons as well as in the experiment to determine the energy and angular distribution of the electrons at the maximum of the shower produced by the synchrotron x-rays.

Particle Spectrometer. The parts of this equipment which involve gated Geiger-Müller counters have been completed and put to use in determining the energy spectrum of the neutron beam produced by bombardment of a beryllium target by 350 Mev protons in the 184-inch cyclotron. The neutron energies are determined by measuring the energies of elastically scattered protons from paraffin placed in the neutron beam.

Proton Elastic Scattering. An experiment to measure the angular distribution of the elastic scattering of 350 Mev protons by various nuclei is in progress.

Measurements have been carried out for five elements, C, Al, Cu, Ag, Pb. The geometry of the scattering target and detecting telescope, and the amount of multiple scattering in the targets, have been such that the angular resolution has been $\pm 1^\circ$. The angular range between 5° and 20° has been covered.

The results to date have been consistent with the predictions of the transparent nucleus theory of Fernbach, Serber, and Taylor. Diffraction minima and maxima have been observed for the heavier elements at the following angles ($\pm 1:0^\circ$)

| | Min. | Max. | Min. | Max. |
|----|--------------|--------------|--------------|--------------|
| Cu | 11.5° | 14.5° | | |
| Ag | 9.5° | 12.0° | 17° | |
| Pb | 7.5° | 9.5° | 12.5° | 16.0° |

Electronic Equipment for High Energy Pair Spectrometer. The specifications for a high energy pair spectrometer to be used for neutral meson investigation and other experiments require fast coincidence and counting circuits. Approximately three months ago, experimental work was begun in applying the latest developments in fast acting circuits; namely, the photomultiplier-crystal counter, and the distributed amplifier. At the same time, as an aid to observing the performance of

¹ H. Bradner and S. B. Jones, Bull. Am. Phys. Soc., 24 No. 8, 13 (1949)

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these circuits, construction was started on a high voltage oscilloscope and a pulse generator. Tentative plans called for resolution times not greater than 10^{-8} seconds, and for a coincidence counting rate of 10^6 counts per second. Progress has been made on the oscilloscope, pulse generator, coincidence circuit, and a pre-amplifier.

Measurements of Total Cross Sections. The bismuth fission ionization chambers were altered electronically for operation on the new linear amplifiers that have been installed in the counting area. Operating characteristics of the chambers have not changed appreciably, but noise level is higher and accidental coincidences may be worse than previously.

Measurements of total cross sections for neutron energies in the range from 90-270 Mev are in progress. It appears that at 270 Mev the minimum values of σ_T may already be attained.

Growing of Trans-Stilbene and Anthracene Crystals. The growing of trans-stilbene and anthracene crystals for use in crystal counters has been centralized in one room in the Central Research Laboratory devoted to that purpose. Production is still inadequate to meet the laboratory's demands but production techniques are being investigated and perfected.

Neutron Induced Stars in Photographic Plates Outside the 184-inch Shielding. The number of stars observed per mm^2 show correlation with data taken with fission chambers and proton recoil counters. At present three sets of ten plates are being exposed during three types of cyclotron operation (1) deflected protons (2) protons on an internal target and (3) reversed proton beam on an internal target. All plates are exposed during full energy, full intensity operation.

Delayed Neutron Emitters. Work on the investigation of delayed neutron emitters was continued. One run on cyclotron was made using five targets. The most promising one had an activity too short for the brush recorder and another run will be made using variable delay and gate circuit.

High Energy Photons. The recent experiments permit the following conclusions to be made concerning the high energy photons under study:

- (1) The yield from bombarding a hydrogen nucleus with 350 Mev protons is less than 2 percent of the yield observed from a carbon nucleus.
- (2) If a neutral meson exists as the emitting particle then its lifetime is not greater than 2×10^{-13} seconds. This has been determined by the "shadow casting" method referred to in previous reports.

The important question of whether these photons are emitted singly or in pairs is about to receive active study with a cloud chamber and magnetic field method whose preparation is nearly completed.

Capture of Negative π Mesons in Hydrogen. The high pressure vessels containing hydrogen at liquid air temperature and 3000 p.s.i. pressure has been used successfully in a number of exposures to study the absorption of π^- mesons from the cyclotron target in hydrogen. Gamma rays produced by this capture process have been studied

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by means of a pair spectrometer of low resolving power. The results obtained thus far indicate: 1. Gamma rays are produced in hydrogen and in hydrogen only. 2. The gamma rays emanating from the hydrogen are not monochromatic. 3. The gamma ray spectrum is compatible with several alternate interpretations.

Proton-proton Scattering Near 30 Mev. New plates have been exposed for proton-proton scattering at 32 Mev in order to improve statistics on the past work. The plates are of considerably higher quality than the former ones and it is expected that better statistics will be obtained.

An experiment is also in progress to study the absolute cross section at 45° angle for proton-proton scattering as a function of energy up to 32 Mev. This work is being done by 90° coincidence counters.

Production of Mesons by Proton Bombardment of Liquid Hydrogen. Further studies have been made on the plates exposed to mesons from a liquid hydrogen target. The yield confirms the high relative cross section per nucleon as compared to production of mesons in more complex nuclei.

Synchrotron Studies. In the meson program, additional data has been obtained on the energy spectrum and angular distribution. The transition curve work in Pb, Al, Cu and C and angular distribution of protons from (γ, p) reactions were completed. Further bombardments have been made in the study of gamma-induced activity in Zn, and some further work was done on the production of mesons in nuclear plates using the emulsion as a target.

8. Theoretical Physics

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Scattering Problems. A paper has been completed on the interpretation on p-p scattering. While it has been possible to find potentials which give a reasonably good account of the scattering, the lack of simplicity in the description of the forces leads us to distrust this interpretation. Measurements have been made of the diffraction scattering of high energy protons by nucleons. The position of the diffraction maxima and minima agrees well with our models, and it is expected that detailed evidence will allow closer check on features such as nuclear radius and transparency. Difficulty is still being encountered in interpreting the scattering of nucleons by nuclei.

Mesons. A paper has been completed on the photo-production of mesons, discussing such questions as angular distribution, positive-negative ratio and total cross section. Pseudoscalar meson theory (in lowest approximation) seems to give the best fit. Work is being done on the meson production in nuclei. Various mechanisms have been examined to account for the spectra of the gamma radiation emitted on π -capture in hydrogen. The most likely explanation at the moment seems to be that π^0 's are emitted which will give two gammas, and in addition that there is some competition of single gamma emission. Work is also proceeding on strong and intermediate coupling meson theory.

Machines. A paper has been written on various design features of the high current cyclotron.

9. Chemistry

Part A

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Properties of the New Element 98. Curium has been bombarded by helium ions in the 60-inch cyclotron. A new activity of 7.1 Mev alpha-particles decaying with 44 ± 5 minute half-life has been separated from the great amount of Cm^{242} activity by citrate elution in the eka-dysprosium position from a high temperature ion-exchange resin column. The chemical procedure consumed about 100 minutes. The nuclear properties of this activity indicate that it is an isotope of element 98, most likely of mass 244.

Properties of Berkelium. Further chemical tests have been made with the new element, berkelium. The formal potential for the III, IV couple is estimated as about -1.6 volts in nitric acid solutions. The elution with citrate from ion exchange resin columns is quite normal for a trivalent actinide element. The relative rates of elution of Bk, Cm and Am are analogous to those of Tb, Gd, and Eu, the corresponding lanthanide elements, and indicates the same kind of break in ionic radius at the point of half filling the 5f electron shell (curium) as has been known to exist for the 4f shell (gadolinium).

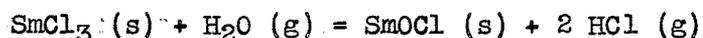
The daughters of the 4.6 hour berkelium have been investigated further. An americium electron-capture activity similar to Am^{239} has been observed, as well as a curium alpha-activity similar to Cm^{244} . The best interpretation at present is that the berkelium isotope has mass 243 and that Cm^{243} and Cm^{244} have very similar alpha-decay energies.

Half-life of Po^{208} . The half-life of Po^{208} has been determined by decay measurements over a three-year period. The samples contained small amounts of Po^{209} and Po^{210} , which were determined by alpha pulse analysis. The final result is 2.93 ± 0.03 years.

Mass Spectrograph. A new mass spectrograph for collecting microgram amounts of heavy isotopes is being designed. It will have a 60° magnetic prism with mean radius of curvature 75 cm. The magnet is being designed to give second order focusing correction. The dispersion will be 5 mm/mass at mass 300. The design is well along, and shop work is expected to start within a few weeks.

The primary objective is to collect isotopes, but provision will be made for measuring abundance ratios and for making mass assignments of radioactive isotopes.

Vapor Phase Hydrolysis of Rare-earth Chlorides. The measurements of hydrolysis equilibrium constants have been extended to the reaction:



for the temperature range 678 to 785°K. The final data will be reported later. As expected, the hydrolysis is more complete in this case than with lanthanum.

Short-lived Astatine Activities. Use of the new rabbit with the 184-inch cyclotron has led to some new results concerning short-lived astatine isotopes. Bismuth was bombarded with 250 Mev helium ions. Astatine was separated by distillation from the metal. The degree of separation from polonium in these experiments is not known. At 23-minute activity (previously reported as 30 minutes) was shown to consist of 5.88 Mev α -particles. A 7-minute activity (previously reported as 10 minutes) had 6.07 Mev α -particles. A 3-minute period had 6.3 Mev α -particles.

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At least one shorter period is also present. Some of these activities may be polonium daughters, rather than astatine isotopes.

Rare Earth Alpha-Activities. Work has continued on the alpha-activities of rare earth elements produced with the 184-inch cyclotron. The present knowledge of these is as follows:

| Element | Half-life | Alpha-energy |
|----------------|------------|--------------|
| Ho or Dy | ~22 min. | 4.1 Mev |
| Tb or Dg | ~ 7 min. | 4.2 |
| Ho or Dy | ~ 5 min. | 4.3 |
| Tb | 4.0 hrs. | 4.0 |
| Tb | 19.5 hrs. | 3.7 |
| Gd | > 2 yrs. | 3.2 |
| Ho,Dy,Tb,or Gd | ~ 1.5 hrs. | 3.8 |

ChemistryUNCLASSIFIED

Part B

Synthetic and Experimental Chemistry. The synthesis with C^{14} of the following labeled compounds has been studied during the past month: Malic- $1-C^{14}$ acid, fumaric- $1-C^{14}$ acid, succinic- $1-C^{14}$ acid, tartaric- $2-C^{14}$ acid, diethylmalonate- $2-C^{14}$, propanol- $1-C^{14}$, propyl bromide- $1-C^{14}$, propanol- $2-C^{14}$, propyl bromide- $2-C^{14}$, isocaproic- $6-C^{14}$ acid, isovaleric- $5-C^{14}$ acid, β -diethylaminoethanol- $1-C^{14}$, valine- $7-C^{14}$, vinyl acetic- $1-C^{14}$ acid, glucose- $1-C^{14}$ and mannose- $1-C^{14}$.

A Tiselius multiple stage column is being constructed for the purification sugars and other compounds difficult to isolate. Some work with clay columns has been carried out on the purification of sugars with promising but as yet inadequate results.

Biological Chemistry. Two new problems on the metabolism of C^{14} -labeled compounds in human beings are being studied, namely, the use of stilbamidine in multiple myeloma patients and the use of glycine- $2-C^{14}$ in leukemia patients.

Work has begun on the general subject of cholesterol and atherosclerosis. Preparation of tritiated cholesterol by exchange of inactive cholesterol with T_2O in the presence of platinum and acetic acid has been attempted. The possibility of paper chromatography of cholesterol is also being studied. Effort is being directed toward the determination of satisfactory color reaction tests for this compound on the paper.

The work on the metabolism of labeled nucleic acids is as yet in the synthesis stage. However, warm syntheses of adenine, guanine, 7-amino- $1-v$ -triazolo pyrimidine and guanidine are progressing satisfactorily.

The catalytic reduction of 4,6-diamino-5-phenylazopyrimidine has been investigated and optimum yield conditions determined, and the preparation of 7-amino- $1-v$ -triazolopyrimidine has been studied and accomplished by a slight

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modification of the previously published procedure starting with 4,5,6-triamino-pyrimidine sulfate.

The work on the preparation of inactive purines, pyrimidines and isoteres has progressed. The following compounds have been made and will be checked for biological activity: 2,6-Diamino-7-thiapurine, 2,6-diamino-8-methyl-7-thiapurine, 2,4,6-triamino-5-bromopyrimidine and 5-mercapto-2,4,6-triamino-5-bromopyrimidine. From uric acid two other known compounds have been prepared, namely, 2,6-dichloro-8-hydroxypurine and 2,6-diamino-8-hydroxypurine. The determination of the infrared spectra of these and about a dozen other compounds has been begun for identification and analytical purposes.

Work on the identification of unknown acid constituents obtained from liver metabolism studies of labeled propionate, acetate and carbonate has continued.

Photosynthesis Chemistry. Sequence of intermediates in photosynthesis. The question of the identity of the first product of carbon dioxide fixation in green plants has been repeatedly investigated in this laboratory. While phosphoglyceric acid seems the most likely compound from the standpoint of known reactions it has been shown that labeled phosphoglyceric acid, the hydrated form of phosphopyruvate, appears first after feeding $C^{14}O_2$. Phosphopyruvate appears after phosphoglycerate in photosynthesis by the alga Scenedesmus at high light intensity (8000 foot-candles) and low temperature ($5^{\circ}C$).

The separation of the two carboxylation processes in photosynthesis was described in the previous monthly report and has now been further confirmed in carbon dioxide fixation experiments by algae at high pH.

The intermediates involved in the synthesis of the C_2-CO_2 acceptor molecule have been the subject of investigation.

Effect of pH on photosynthesis. The classical experiments on this problem extend from pH 4 to pH 9. These limits have been extended using $C^{14}O_2$ fixation for measurement. At pH 1 it has been shown that the fixation products are similar and probably identical with those in the physiological pH range. Apparently the acidity of the medium does not affect that of cell very rapidly. At pH 11 the $C^{14}O_2$ fixation radiogram (radioautograph of two-dimensional filter paper chromatogram) deviates from the normal in that all reactions other than those forming malic and aspartic acids are inhibited. Ninety percent of the fixed C^{14} is found in these acids after one minute.

Degradation of intermediates. The degradation of phosphoglyceric acid as a function of time has been extended to include glycolic acid. In 15 and 40-second photosyntheses by barley leaves the two carbon atoms of glycolic acid have been shown to be equally radioactive. This is in agreement with the equal radioactivity found in the α and β carbon atoms of phosphoglyceric acid. The nature of the apparently symmetrical intermediate is under investigation.

Glycolic feeding experiments. Labeled glycolic acid has been fed to algae in the light and dark with appreciable fixation occurring only in the dark. The radiogram appears to be evidence for oxidation of the glycolic or its oxidation products through the Krebs cycle.

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Phosphate ester separation. Work on exchange resin and paper chromatographic separation of phosphate esters is being continued. Oxidative methods for analyses of mixtures of 2- and 3- phosphoglycerate are being developed. The exchange resin (Dow A-1) separation of these compounds is in progress.

ChemistrySECRET

Part C - Project 48B

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

1. Thermodynamics of CN and N₂ gases. A report, UCRL-529 has been issued on this subject.
2. Work has been completed on gaseous aluminum oxide species as reported in UCRL-552.
3. Work has been completed on gaseous oxide species of transition metals and reflection coefficients of gaseous molecules. The following reports have been issued: UCRL-532, UCRL-533, UCRL-534, UCRL-570, UCRL-571, and UCRL-572.
4. Gaseous hydroxide species.
5. Liquid metal systems and heats of formation of intermetallic compounds. A report on the heats of formation of intermetallic compounds has been completed and will be issued as UCRL-578.
6. Theory of refractory behavior.
A report has been issued entitled, "Borides of Uranium and Thorium", UCRL-603.

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

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

Ore Reduction. The following subjects are under investigation:

1. Micro amperometric titration of uranyl ion with chromous ion.
2. Solvent extraction using the chelate process, a study of phosphate complexing.
3. A study of equilibrium in uranyl phosphate precipitation.

10. Medical PhysicsUNCLASSIFIED

Part A

Tracer Studies. Studies with At²¹¹ are being continued. Tracer studies with carrier amounts of Ta¹⁸² have been set up on rats in order to evaluate the fate of this compound after intramuscular and intrapulmonary administration.

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Decontamination and Bone Metabolism Studies. Prompt treatment with large amounts of zirconium citrate has been found effective in lowering the blood level and eliminating carrier-free Cb^{95} which had been injected intravenously. The studies on the effect of radiation and other factors on bone and blood phosphatase are being continued. An experiment has been set up to determine the kinetics involved in the deposition of radio-calcium in bone.

Radioautographic Studies. The study on the effectiveness of radioactive At^{211} in the destruction of thyroid tissue is still continuing. Complete autopsies were made on the final groups of rats injected with 78.5 μc and 157 μc at the 41 day interval and tissues taken for histological work. A survey was made on the following selected glandular tissues: thyroid, parathyroid, salivary gland, stomach, small intestine and kidney. Histologic sections of other organs are in preparation. It may be said at once that the only organ which showed a degree of damage suggesting gross functional impairment was the thyroid gland. At no dose level was the parathyroid gland interfered with to a degree evident on minute histological examination.

Radiochemistry. Analytical procedures have been developed for the quantitative determination of astatine in tissue. Retention of Po^{210} formed by At^{210} decay in vivo has been determined for rat thyroid. Millicurie amounts of Ta^{182} have been prepared for animal injection. A carrier-free procedure has been developed for the separation of Re^{184} from a tantalum target.

Medical PhysicsUNCLASSIFIED

Part B

Biological Effects of Radiation. Deuteron irradiation of rats. Work is being continued with selective irradiation of specific body regions in animals using the collimated deuteron beam of the 184-inch cyclotron.

Yeasts. Further progress was made concerning the mechanism of the effect of ionizing radiation on cell division and the dependence of this effect on specific ionization.

Bacteriology. The phenomenon of photodesensitization of bacteria to the lethal effects of ultraviolet light is being studied further. Reproducible irregularities in the survival curve previously thought to be a simple logarithmic function, have indicated additional effects which must be worked out in the course of this study.

Survival data on strains B and B/r with deuterons from the 184-inch cyclotron have been completed for the time being and will be compared with similar data gathered with other types of ionizing radiation.

Hematology - Double nucleated lymphocytes. Additional counts on Radiation Laboratory personnel are being continually made in an effort to determine whether or not a relationship exists between the incidence of double nucleated lymphocytes in a person's peripheral blood and the amount of ionizing radiation to which he is exposed. More effort has been directed toward determining the extent of exposure to radiation and especially to neutrons by the use of interviews, film badge,

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neutron chamber, and electroscope readings, supervisor's reports and area monitoring readings. Results thus far indicate an incidence of $1.8/10^4$ for the "exposed" group compared to $0.2/10^4$ for the control group. Contrary to our earlier results this indicates that a correlation may be found between the number of such cells and exposure.

Metabolism of simple carbon compounds labeled with C^{14} . The efforts of the entire group working on this problem have been temporarily transferred to the lipoprotein and atherosclerosis problem.

Studies with C^{14} labeled stilbamidine. Stilbamidine labeled with C^{14} has been injected into a patient with multiple myeloma and the following information has been obtained so far:

1. There is no significant excretion of $C^{14}O_2$ in the breath, indicating no metabolism of stilbamidine to CO_2 .
2. The rate of disappearance of stilbamidine from the plasma is very rapid. The first blood sample was taken 3 minutes after intravenous injection, and at this time the total plasma contained only 10 percent of the injected activity. 45 minutes after injection the total plasma contained roughly 1 percent of the injected dose.
3. Samples of tumor, bone, muscle, skin and fat were obtained by biopsy two and ten days after injection. Concentrations of stilbamidine were quite low in all the tissues. However in the first biopsy, specimens, the specific concentrations were in this order: tumor > muscle > skin > bone > fat. The tumor concentration was more than twice the muscle concentration. In the second biopsy the tumor concentration was the same as the first tumor specimen while the concentration in the other tissues had decreased considerably. The tumor specific activity was over four times greater than that for muscle.
4. Excretion of stilbamidine occurs via the urine and feces, as had been anticipated by the mouse experiments.

Trace Analysis. Activation analysis in tissues is being continued. A gamma ray counter using a stilbene crystal was put into operation with an overall efficiency of 3 percent for 1 Mev gamma rays.

Physical Chemistry. A great deal of effort has been put with the blood lipoprotein problem using ultracentrifugation as the chief tool of investigation.

The mechanism of cholesterol transport in the serum of rabbits and humans via giant lipid and lipoprotein molecules of low density has been characterized. In both species there exist classes of molecules of higher S_f rate and lower density than the major group of cholesterol-bearing lipoproteins. The evidence indicates that the lower density of the molecules of higher S_f values is at least partly due to a lower content of protein per molecule.

Evidence implicating the cholesterol-bearing molecules of the S_f 10-30 class in the production of cholesterol-induced atherosclerosis in the rabbit has been presented.

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A study of 104 patients with proved myocardial infarctions reveals an almost universal occurrence of cholesterol-bearing molecules of the S_f 10-20 class (a class of molecules similar in many respects to the S_f 10-30 class in rabbits) at fairly high levels in the blood. All categories of normal humans studied show a lower frequency of occurrence of measurable concentrations of S_f 10-20 molecules than do the myocardial infarction patients (a group of patients almost all of whom have coronary artery atherosclerosis). The findings in the groups other than the myocardial infarction group are also consistent with the expected incidence of atherosclerosis in such groups.

Preliminary evidence indicates that exogenous cholesterol in the human being as well as in the rabbit is a factor in influencing the blood level of molecules of the S_f 10-20 class.

Studies are now in progress with other categories of patients who develop atherosclerosis to a degree beyond that for supposed normal individuals of corresponding ages. These categories include hypertensive patients, patients with the anginal syndrome but without proved infarctions, nephrotic patients, and hypothyroid patients. In addition, long term studies of the effect of diet with and without adjunctive drugs such as thyroid, lipotropic factors, and possibly sex hormones, on the blood level of molecules of the S_f 10-20 class are continuing. All these groups should help to evaluate further the role of these giant molecules in the development of atherosclerosis.

Metabolism of Cobalt. Further data were obtained on the distribution and rate of turnover of tracer cobalt in nuclear and cytoplasmic tissue.

Metabolism of Iron. A group of investigators is in the Peruvian Andes at the present time studying effects of high altitude on iron metabolism in the human being. Methods using Fe worked out previously here are being employed.

Further data on iron metabolism in the normal human being are being gathered on prison inmates. Iron distribution studies in rabbits continue.

11. Health Physics and Chemistry

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Progress has been made on several items by personnel in the Research and Development group. The following projects have been completed: A rotating reagent rack for use in Berkeley Boxes with remotely operating circulator manipulator, a model for a circulator manipulator chain lift, a cone hot bath, micro balance tongs, a capsule target for use on the 60-inch cyclotron, a heavy-duty dolly for moving Berkeley Boxes enclosed in portable lead caves, a box for transporting 60-inch cyclotron targets, a special sliding door gloved box, and 4 standard Berkeley Boxes.

The pneumatic tube "air-lift" for quick transport of targets to Bldg. 5 from the 184-inch cyclotron for study of short-lived isotopes has been successfully put into use. Fifty-five short bombardment targets were carried during the month.

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12. Plant and EquipmentUNCLASSIFIED

Bevatron Building and Equipment. The first structural steel for the building was erected on February 7, 1950. Some concrete is still being poured. Fabrication of magnet steel is progressing at about the anticipated rate. Design of the raceway has been completed and will be sent out for bids in the near future.

Construction of Cafeteria. The contractor began work the first week of January, 1950 but construction has been delayed by heavy rains. About 1/4 of the concrete is in place and the bulk of wall forms have been erected. 3/4 of the reinforcing steel is in place.

Construction of Animal House. Design of the animal house is still in the preliminary stages.

Construction of Sheetmetal and Salvage Shop. This project, though budgeted, has not been started.

Warehouse. The receiving room in the warehouse is substantially complete. 80 percent of the shelving in the storeroom section has been installed and stores are being moved thereto from other storage areas.

Radiological Laboratory at the University of California Medical School. The architects are continuing with working drawings which, owing to details on the part of structural engineers, are not scheduled for completion until the end of March, 1950.

Miscellaneous Construction. Alterations to Laboratory Buildings. The cave in Room 203 of the chemistry building is nearing completion - only a few technical details have yet to be worked out.

Power Distribution. Work on this job has been continuing and the 12 kv line to the hill substation is nearly complete. Temporary power has been established to the Central Research Laboratory. Engineering has been started on the other sections of this job.

Fire Protection. Present phase of work is essentially complete; the remaining work is to be accomplished next spring.

Alterations to Synchrotron Building. The shop extension is essentially complete. Plans are being prepared for extending the experimental area housing the counting equipment.

Decontamination Unit. This project has been progressing. The building shell has been erected but minor painting and touch up remains to be done.

Roads and Parking Areas. The first section of this job to be done this year which was outlined in December, 1949 has progressed as follows: the rough grading and laying of the rock sub-course is complete and the contractor is awaiting dry weather to apply the seal coat.

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MAN MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

| PROGRAM | SUBDIVISION | MAN MONTHS EFFORT | COMMENTS | |
|----------------------|---|-------------------|-------------|--|
| 184-inch Cyclotron | Operation | 10.0 | | |
| 60-inch Cyclotron | - - | - | Non-Project | |
| Synchrotron | Operation | 8.2 | | |
| Linear Accelerator | Linear Accelerator - General | 4.5 | | |
| | Van de Graaff - General | 4.6 | | |
| | Development | .9 | | |
| Bevatron | Building | .1 | | |
| | Injector | 1.0 | | |
| | Magnet | 4.5 | | |
| | 1/4 Scale Model Development | - | | |
| | Vacuum System | .1 | | |
| | Miscellaneous | .5 | | |
| Experimental Physics | Cloud Chamber | 9.5 | | |
| | Film Program | 10.8 | | |
| | Ionization Chamber and Crystal Counter | 2.3 | | |
| | Neutron-proton Scattering | .5 | | |
| | Proton-proton Scattering | 1.8 | | |
| | Meson Range and Decay Measurement | - | | |
| | Absolute Cross Section Measurements | .8 | | |
| | General Physics Research | 10.6 | | |
| | Instruments for General Use | .5 | | |
| | Meson Experiments with Synchrotron | 4.9 | | |
| | Scintillation Counters - Research | | | |
| | | Experiments | .4 | |
| | Pair Counter Experiments | 6.8 | | |
| | Compton Scattering Experiments with Synchrotron | | | |
| | | | - | |
| | XC Cyclotron | 2.6 | | |
| | Particle Momentum and Energy Analysis | 1.5 | | |
| | Proton Elastic Scattering | .9 | | |
| | Magnetic Measuring Equipment | .4 | | |
| Neutron Half Life | .5 | | | |
| Theoretical Physics | Bevatron | .5 | | |
| | General Physics Research | 9.6 | | |
| | Linear Accelerator | 2.8 | | |
| Isotope Separation | Nier Spectrometer | .4 | | |

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MAN MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

| PROGRAM | SUBDIVISION | MAN MONTHS EFFORT | COMMENTS |
|---------------------------------|--|---|------------------------------|
| Chemistry, Part A | Chemistry of Transuranic Elements | 4.1 | |
| | Nuclear Properties of Transuranium Elements | 5.0 | |
| | Transmutations with the 184-inch Cyclotron | 13.4 | |
| | Analytical and Service | 16.7 | |
| | Process Chemistry | 9.8 | |
| Chemistry, Part B | Synthetic and Experimental Chemistry | 6.5 | |
| | Biological Chemistry | 6.3 | |
| | Photosynthesis Chemistry | 5.0 | |
| Chemistry, Part C | Metals and High Temperature Thermodynamics | 3.5 | |
| | Basic Chemistry, including Metal Chelates | 1.5 | |
| | Ore Reduction | 2.5 | |
| Biology and Medicine, Part A | Metabolism of Plutonium and Allied Materials | 11.0 | |
| | Decontamination Studies | 6.0 | |
| | Radiochemistry | 4.0 | |
| | Radioautography | 2.0 | |
| Biology and Medicine, Part B | Tumor Metabolism | .7 | 1.4 Consultant man-months |
| | Special X-ray Studies, Radioactive Measurements, etc. | 6.7 | 2.2 |
| | Radioactive Carbon Studies | .6 | - |
| | Fundamental Medical Research | 5.2 | 2.6 |
| | Hematology | .6 | .7 |
| | Medical Work with the 184-inch Cyclotron | 2.1 | .1 |
| | Fly Genetics | 1.8 | .3 |
| | 60-inch Cyclotron Bombardments | .2 | - |
| | Physical Chemistry | 6.4 | 1.0 |
| | Specific Irradiation | 3.5 | - |
| | Donner Animal Colony Expense | 1.5 | 1.0 |
| | Biology and Medicine, Part C | Synthetic and Experimental Organic Chem- istry | 18.1 |
| Health Physics, Chemistry | Monitoring and Disposal | 6.3 | |
| | Research and Development | 17.9 | |
| | Film Badge Program | 4.8 | |
| | Medical Examination Time | 2.6 | |

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