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Radiation Laboratory

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MONTHLY PROGRESS REPORT
No. 81

December 15, 1949 to January 15, 1950

January 27, 1950

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Classification change to _____
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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

December 15, 1949 to January 15, 1950

MONTHLY PROGRESS REPORT NO. 81

1. BevatronUNCLASSIFIED

Magnet Model Tests. Decisions have been reached to divide the vacuum tank covers into 5 degree sections to reduce the eddy current effects, to use double rubber gasket joints across the center of every other magnet sector with provision for pumping between the gaskets, and to provide a recess in the pole tip and pole base slabs where a gasket joint occurs. The effect of the recess and the gasket clamping bars has been checked by model tests and found to be negligible. The gaskets, although somewhat complicated, are believed as economical and less liable to production problems than the welded joints required to make continuous sheets. The eddy current effects in the continuous sheets could have been compensated by currents in the bias windings but it was considered preferable to save the capacity of these windings for possible corrections or intentional changes in the field.

Building. As the magnet foundation is not to be poured until March, decision on insulating the reinforcing steel has not yet been reached. The retaining walls and column footings are now substantially complete and the possibility of trouble from slides is past. Work has been proceeding slowly on the generator foundations during the delay of structural steel caused by the strike. The steel is expected to begin arriving on the site in the middle of February.

Magnet. 1500 tons of steel has been received by the fabricator and is being flame cut. Delays have occurred in finishing the edges of the long plates due to an attempt to substitute close tolerance flame cutting for machining. At the present time various methods of grinding and milling are being tried by the fabricator with the expectation that a satisfactory method will be decided on in a few days.

Injector. Assembly of the ion gun is proceeding. The final drawings of the r.f. high voltage supply units were released December 30 following detail changes resulting from tests on the sample unit.

Tentative decisions for the linear accelerator electrical system were reached. Four oscillators using 1 Eimac XM15 tube each and two pre-exciter from the BC677 radars as used on the 32 Mev Linac are planned. Three 160 ohm 1 milli-second 15 kv output pulse lines will be used. Half of the pulse power will be absorbed in shunt resistors. Operation will be possible with any oscillator, pre-exciter and pulse line out of service.

Controls. Plans are being made for the control room desk and rack location.

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2. 184-inch Cyclotron Operation

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The cyclotron was used for research experiments approximately eighty-six percent of the 471 hours that the crew was on duty.

Work on the new equipment installed during the last major shutdown reduced the operating time somewhat, but the difficulties are being eliminated.

3. 60-inch Cyclotron

Operation efficiency has returned to 70 percent level since the long overhaul. We now are on a regular bombardment schedule, satisfying the requests on campus and requests from Oak Ridge. Determination of internal alpha beam indicates 260 microamperes of circulating beam. As high as 25 microamperes external have been seen at this new energy of 40 Mev.

4. High Current Cyclotron

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Work on the cyclotron is now entering the assembly stage. The vacuum chamber and pole pieces will be vacuum tested and installed during the week beginning January 30. The dees are under construction. Rapid delivery is expected since the copper welding problems are well under control. The target fluid pump is undergoing the final design changes.

The magnet and magnet cooling system are 90 percent complete, as scheduled. To date there have been no deviation from the construction schedule.

5. Synchrotron Operation

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Beam output for the past month has been average and the peak intensities of the month before last have not been attainable. Average beam intensity has been approximately 750 R/hr and although somewhat lower than desired, this value of intensity has enabled the experimental program to proceed.

Considerable outage during the past month has been encountered because of component part failures. The first of these was a series of glass punctures in the injectors which was cured by deducing that positive ion bombardment from local high pressures in the stems of the injectors caused the breakage. The trouble was eliminated by installing new gaskets on the injector support stems. The second and major trouble was due to a failure incurred by the reactor designed to effect current sharing between the two GL 506 ignitrons which conduct the magnet current during the first half cycle of the alternation. Following the failure of a leading ignitron and later the failure of a grid lead on one of the trailing GL 506 ignitrons, the machine was shut down for a thorough check of all of the high voltage equipment in the cubicle. The load sharing reactor was found to be shorted to the core. Later operation showed a perturbation in the betatron flux and inter-turn insulation failure of the load sharing reactor. A somewhat effective repair was achieved by adding thyrite discs in parallel with the reactor. Other reactors are being obtained.

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The technique for studying the magnetic field by means of the octant peaking strips is being refined. Some interesting data has been taken indicating that non-circular orbits may be used and still maintain a usable beam. These octant peaking strips have been very useful in checking for trouble in the event of the loss of the beam due to octant compensation loop failures.

During experiments involving scintillation counters, it is usually desirable to bring the gamma ray beam out slowly during each pulse. This is now being done by leaving the r.f. voltage on for approximately 130 electrical degrees after the start of the magnet cycle and injection and using a decaying r.f. voltage adjusted so as to spill the beam out as near peak magnetic field (at 90°) as possible. With the best adjustment possible using this system, a pulse of gamma rays lasting approximately 2 milliseconds has been obtained but debased in energy because practically all of the pulse occurs before the peak magnetic field (corresponding to 335 Mev). It is thought that the use of a complex r.f. voltage wave form based on minimum r.f. voltage requirements, rate of change of magnetic field, and electron energy loss due to radiation can be used to bring the beam out symmetrically disposed about peak magnetic field at 90 electrical degrees. This would be the most homogeneous beam energy compromise. Equipment for this purpose has been designed and is being built. R.f. voltage modulation will be accomplished by the use of a secondary oscillator, and it is hoped to secure a beam pulse of duration 90 ± 25 electrical degrees or any period shorter down to 10 μ secs and symmetrically disposed about peak field.

A marker generator of considerable accuracy for defining the time of peak magnetic field has been built and is now in operation.

6. Linear Accelerator and Van de Graaff

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The Van de Graaff machine operated very well during this period with only two openings. Both openings were caused by shorted probe insulators in the ion source. Steps have been taken to design and install a new shield for the probe insulator which should eliminate further breakdowns from this cause.

One of the shutdowns was used to do routine maintenance work and to remove the upper diffusion pump and graphite adsorption trap. It had been found previously during the month that successful operation could be obtained with the upper pump off. At this time the Hypervac backing pump for the diffusion pump was also turned off.

Operation during the period December 15 - January 15 consisted of 211.5 hours of bombardment and 64.9 hours of repairs, for both the linear accelerator and the Van de Graaff with 8 hours for bake in.

Useful operating time was 74.5 percent of the total time involved.

Bombardments were made principally for the following projects: 1) inelastic scattering of protons on heavy elements. 2) limits of Rutherford scattering on heavy elements. 3) short lived isotopes of the type having two fewer neutrons than protons. 4) proton-proton scattering photographic plate method. 5) studies of secondary neutrons from targets bombarded by protons. 6) neutron survey. 7) chemistry.

7. Experimental Physics

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Film Program. Meson Mass Measurements. Work is continuing on a program for measuring masses of π and μ mesons. This program has been described in previous reports.

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Positive-Negative Ratio. Study of the ratio of positive to negative π mesons produced by bombarding targets with high energy protons is continuing.

Investiation on the Possibility of a Branching Ratio in the Decay of π^+ Mesons. To October, 1949, investigation on various aspects of π^+ mesons particularly the measurement of the mass, has shown that roughly 5 percent of the mesons detected do not, upon stopping in matter (photographic emulsion) give rise to μ^+ mesons. These might be μ mesons, arising from another source than the target, that have lost enough energy in the apparatus to have a range in the emulsion consistent with π mesons. L. W. Alvarez has suggested however, that a study be made on the possible existence of a phenomenon in which the π meson decays directly to an electron, and apparatus has been built which will detect π^+ mesons from the target and only μ^+ mesons which have such a range that they cannot be confused with π mesons from the target. To date, of 110 mesons detected in this apparatus, 109 show distinct decays and only one has no decay. The ranges in the emulsion and the momenta of these particles are consistent with those of π mesons from the target. The possibility of this one being spurious cannot be eliminated as yet, and this study will be pursued until sufficient data is gathered to offer convincing results.

Cloud Chamber. In the experiment to determine the spectral distribution of the synchrotron x-rays, a few of the pictures had not been measured. These have now been included in the data.

Two more runs have been made in the experiment on the scattering of 90 Mev neutrons off deuterium gas and the evaluation of these data is proceeding.

Measurements are also proceeding in the experiment to determine the energy distribution of the electrons that are produced when the synchrotron x-ray beam falls on a 1/2 inch thick piece of lead. This point corresponds to the maximum of the shower.

One day was spent in the investigation of the background in the synchrotron magnet room. A small cloud chamber that could be completely surrounded with lead was used. The results indicate that the background just out of the beam is surprisingly low and that it would be practical to operate a cloud chamber in the magnet room.

Meson Induced Fission Experiment. The continuation of this experiment at the synchrotron seems hardly worthwhile upon further consideration of the maximum counting rate possible from fission pulses induced by the present negative pi-meson production at the synchrotron.

Particle Spectrometer. The portion of this equipment to be used in analyzing particle curvatures in a magnetic field, namely the G.M. amplifiers and gating circuits, has been completed and is being tested with protons ejected from paraffin by the high energy neutron beam of the 184-inch cyclotron. Preliminary results are promising, but show that more attention should be given to eliminating background counts and to reducing delay times between coincidence pulses. It is hoped that the latter problem has been solved; this will be checked and attention will be given the former during the next trial run. Plans have been made to put the apparatus to use in measuring the energy distribution of the proton-produced neutron beam of the cyclotron. This will both yield a useful result, in that a good determination of the energy distribution has never been made, and provide an

opportunity to become familiar with the characteristics of the equipment before more difficult scattering problems are attempted.

Bismuth Fission Chamber. Total cross sections for six different elements were measured for the neutron beam formed by the bombardment of a 2 in. Be target by protons of 270 Mev energy (probe at 69 5/16 in.). From previously reported measurements the mean neutron energy was estimated to be approximately 190 Mev. The attenuating materials were placed in front of the concrete igloo which contained a 2 in. diameter 31 inch long concrete collimator. The effective length of the collimator was further increased by lead bricks. The detector was a bismuth fission chamber placed 11 feet from the front of the collimator. A second fission chamber placed to one side of the igloo served as the monitor. The detector was placed at 20° with respect to the incident proton beam in order to have target, collimator, and detector in line. Background, determined by plugging the collimator with 28 in. of brass and 20 in. of lead, was 6 percent of the unattenuated neutron counting rate. The total cross sections for carbon, aluminum, copper, tin, lead and uranium have the same values for the 190 Mev neutrons as for the 270 Mev neutrons, within the statistical errors of the measurements.

Delayed Neutron Studies. Preliminary experiments to investigate the delayed neutron activities from uranium bombarded with 350 Mev protons have revealed the well known 55 second, 23 second, 4 second and 1/2 second activities, but not the one second activity which occurs in low energy fission. A clear indication of an activity shorter than 1/2 second was observed but a low neutron intensity did not permit its measurement. The intensity, however, is easily raised and a subsequent experiment will allow its measurement.

High Energy Photons from Proton-Nuclear Collision. Recent efforts on the high energy photon problem have been concerned with the following items:

1. The life-time of an intermediate particle whose decay may yield the photons.
2. The yield of photons from proton collisions with hydrogen nuclei.
3. The yield versus atomic number.

The first problem has been attacked by the "shadow castor method" previously described. It is possible to say that the mean life time of any intermediate particle is not greater than about 10^{-12} seconds. This experiment is being refined.

The yield from hydrogen has been sought by a C-CH₂ difference method. The pairs of targets were adjusted so as to provide equivalent numbers of carbon atoms exposed to the beam. Both gamma ray yields and neutron yields were measured from each target. The conclusion is that there is no yield of photons from p-p collisions which is larger than about one percent of the yield from collision with the carbon nucleus.

The photon yield as a function of atomic number has not been well enough determined to warrant numerical statements.

Neutrons Produced in Be by 31 Mev Protons from the Linear Accelerator. As a preliminary experiment to the investigation of neutrons produced by 31 Mev proton reactions in light elements, the angular distribution of neutrons from Be was

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determined with carbon detectors. The neutrons detected were those of course above the 18.7 Mev threshold of the $C^{12}(n,2n)C^{11}$ reaction and probably had a maximum energy of around 29 Mev. The Be target used was 10 Mev thick for 31 Mev protons to give the maximum possible yield. By using a 35 Mev thick carbon absorber in front of the detectors it was possible to determine the relative neutron intensity at 0° . The results are given in the table:

θ	Relative Intensity	Background
0°	$1.00 \pm .08$	----- .012
12°	$.64 \pm .12$	
23°	$.33 \pm .04$	----- .017
45°	$.13 \pm .03$	----- .007
56°	$.08 \pm .05$	
68°	$-.02 \pm .03$	----- .02
90°	$-.01 \pm .02$	

The half width at half maximum is approximately 17° and the distribution evidently cuts off somewhat short of 68° .

As might be expected from energy consideration a carbon target gave no intensity appreciably different for background. The background is sufficiently low relative to the Be effect to indicate that rather more detailed experiments of this nature including energy distributions are feasible. A recoil proton coincidence telescope is being prepared to extend this work.

Electronics for Fast Crystal Counting. The high speed oscilloscope for testing scintillation counters is now operating with a top sweep speed of roughly 10^{-8} second per inch and a deflection amplifier having an upper cut-off frequency of about 125 mc and a sensitivity of about two volts for a deflection of 1/2 inch. A pulse generator with a rise time of something like 10^{-9} sec. has been built. Further work is being done on the test equipment.

Using the above apparatus, the pre-amplifier mentioned in the last report has been tested and found to operate about as predicted. We are now able to design and construct distributed amplifiers without much difficulty. However, there is still some doubt as to the best design for the pre-amplifier and main amplifier because of uncertainty regarding the voltage requirements of the coincidence circuit. Design work on the coincidence circuit has recently been started.

Meson Research in the External Beam. In the last month the program for observing production cross sections of π mesons in carbon and in lead by 345 Mev protons at 90 degrees to the beam has been finished. The results will be written for publication. In addition, the magnetic separation technique has been successfully applied to measurements of cross sections for mesons at 0° to the beam. The first experiment was to measure the cross sections of the carbon atom and the CH_2 molecule. As expected, no significant difference in the negative cross sections was obtained. A significant difference in the positive cross sections, however, was observed. This indicates that the technique can be successfully applied to measuring the meson production cross section for protons on protons.

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Production of Mesons in Liquid Hydrogen. The study of the plates exposed in the last month has been continued and an error has been found in the past calculations in solid angle and energy interval. As a result it appears now to be fairly certain that the cross section of mesons produced in hydrogen is about 15 times larger than has been predicted theoretically. This is in qualitative agreement with the results of Richman and Wilcox.

A larger liquid hydrogen target is being tested which will permit the studies to be carried out to smaller scattering angles (15°) and which also permits the study to extend to much lower meson energies. Also the diameter of the hydrogen chamber is now large enough so that the collimation requirements of the external beam of the cyclotron are not as excessive. This results in a decreased low energy impurity of the primary beam and consequently less background in the plates due to low energy proton-proton scattering. This equipment is now vacuum tight and it is expected to be used during the next month.

Inelastic Scattering of 32 Mev Protons in Heavy Elements. The study of inelastic scattering energy distribution previously completed for carbon and aluminum have been extended to lead and gold. It was of course expected that in these heavy elements only a continuum of levels would be obtained. Contrary to expectations, level structure was obtained from bombardments of (unseparated) lead and even at high excitation the secondary spectrum does in no way correspond to the theoretical distribution. The distribution from gold has not shown up any level structure, but also the distribution does not appear to fit the theoretical expectation based on the statistical model of the nucleus.

Capture of Negative π Mesons in High Pressure Hydrogen. A positive effect in the search for gamma rays from the capture of negative π mesons in hydrogen has been obtained. However, the spectrum of the out-going gamma rays, as far as can be studied with the limited resolving power available, did not show the expected monochromatic peak at 130 Mev, but appears to have a distribution similar to the gamma rays directly produced by proton impact on a target, when such gamma rays are observed in the backward direction. The spectrum appears therefore to be peaked in the neighborhood of 65 Mev. Whether this means that a two gamma process is taking place or whether there is another explanation is subject to further studies.

Proton-Proton Scattering. A successful exposure has been made of photographic plates in hydrogen in the linear accelerator beam. The plates show considerably less background than the plates on which the previous studies have been based. It has therefore been decided to read these plates also in order to improve statistics and accuracy of the previous work.

Proton-Proton Scattering at 345 Mev. Two runs have been made with the new apparatus (90° coincidences, crystal counters, distributed amplifiers). These runs proved a substantial superiority of the new technique over the old one. Within the limit of their accuracy the old values of the differential cross sections were confirmed.

One run with liquid hydrogen at small scattering angles showed that the scattering cross section did not change down to a 17° deflection in the center of mass system.

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Pb and Bi bombarded with α 's with the 60-inch were further studied to find the energy of the α 's emitted in several new short periods.

Synchrotron Studies. Considerable progress has been made in the meson counter work. This equipment was used to measure the angular distribution of mesons produced in hydrogen by 250 Mev photons. A carbon paraffin difference was utilized and the plateau characteristics of the detection system measured.

In the induced activity experimental program, further data has been taken on the relative yields of activity from various gamma induced nuclear reactions in Zn isotopes.

The (γ ,p) studies planned have been completed on the energy distribution curve of protons in the (γ ,p) reactions on C, Cu, and Pb and the proportionality of the cross-section to $A^{2/3}$ has been further investigated.

The detection of fission neutrons has been postponed pending higher beam intensities.

Further bombardments in the meson nuclear plate program and meson triggering of the cloud chamber will be resumed this month.

8. Theoretical Physics

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The study of proton-proton scattering is essentially completed and has been reported in UCRL 554. The perturbation calculation on the production of mesons by photons has also been finished. Measurements of the production of mesons by photons are well under way while work on the $\mu \rightarrow e$ decay spectrum has just begun. Work on the theory of the beam dynamics of the linear accelerator is continuing. The I.B.M. machines are being used to find solutions for the phase and radial motions of the particles to obtain estimates of the efficiency for acceleration in such machines.

9. Chemistry

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Part A

Discovery of Element 97. An isotope of element 97 has been prepared by bombardment of Am^{241} with 35 Mev helium ions in the Crocker 60-inch cyclotron. Its identity as an isotope of element 97 is proved by evidence concerning its radioactivity combined with chemical procedures which should separate it from all other elements. Its mass number is probably 244, but mass 243 has not been completely ruled out. The name "berkelium" with the symbol Bk is suggested for the new element.

The isotope decays with a 4.8-hour half-life. Radiations observed include three groups of alpha-particles of energy 6.20 (17 percent), 6.55 (53 percent), and 6.72 (30 percent) Mev, conversion electrons, Auger electrons, L x-rays, and harder radiation which is K x-rays or soft gamma-rays. The decay is predominantly

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by electron capture. After decay of the 4.8-hour activity, a weak alpha-activity of 5.79 Mev remains which is probably Cm²⁴⁴ daughter, but this has not yet been proved. The α/K branching ratio is ~ 0.1 percent and the energy spectrum of soft electromagnetic radiation associated with the 4.8-hour decay was observed to have the characteristics of curium L x-rays as shown by a Xe proportional counter. Comparison of the ratios of the alpha-particle groups in two separate bombardments made at different energies revealed no differences in abundances as might be the case if two isotopes were present. The decay of the electromagnetic radiation was followed through a factor of about 100 and if two isotopes are present in similar abundances, their half-lives must be nearly identical.

The new element has a +4 state which carries on zirconium phosphate precipitated in solutions of moderately high acid concentration, and a +3 state which does not. It can apparently be oxidized to the higher state by means of bromate in nitric acid, dichromate in nitric acid, and not by bromine in sulfuric acid. As indicated by carrying with zirconium phosphate, none of these oxidized it in hydrochloric acid. Elution from a column of cation exchange resin with citrate solution removes element 97 far ahead of Am and Cm, as is the case with Pu(IV). It is carried in both oxidation states by LaF₃ and by La(OH)₃.

Bent-crystal X-ray Spectrometer. Certain improvements have been made in the counter arrangement of the x-ray spectrometer to increase the sensitivity and to lower the background. The instrument at present has a proportional counter with pulse-height discrimination which results in a background of about 3 c/m. It has been used successfully to observe neptunium L x-rays from the decay of Am²⁴¹.

Mass-Assignment of Zr⁸⁷. A 90-minute positron-emitter previously reported as a zirconium isotope has now been assigned to mass 87 by milking of its daughters. It is found to decay to two isomers of Y⁸⁷, of 14 and 80 hour half-lives, and ultimately to the 2.7-hour metastable state of Sr⁸⁷. These observations also give independent confirmation of the assignment of the two yttrium activities to the same mass number.

Alpha-energy of U²³¹. The alpha-particles of U²³¹ have now been observed with the pulse-analyzer, at energy 5.45 Mev. The activity was prepared by irradiation of thorium with 55-Mev helium ions, an energy which favored the ($\alpha, 5n$) reaction over the ($\alpha, 6n$) and greatly decreased U²³⁰ interference. A sublimation technique for preparation of counting samples also improved the result, as it has many other experiments. The alpha-particles were observed to decay with the known 4.2-day half-life of U²³¹.

Time-of-flight Mass Spectrometer. Recent experiments with a preliminary model of a new kind of time-of-flight mass spectrometer show promise of its equalling the performance of the usual magnetic-deflection type. In this device, the ions of each mass are bunched by means of a saw-tooth accelerating potential. The ions of different masses arrive at different times at a receiving electrode. The current at the receiving electrode is amplified by an a.c. amplifier and observed on an oscilloscope swept by means of the same sawtooth voltage. The geometry is such that about 90 percent of the ions from the ion source reach the collecting electrode.

Chemistry of Lanthanum and Praseodymium. The heats of solution of samples of pure lanthanum metal and pure praseodymium metal have been measured in a microcalorimeter

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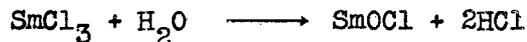
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previously described. The values found for the heats of solution in 1.5M HCl were:

La 165.6 \pm 1.3* Kcal/mole
Pr 164.6 \pm 0.4* Kcal/mole

(*mean deviation)

Chemistry of Samarium. Equilibrium constants for the reaction



have been measured at various temperatures in the range 350-500°C, by a technique previously described. The data obtained have not been analyzed completely, but the following free energy equation probably is accurate to within 1 kilocalorie:

$$\Delta F = 23,400 - 38.1T$$

Chemistry of Vitamin B₁₂. The magnetic susceptibilities of samples of vitamin B₁₂ from two different sources have been measured at room temperature.

A sample prepared by the Upjohn Company was found to be diamagnetic, with $X = -0.66 \times 10^{-6}$ cgs. units. This suggests that this material is a covalent cobaltic complex with octahedral d^2sp^3 bonding.

A sample prepared by the British Drug Houses was found to show a slight and variable paramagnetism. On careful examination the samples were seen to be inhomogeneous. The paramagnetism of this material may have been due entirely to impurities.

Chemistry

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Part B

Synthetic and Experimental Chemistry. The work of preparing metabolic intermediates and compounds of biological interest, all labeled with C^{14} , has continued.

The study of the synthetic steps necessary for the preparation of guanine and guanazolo is virtually complete, and warm runs will be started soon.

Powdered zinc in glacial acetic acid has been found to reduce 4,6-diamino-5-phenylazopyrimidine smoothly to 4,5,6-triaminopyrimidine. This method appears to have advantages in technique over a method previously described in the literature. The reaction of this latter compound with formamide and formic acid in a sealed glass ampule has been found to be unsatisfactory due to the pressure developed during the reaction, and this step is being studied further. A warm preparation of adenine is contemplated as soon as this last step has been improved.

Biological Chemistry. Work has been continued on the metabolism of sodium propionate by mouse liver slices. A comparative study has been started of the metabolism of sodium bicarbonate in the presence of sodium propionate and of sodium acetate. Initial results indicate, as might be expected, the presence of many common intermediates in the metabolism of these compounds.

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Other biological studies in progress during the last month include:

- (1) The metabolism in chicken and distribution in eggs of labeled choline;
- (2) the retarding of tumors by purine or pyrimidine derivatives and isoterese;
- (3) the metabolism of C^{14} labeled stilbamidine in mice and humans; and
- (4) the metabolism of C^{14} labeled glycine in humans and the half-life of the red blood cells therein.

Photosynthesis Chemistry. The intermediates of carbon dioxide reduction in plants are being studied as a function of time under a variety of conditions of photosynthesis. The purpose of these studies is to determine the relative order of synthesis and the effects of conditions upon the steady-state equilibria involved.

Identification. The paper chromatographic separation and identification of 2- and 3-phosphoglyceric acids (PGA) is being continued. The former has been purified on ion exchange resins and is being compared with the latter.

The simple polysaccharides (oligosaccharides) formed in short photosynthesis are under investigation. Acid hydrolyses yield glucose, maltose and simple polyglucose compounds are being compared.

Glyoxylic acid has been synthesized from radio-glyceric acid obtained from plants and its chromatographic position determined. It is still necessary to identify the compound obtained upon periodate oxidation of glyceric acid as glyoxylic acid.

Degradation. Further degradations of photosynthetic glyceric acid have been performed. It appears that the α and β carbon atoms have equal specific activities. This suggests that the cycle involved in regeneration of the two-carbon carbon dioxide acceptor molecule may include a symmetrical intermediate. A method for degradation of glycolic acid using periodic acid has been developed and will be used for degradation of glycolic acid formed during photosynthesis.

Glycolic Acid Feeding Experiments. $2-C^{14}$ labeled glycolic acid has been used as a substrate during short photosyntheses by Scenedesmus with $C^{12}O_2$ but the amounts absorbed have been too small to measure. The same alga was then fed glycolic acid during six hours in the dark and a number of products were formed. Radioautographs of these chromatograms are being exposed.

Effect of pH on Photosynthesis. The great difference in quantum yield for Chlorella at pH 4 and pH 8 which was observed by Warburg has elicited interest in the effect of pH on respiration photosynthesis and their relationships. The dependence of $C^{14}O_2$ uptake upon pH has been determined. Even at pH 1 and pH 10 the rate of carbon dioxide uptake is about fifty percent of the effect of time at the optimum rate. It is now conceivable that experiments in feeding acidic substrates can be carried out at pH levels more conducive to assimilation.

Effect of Iodoacetamide Inhibition on Sucrose Synthesis. The effect of iodoacetamide upon $C^{14}O_2$ uptake has been determined for Chlorella was found to differ considerably from published oxygen-evolution measurements. It was expected that sucrose synthesis should be blocked at the phosphoglycerictriose phosphate step. No decrease in the amount of radiosucrose was observed until ninety-five percent inhibition was reached.

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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.
2. Gaseous aluminum oxide species.
3. Gaseous oxide species of transition metals.
4. Gaseous oxide and hydroxides species of Mo and W.
5. Reflection coefficients of gaseous molecules.
6. Liquid metal systems.
7. Refractory studies.
8. Thermal conductivity of gases.
9. Heat transfer in forced convection film boiling.

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.

Ore Reduction. The following subjects are under investigation:

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

10. Medical PhysicsRESTRICTED

Part A

Tracer Studies. Metabolism studies with Lu¹⁷⁷ has been completed in rats. Metabolic studies using Ta¹⁸² are being set up in rats.

Decontamination and Bone Metabolism Studies. Further experiments are being carried out on the effect of bone deposits of plutonium on the level with alkaline phosphatase in bone and blood. The studies with rachitic animals are continuing.

A simplified method has been developed for the determination of radio-calcium.

Radioautographic Studies. The radioautographs in the series of studies on the uptake of various elements by skeletal tissues of the rat at the costochondral junction have been completed. Counterstains of the sections are being prepared to facilitate the exact localization of the various elements in the bony, cartilaginous and ancillary tissues of this site.

Histological studies of Astatine 211 on the rat is continuing. Thyroids and trachea were taken for histological work on the two groups of rats injected

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with 1.2 microcuries and 6 microcuries at the 41 day interval. Complete autopsies were made on the group injected with 30 microcuries, at the 41 day interval and one rat from the group injected with 157 microcuries at the 3 day interval and tissues were taken for histological work.

Radiochemistry. Work continued on the production, isolation and analytical procedures for At^{210} . The $\text{At}^{210} / \text{At}^{211}$ ratio was found to be approximately 4 at full beam energy. Ta^{182} in isotonic saline and citrate has been prepared for animal injection. Approximately 1 millicurie of Na^{22} was isolated from a magnesium target using a previously reported procedure. Factors influencing the retention of carrier-free I^{131} in organic solvents are being studied using cyclotron produced radio-iodine.

Medical PhysicsUNCLASSIFIED

Part B

Biological Effects of Radiation. Animal Studies with the 184-inch Cyclotron Beam. During the month of December deuteron irradiation of white rats was continued as a part of a general study of the physiological effects of localized irradiations. The high energy collimated deuteron beam affords the possibility of irradiating sharply localized regions of the body. A complete survey of a number of important body regions is being done with the collaboration of U. S. Naval Radiation Laboratory at Hunter's Point. A study of the mechanism on the biological effects of radiation on haploid and diploid yeast cells was continued.

Hematology - Double Nucleated Lymphocytes. Careful evaluation of the radiation exposure of various groups at the Radiation Laboratory is being made and compared to the incidence of double nucleated lymphocytes. As far as the study has progressed there has been no evidence of correlation of these cells with exposure.

These cells are also being studied in patients with various diseases.

Bacteriology. Two strains of E. Coli, B and B/r showing different degrees of resistance to the lethal effects of radiation, have been studied further with high energy and low energy deuterons from the 184-inch cyclotron, with 200 kv x-rays and with ultra violet light. If differences in size or configuration of the radiosensitive "targets" in these two strains are important in their response to lethal irradiation, the comparison and correlation of these data together with survival curves run with polonium α -rays should be expected to bring them to light. This correlation is in progress.

Partial desensitization of bacteria to the lethal effects of U-V has also been studied in more detail by producing this phenomenon by pre-irradiation illumination with visible light. The mechanism of this effect is under examination.

Radiation Effects on Water. Work was completed on a phase of the effects of radiation on water and a report is being submitted.

Metabolism of Simple Carbon Compounds Labeled with C^{14} . The rates of conversion of labeled compounds to CO_2 are being studied in mice.

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Studies with Stilbamidine Labeled with C¹⁴. Labeled stilbamidine was given to a patient with multiple myeloma in a dose of 55 mg containing 300 microcuries of activity. Breath, urine, feces, and blood samples are being taken at intervals for analysis; and biopsy specimens of tumor tissue are being collected.

Studies of Blood Coagulation. Blood clotting studies making use of the heparin prolonged clotting time and the electrical resistance technique are being discontinued. Such data as have been collected are being analyzed. It appears that the treatment of patients with leukemia and polycythemia with P³² has no adverse effect on the blood clotting mechanism as measured by these techniques.

Trace Analysis. Activation analysis of micro-composition of tissues and blood is being continued.

Physical Chemistry. This program is continuing with emphasis on the study of cholesterol containing components of the blood by ultracentrifugation.

Iron Metabolism Studies. Plasma and red cell iron turnover studies have been completed on a subject with refractory anemia. A significant difference was found in the specific activity of red cell iron and the specific activity of hematin which was isolated from the same red cells. The latter was lower by a factor of 1/2, indicating that the red cells of this subject contain a significant amount of non-hematin iron. This study is being repeated and is to be applied to a larger series of cases in which such an abnormality is suggested.

The blood content of various tissues of rabbits immediately following death is being determined by the previous injection of iron tagged compatible erythrocytes. It is hoped that enough uniformity will be found so that perfusion or hemoglobin determination of tissues can be eliminated in subsequent determinations of iron content of tissues.

11. Health Physics and Chemistry

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The fast neutron survey previously reported as underway at the 60-inch cyclotron has been completed and the results discussed with the Staff; additional shielding is being arranged for.

The fast neutron survey recently made for comparison with the results before carbon liners, etc. were installed has shown a decrease by a factor of four in the number of neutrons in several locations per unit current in the beam.

Tests of the large bismuth fission chamber have shown that the chamber is probably counting fast neutrons. But more tests in the right kind of beam are needed.

A fast neutron survey counting neutrons coming from the electrostatically deflected proton beam in the 184-inch cyclotron has shown above-tolerance neutron energy flux densities in some locations. Some additional temporary shielding has been installed.

Survey of the very high energy neutron flux outside the shielding by observation of nuclear stars in photographic emulsion is now being attempted.

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Progress has been made on several items by personnel in the Research and Development Group. The stirrers have been improved after two trial runs on the Hanford dissolver solution extraction box. The model is complete and drawings are being made on the gooseneck reagent rack for use in Berkeley Boxes with a remotely operating circular manipulator.

Some special target tongs have been completed.

Four Berkeley Boxes and modified centrifuges have been completed and a new centrifuge suspension to improve and simplify gloved box installations has been designed and built.

12. Plant and Equipment

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Bevatron Building and Equipment. Progress during this past month has been very slow due to heavy rains; however, work has continued on the pouring of the building and equipment foundations. The magnet foundation has not as yet been started. The structural steel for the building is still expected about the middle of February. Magnet steel has been arriving in large quantities and fabrication is proceeding. Engineering and design work is still progressing on the vacuum system, injector and accelerating system.

Construction of Cafeteria. The cafeteria contractor is ready to begin construction as soon as the site layout is complete.

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 major construction has been completed. Work is continuing on the interior finish. Materials stored in the Oakland Warehouse have been completely moved into this new structure.

Radiological Laboratory at the University of California Medical School. The architects are still preparing working drawings.

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 in the finishing up stages. Temporary power has been established to the Central Research Laboratory. Other sections of this job have not been started to date.

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

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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 and work is continuing on the inside finishing.

Roads and Parking Areas. The first section of this job to be done this year which was outlined last month 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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UNCLASSIFIEDMAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

<u>PROGRAM</u>	<u>SUBDIVISION</u>	<u>MAN-MONTHS EFFORT</u>	<u>COMMENTS</u>
184-inch Cyclotron	Operation	9.9	
60-inch Cyclotron	- -	- -	Non-Project
Synchrotron	Operation	8.2	
Linear Accelerator	Linear Accelerator - General	4.3	
	Van de Graaff - General	4.4	
	Development	1.3	
Bevatron	Building	.1	
	Injector	2.1	
	Magnet	3.1	
	1/4 Scale Model Development	-	
	Vacuum System	.2	
	Miscellaneous	.7	
Experimental Physics	Cloud Chamber	5.8	
	Film Program	1.3	
	Ionization Chamber and Crystal Counter	2.8	
	Neutron-proton Scattering	.7	
	Proton-proton Scattering	2.4	
	Meson Range and Decay Measurement	.5	
	Absolute Cross Section Measurements	2.3	
	General Physics Research	11.5	
	Instruments for General Use	.3	
	Meson Experiments with Synchrotron	2.8	
	Scintillation Counters - Research Experiments	-	
	Pair Counter Experiments	4.3	
	Compton Scattering Experiments with Synchrotron	-	
	XC Cyclotron	4.2	
	Particle Momentum and Energy Analysis	1.1	
	Proton Elastic Scattering	.9	
	Magnetic Measuring Equipment	1.2	
Neutron Half-Life	1.0		
Theoretical Physics	Bevatron	1.0	
	General Physics Research	11.0	
	Linear Accelerator	2.1	
Isotope Separation	Nier Spectrometer	1.0	

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MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL
(Continued)

<u>PROGRAM</u>	<u>SUBDIVISION</u>	<u>MAN-MONTHS EFFORT</u>	<u>COMMENTS</u>
Chemistry, Part A	Chemistry of Transuranic Elements	3.3	
	Nuclear Properties of Transuranium Elements	4.8	
	Transmutations with the 184-inch Cyclotron	13.0	
	Analytical and Service	16.9	
	Process Chemistry	6.3	
Chemistry, Part B	Synthetic and Experimental Organic Chemistry	5.1	
	Biological Chemistry	5.8	
	Photosynthesis Chemistry	5.5	
Chemistry, Part C	Metals and High Temperature Thermodynamics	3.5	
	Basic Chemistry, including Metal Chelates	1.5	
	Ore Reduction	2.5	
Medical Physics, Part A	Metabolism of Plutonium and Allied Materials	11	
	Decontamination Studies	6	
	Radiochemistry	4	
	Radioautography	2	
Medical Physics, Part B	Tumor Metabolism	.7	1.4 Consultant Man-Months
	Special x-Ray Studies, Radioactive Measurements, etc.	6.2	2.2
	Radioactive Carbon Studies	.6	-
	Fundamental Medical Research	6.2	2.6
	Hematology	.6	.7
	Medical Work with the 184-inch Cyclotron	2.5	.1
	Fly Genetics	2.8	.3
	60-inch Cyclotron Bombardments	.3	-
	Physical Chemistry	6.4	1.0
	Specific Irradiation	2.6	-
	Donner Animal Colony Expense	1.5	1.0
Health Physics, Chemistry	Monitoring and Disposal	5.1	
	Research and Development	17.4	
	Film Badge Program	4.7	
	Medical Examination Time	6.0	

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