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RADIATION LABORATORY

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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

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MONTHLY PROGRESS REPORT NO. 122

May 15, 1953 to June 15, 1953

July 17, 1953

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

May 15, 1953 to June 15, 1953

MONTHLY PROGRESS REPORT NO. 122*

July 17, 1953

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

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NaI(Tl) Crystal Investigation of High Energy Gamma Ray Line

A run has been recently made in the 90° position at the 184-inch cyclotron to explore the production of a gamma ray line previously seen with the magnetic pair spectrometer in the region of 16 Mev, when protons bombard a carbon nucleus.

The pulses from the sodium iodide phosphor were photographed, and were also analyzed by a pulse height analyzer. The results obtained indicate a narrow line of energy about 16.4 Mev, and the line persisted even when the bombarding proton energy was lowered to 30 Mev. The range of energies explored for the incident protons extended from 30 to 140 Mev. The upper limit of 140 Mev was set to avoid the production of neutral meson photons. Previously, with the magnetic pair spectrometer the presence of the 16 Mev line had been observed for proton energies as high as 340 Mev.

In order to avoid the unwanted effects due to fast neutrons in the sodium iodide, it was necessary to filter the radiation through a three-foot paraffin absorber, and only by so doing was it possible to cause the desired line to stand out above the neutron produced effects. Attenuation of the photons in carbon, aluminum, and lead absorbers agreed with that expected for gamma rays of this energy.

A beryllium target, replacing the carbon under identical circumstances at 140 Mev, showed no yield of the line in question.

Nuclear Internal Momentum Distributions

Hydrogen, lithium, beryllium, and carbon were observed in the last cyclotron run. For both beryllium and carbon it was found that the number of correlated particles emerging was very small, indicating that nuclear absorption and secondary collisions are appreciable. It is planned to observe deuterium and compare this spectrum with lithium. It is also planned to observe boron, to see if the unpaired proton in this case will give a hydrogen-like peak.

* Previous report UCRL-2235 (No. 121).

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Fast Deuterons from 340 Mev Protons on Nuclei

Differential cross sections for deuteron production at 40° to the beam resulting from proton bombardment of various elements have been measured and are reported in the table below. These cross sections were obtained using the magnetic particle spectrometer with wedge-shaped absorbers of 0.6, 1.2 and 2.0 deuteron ranges thickness placed in front of the 35 channel counters. Deuteron production cross sections can be determined from the change in counting rate going from $0.6R_D$ absorber to a $1.2R_D$ absorber. The cross section of alpha + triton production can be determined from the change in counting rate from OR_D absorber to $0.6R_D$. Also, the effect of proton nuclear attenuation in the absorbers can be measured. Proton production cross sections were also determined from this same data and are listed below:

<u>Target</u>	<u>$\frac{d\sigma}{d\Omega}$ (proton)</u>	<u>$\frac{d\sigma}{d\Omega}$ (deuteron)</u>	<u>$\frac{d\sigma}{d\Omega}$ (a + t)</u>
Li	33.6 ± 0.10	0.57 ± 0.72	
C	49.0 ± 0.21	1.33 ± 0.21	0 ± 0.50
Al	85.5 ± 0.27	4.92 ± 1.00	0.59 ± 1.13
Cu	151.0 ± 0.43	11.55 ± 3.14	
Pb	266.0 ± 1.10	14.37 ± 8.76	

Differential Cross Sections for Production of
Various Charged Particles at 40° to the Proton
Beam

These cross sections were put on an absolute scale by normalizing to the differential p - p cross section. This was done by determining the counting rate from hydrogen using a $CH_2 - C$ target difference. The deuteron cross sections reported are lower limits because the spectrometer will not count deuterons of energy less than 52 Mev. The energy spectrum of the deuterons is essentially zero above $E_D = 110$ Mev, and rises as the deuteron energy falls. The spectrum is at a maximum at 52 Mev, indicating that there are deuterons of lower energy present which are not detected.

The cross section for proton production fits well to a curve of the form

$$\sigma_p = 13.2Z^{0.71} \frac{\text{millibarns}}{\text{steradian}}$$

The exponent 0.71 says that the proton production is predominantly a surface effect which is to be expected from other high energy inelastic cross section data.

The cross section for deuteron production fits well to a curve of the form

$$\sigma_d = 0.035 A^{1.48}$$

This is very interesting in that it says the production goes up faster than A. This can be explained by assuming the process is the indirect pick-up process described by Bransden (Proc. Phys. Soc. Sept., 1952).

It is proposed to determine the angular dependence of the differential cross section for one element to aid in identifying the formation mechanism.

The Photoproduction of Negative Pions from Deuterium

Further calculations are proceeding. A different deuteron wave function is being used to see if better agreement with the experimentally measured ratios can be obtained.

Transparent Integrator for the Linear Accelerator

A neon CO_2 counter set for counting only the delayed heavy particles from the reaction $\text{Ne}^{20}(p, n)\text{Na}^{20}$, $\text{Na}^{20} \rightarrow \beta^+\text{Ne}^{20*} \rightarrow (p \text{ or } \alpha)$ proved to be linear with beam when compared to the Faraday cup integrator up to 2×10^{-8} amperes. As the counter's lifetime varied from a few hours to weeks depending on beam level, it was decided to abandon the use of a quenching gas. Further work with noble gases at higher beam levels indicated the possibility that the Faraday cup was non-linear. The cup was checked by bombarding carbon inside the cup at currents up to 8×10^{-8} amperes and found to be linear within the accuracy of the measurements, ± 2 percent.

Short Half Life Studies

Further investigations of radio isotope Ne^{18} have been carried out. The best value of the half life is believed to 1.6 secs. Magnetic spectrometers data are now being analyzed which should give an excellent value of the β -ray energy. The known He^6 activity was used to provide a comparison spectrum.

Beta Ray Spectrometer

All parts have been completed on six crystal counting units for 1P21 tubes. The beta ray spectrometer was put in operation on a Ne^{18} experiment. It was operated directly in the linear accelerator beam and also off to one side using a target that moved from the beam to the spectrometer. The spectrometer separated Ne^{18} from the more abundant Ne^{19} in both configurations.

An improved power supply is being made for the spectrometer magnet since the supply used was not steady enough. Additional counter tubes are being added to the spectrometer to include more solid angle behind the exit slit. A trajectory plot is to be made using the current in a wire method in order to relocate the baffles in the spectrometer.

A run was made on the double scattering of protons from aluminum. The first scatterer was placed in the steering magnet of the linear accelerator and the second scatterer was placed in the $+20^\circ$ port scattering chamber. Two proportional counter-crystal telescopes were used to detect the double scattered protons. This was the first time that these counters had been used and the crystals are not of the desired shape. There were counts which seemed to be doubly scattered protons. Improvements must be made in the counters and the shielding.

Anomalous Thompson Scattering of 2.8 Mev Gamma Rays by Light Nuclei

Elastic scattering of gamma rays on an atom can take place through scattering from nuclear levels (resonant scattering), scattering by tightly bound electrons (Rayleigh scattering), or by scattering off the entire nuclear charge (Thompson scattering). The first of these is negligible because of the narrowness of the nuclear levels. The second also is negligible compared to Thompson scattering if we choose a nucleus of low enough atomic number, look at angles not too far forward, and use a gamma energy sufficiently high compared to electron binding.

The effect of the charged meson cloud surrounding the nucleus is expected to produce an enhancement of the Thompson scattering. Huddleston predicts almost an order of magnitude increase of the proton Thompson scattering over the classical Thompson cross section, for low energy gamma rays.

An experiment has been initiated to detect 2.8 Mev gamma rays from Na^{24} scattered elastically through 90° off of light nuclei, by means of a large NaI crystal and a multi-channel pulse height analyzer.

Beta Ray-Neutrino Angular Correlation Experiment

Search was made for delayed coincidences between the beta particle and the recoiling nucleus in the Ne^{19} beta decay. No coincidences were observed, which indicates that the detection efficiency for recoil ions is low, at the bias used. This means that the search should be repeated with the intensity reduced, so as to reduce the random coincidence background, and with a lower bias.

Under these conditions the background of the recoil counter is too high to allow the search to be performed. We are therefore engaged in reducing this background, which is due chiefly to particles being pulled off various surfaces in the counter by our accelerating field.

Film Program

The meson mass measurement program has been completed. The method has been partially described and preliminary results have been reported at earlier stages of the work. To determine the mass ratios the ranges and momenta of the particular particles were measured in the same velocity intervals. The decay momentum of the positive muon was found by comparing the muon ranges with the ranges of pions of known momentum and of nearly the same velocity. Complete reports of the theoretical and experimental details are being prepared for publication.

The values for meson masses and related quantities are given below. The errors quoted are statistical probable errors. The uncertainties in the various quantities are not independent. The mass assumed for the proton is 1836.1 electron masses. The bracketed numbers are absolute mass determinations in the derivation of which no use is made of information obtained from the direct comparison of masses with that of the proton, but it is assumed that a neutrino of zero rest mass is emitted in a two body decay of the pion.

Values obtained for fundamental mass ratios are: for π^+ /Proton, 0.14888 ± 0.00011 ; for π^- /Proton, 0.14840 ± 0.00017 ; and π^+/μ^+ 1.321 ± 0.002 .

The absolute decay momentum of positive muon, $P_0 = 29.80 \pm 0.04$ Mev/c.

The derived mass in units of the electron mass for $\pi^+ = 273.4 \pm 0.2$, for $\pi^- = 272.5 \pm 0.3$, for $\mu^+ = 207.4 \pm 0.4$.

The absolute mass measurements in units of the electron mass for $\pi^+ = 273.5 \pm 1.2$, for $\mu^+ = 207.1 \pm 1.1$, for $\pi^+ - \mu^+ = 66.41 \pm 0.07$.

The following papers have been submitted to the Physical Review for publication:

(1) Measurements of Meson Masses and Related Quantities; F. M. Smith, W. Birnbaum, and Walter H. Barkas. This paper is to appear as a letter, giving the results of the work described above.

(2) Large Angle Scattering of Negative Pions in Aluminum, Copper, and Lead; Harry H. Heckman and L. Evan Bailey. The total cross sections for backscattering of 32 ± 10 Mev negative pions in Al, Cu, and Pb have been measured. A stripped emulsion was embedded in a semi-infinite absorber, and exposed to an incident beam of π^- mesons. The positions and direction of mesons stopping in the emulsion were recorded. The cross sections are proportional to the ratio of the backward flux to incident flux, both of which are observed on the same strip of emulsion. The conclusions of this investigation are: (a) the scattering is consistent with energy dependence in the region of 32 ± 10 Mev; (b) the angular distribution has a maximum at 180° ; (c) the cross section for backscattering is proportional to the mass number A. The total nuclear backscattering cross sections (elastic and inelastic) for negative pions in Al, Cu, and Pb are 59.6 ± 11 mb., 192 ± 27 mb., and 577 ± 80 mb., respectively.

Accelerator time was used for the following experiments: (a) γ -ray spectrum at 90° from Cu and Pb targets when bombarded by the 330 Mev bremsstrahlung beam; (b) high energy spallation products emitted at 0° from Al under 345 Mev proton bombardment; (c) energy spectra at 0° for secondary particles from Ni, Ag, Au, and Be under d and α -bombardment; and (d) development of a 26 Mev meson beam using a modified spiral orbit spectrometer.

Work has continued in (a) high energy electron processes; (b) β -ray spectra; (c) γ -ray spectrum from Be under 340 Mev proton bombardment; and (d) angular and momentum distributions of spallation products from various targets under proton, deuteron, and alpha bombardment.

Cloud Chamber Studies

A run was made at the cyclotron using the 270 Mev neutron beam and the 10 atmosphere chamber to obtain additional data for the study of π^- production in deuterium. About 30 mesons were noted during the run and careful scanning may be expected to locate more.

Measurement of the reprojected events in the study of the disintegration of helium by 270 Mev neutrons has been completed. Calculations on the basis of these measurements are now being made.

The 4 ft. x 8 ft. diffusion chamber was in continuous operation for 30 days and nights to obtain pictures of Auger showers. The camera was counter-controlled and pictures were taken whenever a shower passed near the chamber. Several hundred pictures were taken. About one hundred pictures show a particle density greater than 300 particles per square meter, with the maximum approximately 10,000 particles per square meter.

Modifications have been made in the vapor supply of the 35 atmosphere chamber and it is being assembled for a run in the near future. A device to detect hydrogen in the air around the chamber is being constructed. It will turn off the high voltages which flash the lights if any hydrogen has leaked out of the chamber. Other safety measures are being incorporated.

Synchrotron Studies

During this month a new method of monitoring has been developed and used. Its purpose is to monitor accurately the number of high energy quanta near the upper limit of the x-ray spectrum. It utilizes a magnet immediately following the collimator. Electrons produced on the edges of the collimator hole and having a high energy are bent in the magnetic field through a collimating channel on to a NaI crystal viewed by a 5819 photomultiplier. The DC output of the photomultiplier is integrated to give the beam which is passed through the collimator. The magnetic field is adjusted so that only very high energy electrons are measured. That this instrument does monitor the high energy quanta was determined by using the pair spectrometer to measure the high energy quanta and showing that under different operating conditions this instrument tracked it very well. Plans are being made to construct a permanent device of this sort. The collimator size used was small so that it was possible to use the spray from its edges. With a larger collimator it would probably be necessary to use a foil in the beam.

Running time has also been used in an experiment to determine the triplet cross section.

More nuclear emulsions have been exposed to the scattered γ -rays at 90 degrees from copper and lead. The analysis of the plates exposed to scattering from carbon is not complete but indicates that the cross section for the scattering of 20-30 Mev quanta can probably be obtained.

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

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The Feynman-Schwinger Green's function technique hitherto employed to formulate bound state and scattering problems independently of perturbation theory has been extended to cover nonstationary processes involving the creation and annihilation of particles. It was shown that the transition amplitude of this type may be expressed in terms of a Green's function. The equations for the Green's function derived by this technique, unlike those conventionally employed, are nonlinear even in the lowest approximation, thus allowing perhaps for the possibility of radiative transitions which is absent in the Bethe-Salpeter equations. Attempts to solve these equations are being made.

Very high energy nuclear processes are being studied by using the statistical model which for such processes may be regarded as an opposite extreme from perturbation theory. A method is being devised to evaluate the fundamental phase space integrals. Results will be compared with the formulae based on the limiting cases of non-relativistic nucleons and extremely relativistic mesons.

The low energy (15 Mev) photo-neutron resonance is being studied by means of a perturbation method which takes into account correlations between nuclear particles. It is hoped in this way to calculate the shape of the excitation function for photo-neutron emission.

A detailed investigation is being made concerning the relation of the Tomonaga intermediate coupling approximation in the strong coupling limit to the conventional strong coupling theory of Wentzel, et al. The primary emphasis is upon the application of these results to the problem of meson-nucleon scattering.

A pair of coupled non-linear differential equations describing all electrodynamic self-energy effects (excluding overlapping and vacuum polarization graphs) has been derived using the integral equation formalism of Schwinger.

Calculations of the target thickness corrections to the bremsstrahlung spectrum from bombardment of high energy electrons on copper have been carried out. The work is to be extended to heavier elements.

An investigation of the proton-deuteron scattering problem has been undertaken with particular interest in the associated polarization effects.

π^- meson production in n-d collisions is being investigated for the special case in which a final deuteron is formed. The R-matrix for this reaction has been chosen to agree with experimental data for the reaction $n + n \rightarrow \pi^- + d$.

The matrix element for the non-pickup scatterings in the reaction $p + t \rightarrow d + d$ reduces to a double integral. After algebraic manipulations this integral is expressible as the sum of sixteen formidable quadratures, but it appears easier to evaluate the original double integral numerically.

Work has continued on the meson-nucleon wave equation in the adiabatic limit. The low energy total cross section for π^+ - p scattering has been calculated. At 37 Mev the result is 19.5 mb. in good agreement with the experimental value of 20.8 ± 1 mb. reported by Angell and Perry (Rochester) but not with the value of 7.9 ± 2 mb. at 33 Mev obtained by Leonard and Stork here.

3. MTA TARGET PHYSICS PROGRAM (A. E. C. Program No. 4900)

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During the past month, two more runs were made with 190 Mev deuterons and 340 Mev protons to establish more definitively what processes must be postulated to interpret the attenuation curves of these particles in various materials. A good interpretation of the deuteron attenuation curves is afforded by means of only three cross sections: the inelastic cross section for the primary deuterons, a stripping cross section for the deuterons, and an inelastic cross section for the resulting protons. By proper utilization of the Coulomb barrier in taking energy from the incident deuteron and giving up energy to the stripped proton, it is possible to explain satisfactorily the quite definite break in deuteron attenuation curves at $0.58 R_0$, where R_0 is the range of the deuteron.

The neutron time-of-flight apparatus was given a brief shake-down run, using 190 Mev deuterons in an extremely weak beam as the particles initiating pulses in the scintillator crystals. The electronics was checked as regards resolution time of the coincidence bridge, and a length of cable only 10 cm long was sufficient to stop all coincidence counts. This resolution corresponds to a resolving time of about 4×10^{-10} seconds. The need for a reliable beam monitor was clearly brought out, and further work on this problem is in progress.

Explorations of the internal He^3 beam were carried out by means of two internal ion chambers mounted on the proton probe, in an effort to increase the external deuteron beam. On the basis of the first measurements, it was felt that the target should be placed farther back inside the dee proper, and accordingly such a movable target assembly was built and further beam profiles taken with it. External beam measurements have not yet been made with this arrangement, but are planned in the near future.

After a trip to Hanford, Washington, to inspect the Los Alamos large liquid scintillator tank, a similar tank has been designed to be built here, and most of the necessary accessory equipment has been ordered.

4. ACCELERATOR CONSTRUCTION AND OPERATION UNCLASSIFIED

Bevatron Construction (Program No. 9001)

Magnet. By June 15th pole tip assembly was complete except for some sandblasting and attachment of the pole face winding supports. None of the pole tips had been installed due to the reworking of the quadrant tanks.

Vacuum System. Reworking of the first quadrant tank was completed on June 12. No difficulty was obtained in securing adequate insulation resistance of the joints following the changes described in last month's report. Tests of typical gasket joints indicated that no trouble would occur from electrical discharge at any pressure that might exist in the inter-gasket pumpout space.

Injector. The linear accelerator output beam was obtained on May 19th practically as soon as high voltage was applied to the oscillators. The maximum steady current is 35 ma with the existing arrangement of grids. Measurements of the beam energy are now in progress.

Accelerator. Electrical wiring and plumbing remains to be completed before the electrode can be excited from the power amplifier. Testing of components is continuing in the electronics laboratory.

General. Plants for the beam measuring probes and targets for the high energy beam have been completed and engineering design is starting. Low energy targets will be similar to those used on the 1/4 scale model. The high energy targets will be provided with a power operated reciprocating means to move the target into the beam near the end of acceleration. One of these latter targets will be located inside the southwest quadrant.

Detail drawings are being prepared for the shielding blocks as described in previous reports.

Plans for the layout of the control and counting rooms on the first floor are nearing completion. Three bays of the building, providing a total area of 3200 sq. ft., will eventually be available allowing space for 87 relay racks. An additional trench below the floor is planned between the counting area of the west tangent area where the principle targets will be located.

184-inch Cyclotron Operation (Program No. 5741)

The cyclotron was used for research experiments approximately 96 percent of the 532 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	509.50 hours	96.1 percent
Electrical troubles	11.25	2.1
Mechanical troubles	5.25	1.0
Others	<u>6.00</u>	<u>0.8</u>
Total	532.00 hours	100.0 percent

184-inch Cyclotron Conversion (Program No. 4900.02)

The order for fabricating the auxiliary magnet coils for the 184 in. cyclotron conversion has been awarded to Westinghouse Electric Company. The copper has been received in their plant and their tooling is proceeding. It is believed that the first winding spool will arrive at the Emeryville plant during the first half of August.

The shop work for the 1/2 Scale rf Model has been completed and assembly is in progress.

The experimental work on the vibrating condenser blades has resulted in the decision to use a 32 in. active length with a straight taper and requests for bids on materials and machining are outstanding.

Theoretical and experimental work is continuing on the various deflectors. The 184 in. electron model has obtained a small electron beam which, however, is somewhat off center. After this beam is centered, deflector experiments will be performed therein.

Studies of revised shielding requirements and experimental facilities are nearing completion. It is planned to present these results at a meeting in the near future in order that a decision may be made as to which of the proposed revisions should be included during the modification shutdown.

60-inch Cyclotron Operation (Operated by the University of California)

The 60 in. cyclotron has been operating on a 16 hr., 5 1/2 day week, with a consistent operating efficiency of between 75 and 80 percent. Commitments for bombardments with alpha, deuteron, proton and carbon particles have been met with minimum difficulties.

Synchrotron Operation (Program No. 5731)

The synchrotron continued to operate in a highly satisfactory manner during this report period.

A number of bombardments for various groups was made with the electron linear accelerator.

Considerable activity on projects for other groups characterized the principal efforts.

Operating statistics are as follows:

Operation for Customers	283.75 hours	90.08 percent
Maintenance	<u>31.25</u>	<u>9.92</u>
Totals	315.00 hours	100.00 percent

Linear Accelerator Operation (Program No. 5751)

Linear Accelerator and Van de Graaff operating time was distributed as follows:

Running time (physics research)	359 hours	75 percent
Repairs	103	21
Maintenance	<u>18</u>	<u>4</u>
Totals	480 hours	100 percent

5. CHEMISTRY
(A. E. C. Program No. 5311)

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Alpha Decay of Em²²⁰

From the correlation of properties of other even-even alpha emitters, it was predicted that Em²²⁰ should decay about 0.5 percent to an excited state about 550 kev above the ground state. An alpha group has now been found 542 kev from the main alpha group, with abundance about 0.3 percent.

Berkelium

Americium containing 10 percent Am²⁴³ was bombarded with 27 Mev alpha particles. Decay curves of K x-rays and of total nucleometer count of the resulting berkelium fraction both showed a 2-day activity which is believed to be Bk²⁴⁶, produced by the (α, n) reaction from Am²⁴³.

X-ray Spectroscopy

Certain discrepancies which were small but outside expected limits of error have been noted for some time in the x-ray energies measured with the bent crystal spectrometer. These have now been explained by errors in the graduation of the arc scale. A new scale has been made and installed, and the discrepancies have been removed. With the new scale, the energy of the prominent gamma ray of Am²⁴¹ is 59.62 ± 0.06 kev.

The Crystal Structure of Nb₂C

A new carbide of niobium has been identified as Nb₂C from its powder diffraction pattern, which is closely analogous to that of Ta₂C. The lattice is hexagonal, with the dimensions:

$$\begin{aligned} \underline{a} &= 3.117 \pm 0.003 \text{ \AA} \\ \underline{c} &= 4.969 \pm 0.005 \text{ \AA} \end{aligned}$$

The metal atoms are in hexagonal closest packing. The carbon content has not been determined except by analogy to the tantalum compound. Since NbC was also present in the sample (with $\underline{a} = 4.440 \pm 0.002 \text{ \AA}$), the above parameters are for the carbon rich limit of composition.

Ruling Lines on Quartz Glass

A method has been discovered for ruling very fine lines on quartz glass for use as length standards. If this glass is scratched with a diamond point, it chips so much that the line width is unsatisfactory. If 10 to 20 micrograms of lead are evaporated onto a square centimeter of surface and heated to red heat, the lead reacts to give a lead glass surface which can be ruled very easily. A few lines, spaced 0.0002 inch apart, were ruled on this surface.

Metals and High Temperature Thermodynamics

Work is in progress on the following problems: refractory silicides, heats of formation and absolute absorption coefficients of high temperature molecules, reflection coefficients of molecular beams, magnesium oxide gas, sodium carbonate vapor, and high temperature halide molecules.

Basic Chemistry

The following problems are under investigation: studies involving ammonia, complexing of scandium by fluoride ion, thermodynamics of thiosulfate, study of hydrates, rare earth fluoride complex ions, ferric fluoride complex ions, and hydrolytic polymerization of zirconium.

Process Chemistry

Work is in progress on the following problems: preparation of titanium metal, film boiling from subcooled liquids, thermal conductivity of gases at high temperatures, capacity of perforated plate liquid-vapor contacting columns, mass transfer in agitated liquid systems, gas phase mass transfer studies, and thermal diffusion in liquids.

Health Chemistry

The Equipment Development Group has been engaged primarily on the following items:

1. Further equipment and processes is being developed for processing of special soils and subsequent experimentation with this material.
2. The largest part of the time spent by this group has been used in designing and fabricating boxes and auxiliary equipment for processes at Livermore and in connection with Livermore.
3. Twelve Berkeley Boxes have been assembled, fitted and delivered on requests from researchers.

6. BIOLOGY AND MEDICINE
(A. E. C. Program No. 6300-6500)

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Biological Effects of Radiation

Studies with the 60-inch Cyclotron. Six-times ionized carbon particles are being used for radiobiological studies. In the month of June it was found that the survival curve of diploid yeast cells, which is of the multi-hit variety when x-rays are used, is modified in shape when the carbon particles are used. This indicates that the percentage of dominant lethal effect with carbon nuclei is much higher than with x-rays.

Protection of Small Animals against X-rays. The experiments of Maisin and Bacq using thiolethylamine were repeated. In agreement with the Belgian workers it was found that rats whose liver is protected by lead shield derive additional protection from post-irradiation administration of thiolethylamine.

Fat Metabolism

Further studies of serum lipoproteins in the irradiated rabbit shows that in addition to the development of high S_f lipoproteins after severe irradiation that there is a consistent increase in the flotation rate of the major abundant approximate S_f 6 to an S_f 7 or 8. Presumably this change is related to the previously noted defect in lipoprotein metabolism induced by severe irradiation.

Tracer Studies

Experiments on the relative biological effects of alpha and beta emitters on rats and primates and the deposition of aerosols in the lungs of primates are continuing.

Radiation Chemistry

Studies of radiation effects in aqueous solutions of organic substances have been continued. Methods of rapid mixing which will make possible improved studies of the oxygen effect have been developed for sealed and gas-flushed systems.

Plant Biochemistry

The nature of photosynthetic processes continues to be the principal interest of the Plant Biochemistry section of the Bio-Organic Chemistry Group. Among the research projects which are of current interest are:

1. The isolation of mannoheptulose and parcitol from avocado leaves is in progress.
2. The optimum conditions for the formation of radioactive sedoheptulose from $C^{14}O_2$ in Sedum are being studied.
3. Chemical degradations of radioactive ribulose and sedoheptulose to determine the distribution of carbon-14 in the sugars are being continued.
4. The efficacy of several killing agents (hot methanol, ethanol, etc.) in connection with the flow system used to study photosynthesis during very short time intervals after administration of $C^{14}O_2$ have been compared.
5. To study possible "second carboxylation" reactions, PGA- C^{14} is being formed in the dark, and the subsequent light reaction is being investigated in leaves and algae.
6. The distribution and form of thioctic acids in plants are being determined by bio-assay methods.

7. The photochemical, physical, and chemical properties of thioctic acid, trimethylene disulfide, and related compounds are under investigation.
8. The applicability of potentiometric methods to study the Hill reaction are being tested.

Animal Biochemistry

The following projects are in progress:

1. The effect of X-irradiation upon the incorporation of adenine into the soluble nucleotides, desoxynucleic acids, and pentose nucleic acids of mice has been studied. A particularly large effect upon incorporation of adenine into DNA has been noted.
2. A quantitative colorimetric method for the determination of lathosterol in rabbit serum is being studied in connection with research on the metabolism of cholesterol and lathersterol in rabbits.
3. The synthesis of lathosterol is being continued.
4. The fate of fed or injected thioctic acids in rats has been studied, with particular reference to the amount and form in which it is excreted and retained in the liver.
5. The conversion of acetate-2-C¹⁴ to lipids and proteins in the livers of normal and pantothenic acid deficient rats has been investigated. The effect of coenzyme A on this distribution has also been studied.
6. The conversion of methyl labeled heptanoic acid to CO₂ has been studied in normal and pantothenic acid deficient rats. In addition, the effect of coenzyme A or pantothenic acid on this conversion has also been investigated.

Organic Chemistry

Research problems in organic chemistry which are of current interest include:

1. A study of the effect of high energy beta particles obtained from a 3-5 Mev linear accelerator on several organic compounds has been initiated. Included among the compounds which have been subjected to radiation are choline and methanol. The major products which are formed have been identified. In addition choline and N-acetyl choline have been subjected to gamma irradiation.

2. Palmitic acid-1-C¹⁴ and tripalmitan-carboxyl-C¹⁴ have been prepared.
3. Sodium valerate-2-C¹⁴ has been synthesized.
4. Various procedures for the synthesis of labeled peptides are being investigated.
5. Possible practical synthetic routes for the preparation of thioctic acid-S³⁵ are being tested.

7. PLANT AND EQUIPMENT REPORT UNCLASSIFIED

Bevatron (Account No. 5-271-9001)

Due to unforeseen difficulties in the insulation for the curve tanks, there is at present only one curve tank back in position. Two other curve tanks are in the process. They will be replaced in the near future. All of the pole tips have now been assembled and are complete except for the hardware that holds the pole face windings. The injector is approximately 92 percent complete.

Chemistry Laboratory Building 70 (Account No. 5-271-1002)

Swinerton and Walberg, the general contractor, are now working, and their subcontractor, Ariss-Knapp, are earth-moving and preparing the site for construction. The work has progressed to a point where caissons are presently being drilled for the building foundations. Subcontract 71 with Coast Heating and Air Conditioning Company was recorded on May 5, 1953, and the notice to proceed was dated May 6, 1953. Subcontract 72 with E. C. Braun Co. for plumbing work and Subcontract 73 with T. L. Rosenberg for electrical work were recorded on May 19, 1953, and the notices to proceed were dated May 21, 1953. The entire project is approximately 8 percent complete.

Electronics Research Building 80 (Account No. 5-271-2002)

This building has been reinstated by the Bureau of the Budget, and a new prospectus will be composed in the near future.

Miscellaneous Construction (Account No. 5-271-2001)

Site approval has been given by the Chancellor of the University for the construction of the Gamma House Building 66 and the Destruction Building 62, and the Chancellor has referred this to the Regents for review. The sprinkler system in Building 14 is 75 percent complete. Alterations to the Director's Office will be started in the near future. The parking lot south of Building 15 is approximately 40 percent complete.

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man-Months Effort	Comments
<u>Operations</u> ,			
4000 Reactor Development - MTA	Design and Development	17.28	
5211 Basic Physics Research	General Physics Research	54.20	
	Theoretical Studies	16.13	
	Film Detection	16.74	
	Cloud Chamber	9.06	
	Magnetic Measurements	2.83	
	General Instrument Design	8.14	
	Sub-Total		<u>107.10</u>
5261 Applied Physics Research	Special Cyclotron Development	0.25	
5311 Basic Chemistry Research	Chemistry of Heavy Elements	4.78	
	Nuclear Properties of Heavy Element Isotopes	7.58	
	Transmutations with 184-inch and 60-inch Cyclotrons	3.38	
	Analytical and Services	16.48	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.31	
	Instrument Development and Services	3.88	
	X-Ray Crystallographic Measurements	2.71	
	Radiation Chemistry	0.96	
	High Temperature and Special Chemistry	6.00	
	Health Chemistry Research	8.41	
	Sub-Total		<u>55.49</u>
5361 Applied Chemistry Research	Process Chemistry	5.18	
5731 Electron Synchrotron	Operations	9.12	
5741 Synchro Cyclotron (184 in.)	Operations	10.18	

MAN-MONTHS EFFORT REPORT
SCIENTIFIC PERSONNEL

Program No.	Subdivision	Man-Months Effort	Comments
5751	Linear Accelerator	Operations	17.94
5761	Proton Synchrotron - Bevatron	Operations	5.64
PHYSICAL RESEARCH - TOTAL (5000's)			210.90
6300	Medical Research	Health Medicine	1.96
		Metabolic Ward	-
		Internal Irradiation	6.19
		Sub-Total	8.15
			3.23 Consultant Man Months
			5.31
6400	Biological Research	Miscellaneous	2.99
		Instrumentation	2.29
		C14 Metabolism	4.93
		Use of Radioactive Material in Human Physiology	9.98
		Trace Elements	3.62
		Physical Biochemistry	12.81
		Biochemical Response to Radiation	4.03
		Metabolism of Lipo-proteins	5.35
		Iron Metabolism Hematopoiesis	3.92
		Biological Effects of Cosmic Radiation	2.33
		Radiation and Mutation Rate	2.00
		Bio-organic Chemistry	26.06
		Metabolism of Fission Products	15.65
		Animal Colony	2.00
	Sub-Total	97.96	
6500	Biophysics Research	Health Physics	4.47
		Irradiation Studies	3.89
		Sub-Total	8.36
BIOLOGY AND MEDICINE RESEARCH - TOTAL (6000's)			114.47
GRAND TOTAL - OPERATIONS			342.65

SECURITY INFORMATION

SECRET

-18-

DECLASSIFIED

UNCLASSIFIED

UCRL-2279

SECRET
SECURITY INFORMATION

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