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MONTHLY PROGRESS REPORT NO. 131

February 15, 1954 to March 15, 1954

April 6, 1954

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

February 15, 1954 to March 15, 1954

MONTHLY PROGRESS REPORT NO. 131*

April 6, 1954

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

Alternative Modes of Decay of Heavy Mesons

The Ω^o meson which decays to proton plus π^- may also decay to neutron plus π^o. Since the π^o lifetime is of the order of 10^{-15} sec., π^os formed in the bevatron target will decay before leaving the target. Thus any π^os found in the region behind the target would have to come from the decay of some particle with a longer lifetime. We plan to look for gamma rays in the region behind the target, using a multiple scattering type of detector of the type used by Hildebrand et. al.[1] The target itself will be shielded from the detector. A useful calibration point can be had by observing the π^os formed in the target. We are beginning the design and construction of counters and electronics to be used in this experiment.

Nuclear Internal Momentum Distributions

This experiment has been terminated, at least until after the cyclotron conversion. Data have been obtained for H, D, Li, Be, and B. The experimental spectrum obtained from hydrogen is a measure of the spectrometer resolution, which has a full width at half height of about 20 Mev. The observed spectrum from the deuteron is only slightly wider than the hydrogen spectrum. A momentum distribution obtained from the Fourier transform of the Hulthen wave function fits the experimental data well at low momenta (corresponding to a few Mev of kinetic energy), but does not appear to have enough high momentum components.

The spectrum observed from lithium has a broad base together with a central peak which is very similar to the deuteron spectrum. We have suggested that lithium could consist of two types of protons, two "core" protons which have large kinetic energy, and a third proton which has a low kinetic energy comparable to that of the proton in the deuteron. The relative yield from lithium as compared with the yields from deuterium and beryllium is consistent with this assumption, and with it the shape of the lithium curve can be predicted correctly.

*Previous report UCRL-2512 (No. 130).

1. Hildebrand, Knable, and Leith, Rev. Sci. Inst. 23, 243 (L), (1952).

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The experimental spectrum from beryllium was considerably broader than the previous spectra. On the basis of the alpha particle model it was assumed that the two pairs of protons in beryllium might have rather similar momentum distributions, and an attempt to fit the observed curves was made by assuming various theoretical momentum distributions. The best fit was found with a gaussian with a 1/e value of 20 ± 5 Mev. The degenerate Fermi gas distribution seemed to have too many momentum components near the Fermi energy. An excited Fermi distribution would be experimentally indistinguishable from a gaussian.

The spectrum observed from boron was somewhat narrower than that from beryllium, suggesting that the fifth proton in boron might be somewhat like the third proton in lithium.

Photodisintegration of the Deuteron

The thickness of the scintillator in the specific ionization counter has been increased to one-half inch. This counter has been tested with the range counter at the synchrotron and in the high energy neutron beam at the cyclotron. It appears that the resolution is adequate for separating protons from mesons and electrons.

Preparations for a synchrotron run are nearly complete. The time of the run will depend upon availability of the deuterium target and synchrotron time.

Fast Deuterons from High Energy Neutrons of Various Elements

The E - dE/dx particle identification scheme has been used for a run in the external proton beam of the 184-in. cyclotron. The main purpose of this run was to see that the method would separate a spectrum of deuterons from a spectrum of protons and also to repeat the indirect pick-up deuteron cross sections already measured in the proton beam by the Hp-range method. The E and dE/dx pulses were obtained from plastic scintillators received by 5819 phototubes. The pulses were put on a Tetronix 517 oscilloscope and photographed. The data has not been completely analyzed yet but it is now clear that the method does provide a quite clean separation of protons and deuterons simply by inspection of the E - dE/dx diagram. Calibration points were taken by putting the counters directly in a low intensity beam and using absorbers to degrade the energy. Points were taken with 120 and 50 Mev deuterons and 340, 110 and 40 Mev protons. The spreads in the pulse height distributions obtained this way are indicated in the table below.

	E Pulse	dE/dx Pulse
120 Mev Deuteron	41.7 ± 0.8	20.8 ± 0.8
50 Mev Deuteron	5.7 ± 0.4	41.0 ± 0.9
340 Mev Proton	18.8 ± 0.8	6.7 ± 0.6
110 Mev Proton	41.1 ± 0.9	13.4 ± 0.6
40 Mev Proton	~7	~32

The errors listed are probable errors. Half the observed points fall within these limits. The 40 Mev proton point was confused with a large amount of background. Data was taken using 300 Mev protons bombarding Li, C, Al, Cu, Cd, Pb and U and observing at 40°. The only data that has been analyzed show that about five percent of the counts from Al are deuterons. This is quite similar to the result previously obtained from the Hp range method.

Comparison of the Reactions $P + D \rightarrow \begin{cases} \pi^+ + t \\ \pi^o + He \end{cases}$ as a Test of Charge Independence

The target system was modified so that the vacuum jacket of the deuterium target communicated with the main cyclotron vacuum system. With this arrangement presumably, only the two 1 mil. stainless steel foils which actually contain the liquid deuterium would contribute background. A run was conducted with this arrangement, but it turned out unsucessfully because the sensing elements which indicate the presence or absence of deuterium in the target were not working properly; apparently deuterium was not in the target even though the sensing elements indicated the target was full. The change in capacity produced by the presence of liquid deuterium indicated when the target is full.

One difficulty may have been due to water vapor and oil from the cyclotron vacuum system condensing on the outside of the deuterium target. After the target was taken down a thin film of oil was found inside the target vacuum jacket. It is thought this could perhaps have caused the difficulty with the sensing elements, hence one very thin foil will be used in the next run to isolate the vacuum jacket of the target from the cyclotron vacuum system.

The target is now being operated to verify that deuterium will liquify, that the sensing elements are working reliably, and that the emptying arrangement is adequate. During this process several repairs and improvements are being made on the target. As soon as it is found that the target operates correctly, another cyclotron run will be scheduled.

Gamma Ray Pair Spectrometer

The 180° pair spectrometer was used to measure the spectrum and cross section for the production of proton bremsstrahlung at 0° and 180° in the laboratory system. The Be target was bombarded with 180 Mev protons. As in previous runs, the intensity of the proton beam was determined by measuring the energy lost in the target with a thermocouple. Calibration of the thermocouple has shown that it is necessary to correct for heat radiation at high beam levels.

Cerenkov Radiation Counter

Preliminary calculations on the center of mass transformations of the neutron meson indicate that relativistic effects do not produce the apparent equal energies of the decay gamma electron pairs as reported by Amand.

Two runs were made at the synchrotron to calibrate the Cerenkov "Y" counter as a function of electron energy. The raw date indicates this counter is approximately 70 - 80 percent efficient for electron energies of 50 - 300 Mev with a broad pulse height plateau leading to some arbitrariness in giving a specific efficiency.

Electron-Neutrino Angular Correlation in Ne^{19}

During the last month the vacuum system for the differential pumping modification of the neutrino experiment apparatus was in construction in the shops, and is now nearly finished.

Also a scintillation counter was developed using a plastic scintillator to measure the beta ray energy for this experiment.

Elastic Scattering of Co^{56} Gamma Rays

Automatic target cycling is being installed, in order to collect data continuously against a 90 percent background.

Liquid Hydrogen Bubble Chamber

An electronic time sequencing device has been built and successfully operated. The device triggers a simple pulse from the 3 Mev electron linear accelerator, and provides variable time delays between the electron beam, the solenoid action which reduces the bubble chamber pressure to one atmosphere, and the stroboscopic light which is used to photograph the chamber.

$P + P \rightarrow \pi^+ + D$ Cross Section Near Threshold

New plastic scintillation counters have been built, based on knowledge of the background problem gained during the last run.

A Study of Neutron Polarization

Cyclotron runs have been made to investigate the polarization of neutrons obtained from the bombardment of carbon by a proton beam of known polarization. The polarized proton beam was obtained by scattering 340 Mev protons internally off of Be at about 18° and has been measured by Chamberlain, et al, to be 65.0 percent ± 3.8 percent polarized and to have an energy of about 280 Mev.

Nuetrons in coincidence with their quasi-elastic protons were recorded in forward and backward angles by means of large plastic scintillators with thin scintillators in front of them to discriminate against protons. At the same time the protons in coincidence with their quasi-elastic protons and the quasi + non quasi protons were recorded. The latter were used to check the alignment by comparison with the Chamberlain results. These checked at all points. The results were:

Quasi-elastic Neutrons		Quasi-elastic Protons	
Neutron Angle	$e = \frac{L-R}{L+R}$ Percent	Proton Angle	$e = \frac{L-R}{L+R}$ Percent
15^o	13.4 ± 2.4	15^o	5.5 ± 1.5
20^o	16.4 ± 2.5	20^o	16.5 ± 1.5
30^o	12.9 ± 2.1	30^o	14.7 ± 0.7
43^o	7.6 ± 2.1	36.6^o	1.0 ± 0.8
55^o	-8.4 ± 1.4	43^o	1.8 ± 0.5
65^o	-15.9 ± 3.6	55^o	-22.3 ± 1.3
70^o	-13.0 ± 4.1	65^o	-7.5 ± 1.4
		70^o	+0.4 ± 4.4

Runs were also made in the neutron beam with a similar set-up. Neutrons were produced in a first scatter of 45^o off a carbon target, and asymmetry of neutron yield was observed after scattering in a carbon 2nd target. The results were:

Quasi-elastic Neutron	
Neutron Angle	$e = \frac{L-R}{L+R}$
20^o	7.6 ± 2.9
30^o	6.2 ± 3.0
65^o	-6.4 ± 2.5

Film Program

Synchrotron Research. The study of selective scattering of photons from the 320 Mev bremsstrahlung beam by various nuclei is continuing. Accelerator time was used to detect γ-rays at 90^o from U and Al targets. Scanning is nearing completion on the emulsions exposed to scattered photons from a Pb target. Background studies are also underway.

Cyclotron Research. Under continued investigation are the programs of spallation studies from light and heavy elements. Effort during this report period has been placed upon the high energy spalls emitted in the forward direction. Using the 40-inch spiral orbit spectrometer to obtain 25 Mev π^+ mesons, a preliminary run was performed to investigate a proposed geometrical set-up for a π^+-proton scattering experiment. Water loaded nuclear emulsions will be used.

Other. The research program of the interaction of 380 Mev α-particles in G5 nuclear emulsion is continuing. Approximately 1000 stars have been recorded and an analysis will be undertaken presently. In preparation for bevatron research, probe tubes and heads for hydraulic insertion of nuclear emulsions into the circulating proton beam have been designed and are near completion.

Cloud Chamber Studies

35 Atmosphere Diffusion Chamber. A coincidence counter arrangement yielded 50 pictures of cosmic rays crossing the chamber. With a light delay of 0.1 sec. the tracks were well developed and showed a radius due to turbulence, multiple scattering, and optical distortion of from 5 to 20 meters.

Four Foot by Eight Foot Diffusion Chamber. Modifications are being made in the cooling system. Various techniques have been tried, however no definite system has been decided on yet.

Photography. We have discovered that our cloud chamber films taken with Kodak Linagraph Panchromatic film over the last few months have shown a high haze, fog, and grain. These conditions are not satisfactory for good viewing with the projector and are equally poor for photographic reproduction. Tests are now being made to remedy these faults.

Film analysis continues in the following projects: 32 Mev protons in methane, 32 Mev protons in oxygen, and the scattering of positive pions in lead.

Synchrotron Studies

During this month the demand for synchrotron time was rather low. Preparations for a number of experiments indicate a demand far exceeding supply in the months following March, however. In the period February 15 to March 15 some work attempting to obtain a very short pulse of γ-rays was carried on. The natural way of obtaining these short pulses firing a pulse of current through a coil so as to reduce the field and collapse the beam on the target, is very difficult to accomplish because of the interaction with the many compensating currents used near injection time. Other methods have as yet failed to produce the desired result, which is a pulse of about 1 μsec duration.

Runs on nuclear emulsions for the study of C^{12} and O^{16} disintegrations and for the resonant scattering of γ-rays were made. There is already data on Pb showing a resonant scattering effect but not on Cu and C.

A run was made to test the possibility of studying the photodisintegration of the deuteron with a counting set-up using CD-Ch differences. The liquid deuterium target will be employed for actual measurements.

The monoenergetic electrons emerging from the pair spectrometer magnet have been used to calibrate a Cerenkov counter for various energies. The γ-ray beam has been employed to produce π^+ mesons in different materials. During the past month a run was made to check out the π-μ detection gear, which will need some modification. The problem of setting the high voltage on the stopping crystal is the main difficulty.

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

The investigation of Compton scattering on nucleons using a model that conserves charge and angular momentum density in the static limit (for a nucleon of finite radius) is continuing. For vanishing photon energies, it has been shown that the current vanishes except for nucleon recoil current, which gives the Thompson cross section.

Work on the intermediate coupling approximation for meson-nucleon scattering continues.

A paper describing the formalism of the approximation scheme for the covariant coupled Green's function equations is in preparation.

The study of the approximation scheme for the coupled Green's function equations is continuing. Emphasis is being placed on questions of renormalization.

The polarization of 300 Mev neutrons elastically scattered from nuclei has been calculated by assuming that the nuclear potential includes a spin-orbit part.

The formal methods recently employed in field theory have been applied to the Taylor-Karman theory of turbulance. The relatively involved relations between the various correlation functions become quite perspicuous in this form. The possibility of devising different approximations to these equations is currently being investigated.

The investigation of nuclear shapes under the action of strong particle-sruface interaction is continuing.

An expression for the high energy neutron spectrum produced by protons impinging on complex nuclei has been obtained for the case of an α-particle target, and is ready for numerical evaluation.

A paper is being prepared on the statistical treatment of high energy events. An attempt is being made to utilize the methods developed in this paper to interpret the data on meson production obtained at Brookhaven.

One of the more routine jobs connected with solutions of problems on the UCRL Differential Analyzer is that of turning a crank, following a plotted curve by eye, so that an arbitrary function may be made available to the machine. A simple automatic curve-following device, using photoelectric sensing controlling a thyratron-motor combination has been assembled and tested, and will soon be put into operation.

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

During this month most of the effort of the target group was focused on the large liquid scintillation tank, in view of the May 15 shutdown of the 184-inch cyclotron. It is desired to get a reliable measurement of total yield (neutrons per incident deuteron) using this tank, since cyclotron beams after the cyclotron conversion may be enough lower to make use of the $MnSO_4$ tank difficult, and the scintillator tank may be able to afford a better comparison.

Pulse-height response curves were run for various source positions, before terphenyl was added to the toluene, using a recording pulse-height analyzer built for this purpose. The photographic recording of pulses, using a Tektronix Model 517 oscilloscope and a General Radio camera, was attempted with very good results, and the terphenyl was added to the toluene in preparation for a short cyclotron run to establish the background in the cave. With the deuteron beam clearing the top of the tank, cyclotron background appeared encouragingly low, but the effect of the linear accelerator was found intolerable. Lead and boric acid shielding is being built for the tank for the next run, which will be made without the final addition of cadmium propionate to the solution, in order to test for background (such as short line fission fragments). This next run will be made with a complete list of thin and thick targets of various materials, the yields of which have already been measured with the $MnSO_4$ tank, and the succeeding run will duplicate these targets after addition of the cadmium propionate.

Further data were taken to determine the energy spectra at 0^o of the neutron beams produced by 490 Mev He^3 particles and 340 Mev protons on carbon. At the same time the relative $C^{12}(n, 2n)C^{11}$ and $Al^{27}(n, 2\text{-}2n)Na^{24}$ cross sections were measured as a function of neutron energy. By using the known proton cross sections for the similar reaction, $C^{12}(p, pn)C^{11}$, it will be possible to obtain the absolute cross sections.

The differential cross section $d\sigma/d\Omega$ for production of secondary neutrons was measured for deuterons, He^3 particles, and protons in carbon.

4. ACCELERATOR CONSTRUCTION AND OPERATION UNCLASSIFIED

Bevatron Operation (Program No. 5720)

On February 2 the current was injected into the bevatron from the linear accelerator with d. c. excitation of the bevatron magnet. The beam was picked up at the four straight sections on a few successive turns. On February 4 the same experiment was done with a dynamic magnetic field. The next two weeks were spent in completing the installation of control and detecting equipment, and on February 15 the first accelerated beam was observed. The energy was approximately 25 Mev.

The policy which was pursued during the next month was one of pushing on in energy regardless of loss in beam. The reason being that if any quantity of beam at all could be accelerated to a high energy, the frequency

tracking curve and the various timing functions could not be too far wrong. The following table of dates, with energies obtained, gives a good idea of the rate of progress.

February 15	25 Mev	March 1	630 Mev
18	45 Mev	4	850 Mev
19	75 Mev	5	1.1 Bev
26	340 Mev	8	3.4 Bev
		9	4.7 Bev
		12	5 Bev

Many of the components, especially the timing and frequency tracking, are newly developed and a certain number of faults are expected. So far, none of these have been more than trivial in nature even though they sometimes took a day or more to repair. After this initial period of pushing energy up regardless of losses, we have returned to operation at relatively low energy (below 100 Mev) to optimize injection conditions and to minimize the losses during the early stages of acceleration. This program is just getting under way.

184-inch Cyclotron Operation (Program No. 5741)

The cyclotron was used for research experiments approximately 95.5 percent of the 458 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	438.0 hours	95.5 percent
Electrical troubles	4.2	0.9
Mechanical troubles	8.5	1.8
Other	8.0	1.8
Totals	458.7 hours	100.0 percent

184-inch Cyclotron Modification (Program No. 4900.02)

Magnet. The auxiliary coil fabrication is proceeding on schedule. One coil has been delivered and the other one is in process. The pole face shims are being fabricated as expected and the assembly of these shims to the disc is nearly ready to start.

Rf Design and Vibrating Condenser. Machining of the vibrating condenser blades at Mare Island has been resumed and one pair of blades has been finished. The schedule on the other blades is unsatisfactory, but is apparently impossible to make any substantial improvement on the proposed schedule. The delay will be such as to necessitate the use of dummy blades in the full scale test.

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

There were 394 hours available for cyclotron use during the month of February, 1954. 297 hours were spent on bombardments and 38 hours were spent on 60-in. cyclotron experiments and development. Operating efficiency was 85.7 percent. Further work was done on the third harmonic components

and the frequency was raised with an increase in energy. Beam intensities of 30 μa to 40 μa of alpha particles have been maintained for prolonged periods of time.

Synchrotron Operation (Program No. 5731)

Operation of the synchrotron continued during this period.

Some preliminary investigations on methods and means of shortening the beam pulse dury cycle were attempted. This investigation is continuing.

Following are the operating statistics for the period.

Operation for customers	144.5 hours	47.5 percent
Beam calibration	65.0	21.4
Maintenance	19.5	6.4
No experiments scheduled	75.0	24.7
Totals	303.0 hours	100.0 percent

Linear Accelerator and Van de Graaff Operation (Program No. 5751)

The linear accelerator and Van de Graaff were operated routinely through the period of February 15 to March 15, 1954.

Operating statistics are as follows:

Operation for customers	261.8 hours	83.8 percent
Van de Graaff maintenance	41.0	13.3
Linear Accelerator maintenance	9.2	2.9
Totals	312.0 hours	100.0 percent

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

Alpha-Gamma Coincidence Apparatus

A rather simple alpha-gamma coincidence apparatus has been completed which used a thin NaI (Tl) alpha scintillation crystal mounted on the face of a Dumont photomultiplier tube. The tube is coupled to a Goldsworthy pulse height selector and fed into a coincidence circuit with the 50-channel gamma analyzer. While the alpha resolution is only about 4 percent, the experimental set-up is inexpensive and easily adaptable to angular correlation studied.

The apparatus has been tested on Ra^{222} and Th^{226}. Coincidence studies between the 330 kev gamma ray in the former and its alpha spectrum indicated a coincidence at 6.24 Mev. This indicates that a ground state alpha particle energy for Ra^{222} of 6.24 + 0.33 = 6.57 Mev which compares favorably with the alpha ray spectrograph value of 6.567 Mev. In Th^{226}, a 6.22 Mev

group in coincidence with a 110 kev gamma ray gives 6.22 + 0.11 or 6.33 Mev which again compares favorably with the spectrographic value of 6.342 Mev.

Decay Schemes of Ba^{126} and Cs^{126}

The 12 and 97 minute barium activities prepared from nitrogen bombardments on indium had previously been assigned to masses 124 and 126. Confidence in the latter assignment has been obtained by the milking of a 1.6 min cesium daughter from the 97 minute barium positron emitter and examining its gamma spectrum. The 390 kev prominent gamma ray found in what would be a level in Xe^{126} is also observed in the negatron decay of I^{126}.

Scintillation studies of the gamma ray spectrum of Cs^{126} were made and indicated K x-rays, and two gamma rays of 510 and 390 kev. An anthracene crystal beta spectrometer gave a value of $\beta^+_{max} = 3.5 \pm 0.3$ Mev. Studies were also made on the gamma ray spectrum of the Ba^{126} in equilibrium with the Cs^{126} daughter, and a 230 kev gamma resulted. From these and other data a decay scheme has been formulated in which Ba^{126} decays by two EC paths, separated by 230 kev and Cs^{126} decays by two β^+ groups separated by 390 kev to Xe^{126}.

Decay Scheme of Pa^{230}

Protactinium-230 has been examined in the double focusing beta ray spectrometer, the 50-channel gamma ray analyzer, and beta-gamma coincidence spectrometry. A preliminary decay scheme has been proposed in which four gamma rays of 310, 440, 1000, and 1100 kev are involved in the β^- decay to Th^{230} populated by at least three beta groups.

Beta Spectrum of Np^{236}

The beta spectrum has been examined on the "squirrel cage" magnetic lens spectrometer and the double focusing magnetic spectrometer. The spectrum has a shape such that the typical Fermi plot is concave (downward) and has an end point of approximately 515 kev. This suggests that the gound state transition is forbidden.

Microcalorimetry

The microcalorimeter is being repaired to measure the heats of solution of some of the rare earth metals. It is being calibrated with a 200 μg magnsium sample and will be used initially to check the previously reported values for the heat of solution of lanthanum.

Vibrational Quantum of the Strong Coupling Theory

The model of Bohr and Mottelson predicts that the "rotational" levels will be increasingly depressed at higher rotational values (as also found in the normal molecular models), and the departure will depend upon the average vibrational quantum energy, and a nuclear moment of inertia. If one knows very accurately two excited rotational states of a nucleus, both of these terms can be evaluated. Computations on six nuclei give reasonable values of this

vibrational energy, from approximately 0.7 Mev to approximately 1.4 Mev. Further examination indicates that the energy increases with increasing mass rather than decreases according to the present theory. There are also significant maxima at the closed shells.

Process Chemistry

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

Metals and High Temperature Thermodynamics

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

Basic Chemistry, Including Metal Chelates

Results have been obtained in some studies on fluoride complexing. The chemistry of ruthenium and of titanium (II) ion are under study.

Health Chemistry

The Equipment Development group continued processing the "napkin-ring"-type MTR-irradiated sample, described in last monthly report. The column stripping operations were carried out with success. Work is proceeding on setting up the six-inch straight-type cave in Room 107, Bldg. 5, for subsequent irradiations of this nature.

This group has also been modifying the area in a laboratory behind Bldg. 5, used formerly to process special soil samples, to accommodate large quantities of additional samples of the nature mentioned above.

Numerous equipment modifications and improvements have been made in the Health Chemistry equipment, especially with reference to the six-inch and two-inch lead caves and auxiliary equipment used therein. Pile-irradiated sample encapsulation has been increasingly studied, and slug openers, dissolvers, etc., are undergoing improvements.

Fourteen Berkeley Boxes were assembled and fitted on request.

6. BIOLOGY AND MEDICINE UNCLASSIFIED
(A. E. C. Program Nos. 6300-6500)

Physical Chemistry of Lipoproteins

Investigations of the mechanism of the heparin active-factor induced transformation of lipoproteins have continued. Earlier observations of Nichols indicated that the rate of transformation as measured by fatty acid release from egg yolk lipoprotein slowed down appreciably at about 50 percent conversion of the available glyceryl ester. It was not clear at that time whether this represented inactivation or utilization of the active factor, or whether it represented inhibition due to (a) loss of some other constituent or (b) accumulation of some produce of the reaction which itself poisoned the reaction system. Fatty acid release itself was suspected of being one possibility of a poisoning mechanism and indeed the addition of the sodium salt of oleic acid to the transformation system did slow the glyceryl ester hydrolysis. The current work shows indications that a crucial factor may be the concentration of albumin or other proteins that can act as acceptors of fatty acids produced by the reaction. If this proves to be correct, it may mean that the availability of free fatty-acid bonding sites on albumin or other proteins may represent a limiting factor in the transformations possible in any particular serum sample.

The light scattering photometer has been used to obtain some preliminary molecular weights of isolated lipoproteins. These data will now be available to check determinations by other approaches, such as sedimentation vs. diffusion and sedimentation vs. viscosity. In addition to the molecular weight data, the combined methods should give evaluation of some of the shape factors for the lipoproteins.

The program of determination of chemical composition of isolated lipoprotein species continues. There has been additional confirmation of the definite presence of triglyceride in isolated lipoprotein of the S_f6 class. This, then, definitely confirms the presence of triglyceride (fat) in the entire spectrum of low density lipoproteins, except for one remaining species, S_f4. This species will be studied in the near future.

The studies of the dialysis-induced instability of serum lipoproteins have continued. There is no question now but that some single or multiple small molecule constituents of serum are vital to the maintenance of the integrity of the serum lipoproteins. This conclusion is arrived at both by ultracentrifugal dilution of small molecule constituents or by dialysis dilution of the same substances. Since the dialysis-induced alterations result in the conversion of S_f6 molecules of density 1.063 gms/ml into slower floating species of density 1.075 gms/ml, it appears possible that the residual lipoprotein after dialysis alteration may be identical with the high density lipoprotein of density 1.075 gms/ml normally present in serum. However, molecular weight determinations indicate the residual lipoprotein after dialysis to be of a molecular weight 6-7 times that of the normally occurring lipoprotein of 1.075 gms/ml density. Whether this reflects polymerization of the normally occurring lipoportein, or whether the residual lipoprotein after dialysis is a completely different species is not yet determined. Chemical compositional studies are to be applied to study this particular question.

Liver Blood Flow Changes in Thermal Injury

The rate of disappearance of intravenously injected colloidal chromic phosphate can be used as a measure of liver blood flow, assuming that the removal efficiency is high. The half-time of disappearance of this material in the normal anaesthetized dog is 1.4 minutes. Within the first half hour after severe thermal trauma the half-time of disappearance is prolonged to about 3 minutes, representing a 50 percent reduction in the liver blood flow. Further prolongation of the disappearance half-time to as much as 6 - 7 minutes occurs after several hours. Although marked reduction of colloid removal efficiency is reached by 6 hours after thermal trauma, no impairment of efficiency is noted during the first hour.

Cardiac output measurements have been made by integration of the dilution curve observed in the arterial blood immediately following the rapid intravenous injection of colloidal chromic phosphate. Such measurements show a very marked decrease in cardiac output to as much as 30 percent within the first few minutes after injury, unaccompanied by any change in mean arterial blood pressure or cardiac rate.

The almost immediate reduction in liver blood flow and cardiac output observed following experimental thermal injury may be related to the later development of the shock syndrome.

Effect of Irradiation on DNA Synthesis in Regenerating Liver

Histochemical and chemical studies have indicated that a marked increase in the DNA content per nucleus occurs in conjuction with the initiation of mitotic activity in regenerating livers. In the present studies the incorporation of P-32 was used as an index of DNA synthesis in an effort to follow the events leading up to mitosis and to see how they can be influenced. Liver regeneration was induced in A strain mice by the subcutaneous injection of carbon tetrachloride. At various times after carbon tetrachloride administration the short term incorporation of P-32 into liver DNA was determined. A marked rise in the DNA specific activity was noted at 36 hours, subsequently reaching a value about 30 times that of the normal liver. Mitotic counts done simultaneously showed no marked activity until 48 hours. A second series of mice were treated exactly as above except that they were given an LD_{50} dose of total body x-irradiation at various times after the administration of carbon tetrachloride. No significant difference could be found in the DNA specific activities of the irradiated and non-irradiated livers when the irradiation occurred during the period of maximum P-32 incorporation. Irradiation at earlier or later time intervals resulted in the well known inhibition of P-32 incorporation.

Tracer Studies

Long term studies on rats employing actinium, cerium, eruopium, terbium, and thulium are continuing.

Experiments on the deposition of aerosols and long term astatine effects in primates are progressing.

Data are still being gathered on the relative toxicity and relative biological effectiveness of astatine, iodine, radium and x-rays on rats.

Radiation Chemistry

Studies are continuing on the direct and indirect action of heavy particle irradiation of aqueous acetic acid systems. The contribution of radical reactions to the over-all chemical change is being determined. Studies of oxygen effects on acetic acid products observed in irradiated acetic acid have shown by co-chromatographic methods that glycolic acid is produced. The determination of reaction yields in the glycine system are continuing.

Histology

Further tissue sections have been prepared from human thyroids in the At^{211} studies now being carried out.

Bio-Organic Chemistry

Instrumentation is an important phase of any laboratory, and it is particularly critical to an organization dealing with large amounts of radioactivity. Thus, we find in this group a number of instrumentation projects, among which the more important are as follows: Instrumentation for radioactivity measurements includes a) development of a photoradioscope for rapid scanning of paper chromatograms, b) development of scintillation counting for C^{14}, T, S^{35} assay, singly or in combinations, c) development of a combustion ion chamber apparatus for precision assay of C^{14} samples from the organic laboratory, d) development of better ionization chambers for low level C^{14} and T analysis, e) development of an ionization chamber-CO_2 analyzer for specific activity measurements of CO_2 exhaled in animals' breath, and f) dosemetry of ionizing radiation in radiation effect experiments.

Among the more important optical instrumentation projects are a) development of a device for measuring the absorption spectra of suspensions of micro-organisms, b) development of infrared analyzers for absorption spectra of cell components, c) development of units for measuring quantum yield in photosynthesis, and d) instrumentation for measuring light intensities in photosynthesis experiments.

There is, of course, a certain amount of specialized instrumentation which is in a steady program of modification and evolution. This work includes a) continuous pH monitoring and control of algae growth, b) monitoring of air CO_2 concentrations in animal and algae experiments, and c) development of high energy radiation sources for radiation effect studies.

7. PLANT AND EQUIPMENT REPORT

UNCLASSIFIED

Bevatron (Account No. 5-271-9001)

This machine is now in operation; the job is 100 percent complete.

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

All the main building concrete work has been completed except for the front entrance porch. All the light-weight fill has been poured and the roof is ready for the final roofing. All aluminum sash has been installed but not yet glazed. All frame partitions have been installed in the building. About 50 percent of partitions have been sheet rocked. Cement block partition walls in the building are 50 percent complete. Outside plaster has started on the building. Heating, ventilating, plumbing, and electrical work are in progress. No elevator work has been started. The entire project is approximately 57.65 percent complete.

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

Preliminary plans have been submitted to the Regents and have been approved pending concurrence from the AEC.

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

Construction of the Destructor has started and is 60 percent complete. The Gamma House is 100 percent complete. Wiring of the Accelerator Technicians' Shop in Building 64 is 99 percent complete.

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	UCRL Man-Months Effort	UCRL Vac. and Sick Leave
Operations			
3000 Weapon's Research	General	301.23	18.33
4000 Reactor Development - MTA	Design and Development	25.79	0.64
5000 Physical Research			
5200 Basic Physics Research	General Physics Research	36.72	10.13
	Theoretical Studies	12.37	2.07
	Film Detection	17.12	2.52
	Cloud Chamber	9.24	1.16
	Magnetic Measurements	4.31	1.17
	Physics Projects	1.63	
	Sub-Total	81.39	17.05
5311 Basic Chemistry Research	Chemistry of Heavy Elements	4.53)	
	Nuclear Properties of Heavy Element Isotopes	11.51)	
	Transmutations with 184" and 60" Cyclotrons	5.61)	
	Analytical and Services	9.18)--	6.15
	Mass Spectroscopy, Beta Ray Spectroscopy	1.85)	
	Instrument Development and Services	4.86)	
	X-Ray Crystallographic Measurements	1.43)	
	Office and Travel	16.44)	
	High Temperature and Special Chemistry	4.54	0.28
	Health Chemistry and Research	11.41	4.28
	Sub-Total	71.36	10.71
5361 Applied Chemistry Research	Process Chemistry	3.35	
5731 Electron Synchrotron	Operations	4.88	
5741 Synchro Cyclotron (184")	Operations	7.60	
5751 Linear Accelerator	Operations	8.19	
5761 Proton Synchrotron-Bevatron	Operations	12.03	
	Sub-Total	36.05	
TOTAL PHYSICAL RESEARCH		188.80	27.76

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	UCRL Man-Months Effort	UCRL Vac. & Sick Leave	Consultants Man-Months Effort	Consultants Vac. and Sick Leave
6000 Biology & Medicine Research					
6300 Medical Research	Health Medicine	1.41			
	Internal Irradiation	4.85		0.71	
	Sub-Total	6.26			
6400 Biological Research	Miscellaneous	3.62)		2.98)	
	Instrumentation	2.21)		-)	
	C_{14} Metabolism	3.06)		0.94)	
	Use of Radioactive Material in Human Physiology	9.44)		5.44)	
	Trace Elements	4.68)		-)	
	Physical Biochemistry	10.07)	-- 5.50	3.30)	-- 1.80
	Biochemical Response to Radiation	2.49)		1.49)	
	Metabolism of Lipo-proteins	6.86)		10.19)	
	Iron Metabolism Hematopoiesis	4.02)		-)	
	Biological Effects of Cosmic Radiation	2.50)		-)	
	Radiation and Mutation Rate	1.91)		0.24)	
	Bio-organic Chemistry	25.25	2.65		
	Metabolism of Fission Products	15.97	1.81		
	Animal Colony	1.87	0.13	3.79	
	Sub-Total	93.95	10.09	29.08	1.80
6500 Biophysics Research	Health Physics	5.25			
	Irradiation Studies	2.63		1.01	
	Sub-Total	7.88		1.01	
TOTAL BIOLOGY AND MEDICINE RESEARCH		108.09	10.09	30.09	1.80
GRAND TOTAL - OPERATIONS		623.91	56.82	30.09	1.80

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