GOVERNMENT SUPPORT of BASIC RESEARCH in UNIVERSITY PHYSICS DEPARTMENTS 1952–53

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A collection of data on the sources and distribution of Federal funds for support of research in educational institutions.

IT HAS BEEN SAID that there is no correspondence between the amount of money spent for research and the amount of "true" research being carried out in this country. Others use the terms "research funds" and "research activity" synonymously. It is not uncommon to hear it said that more funds tend to diminish the number of fundamental discoveries in basic research, and on the other hand, that more and more money is needed for the kind of research that we are doing today. Probably the true relationship between research funds and the prosecution of worthwhile research lies somewhere in between these extremes. But whatever the correct correlation factor between tangible funds and intangible research may be, good data on funds invested in research are needed in national thinking and in comprehending some of the problems met with in the administration of research programs.

The opinions expressed in this paper are the author's and do not necessarily represent the views of the National Science Foundation. The data presented are not to be construed as official statistics of the Foundation.

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With this utility in mind, the author has collected data on funds supplied to universities and colleges by the Federal Government through contracts for basic research in physics. An evaluation of the Federal funds from so many different Government agencies for such a specific purpose is quite difficult. The resulting data have, as a consequence, considerable uncertainty attached to them.

Departments as Repositories of Funds

Funds for basic research [1] not only assist in the immediate acquisition of scientific information, but also, over a larger period, assist individuals and groups of individuals to acquire research wisdom. What is more important, these funds help to preserve and maintain an environment in which research thrives. It is to departments of physics within educational institutions that we look for preservation of the research environment and the recognition and nurturing of research

[1] "Basic research" as used here is defined as that type of research which is directed toward the increase of knowledge in science; "Applied research" is that type of research which is directed toward practical applications of science.

TABLE I. Federal Funds for Unclassified Basic Research in Physics by Size of Physics Department, Year Ending June 30, 1953

Size of Physics Department*	Number of Institutions	Average No. of PhD's in Physics Awarded per Year for Total Group (No.)	(Percent)	Federal Funds for Physics Research FY 1953 (Millions)	(Percent)
Large	17	274	65	12.3	72
Medium	20	109	26	3.6	21
Small	23	38	9	0.7	4
No PhD's	—	—	—	0.5	3
Total	—	421	100	17.1	100

* "Large" departments awarded 30 or more PhD's for physics during 3-year period, 1950–52; "Medium," from 12 to 29; "Small," from 3 to 11.

wisdom. Because of this unique role played by the department in a university, it seemed advisable to gather statistics on funds going to departments rather than to given fields such as the field of solid state which would include engineering, mathematics, and physics departments, as well as other research groups.

Physics departments throughout the country were classified as to size, where size was measured by the average number of doctor's candidates turned out annually. The average number of physics PhD's graduated [2] in the academic years 1949–50, 1950–51, 1951–52 was used as a size index. The nineteen largest departments, those turning out an average number of candidates larger than ten annually, were classified as "large." The "medium" size comprised the next group with its average PhD contribution between four and nine, inclusively. Those departments having one, two or three candidates annually during that period were labelled "small" in size. The remaining institutions, colleges and universities, were grouped together even though some of the institutions turned out an occasional PhD and others had no doctor's degree program.

Funds for Unclassified Physics Research

The data gathered were for contracts and grants made by the Federal Government during the year beginning July 1, 1952, for unclassified basic research in physics departments. Data collected and analyzed by the National Science Foundation [3] for the preceding two years were not broken down according to university departments and were only used as a rough check of the data in this report. As stated before, the data presented here were not easy to come by and must be considered as the best current estimates. It is anticipated that a subsequent study of funds for the year beginning July 1953 will lead to more reliable information.

Data were gathered from official circularization of contract records among government agencies and by interviews with agency program directors. It was found that the total Federal funds going only into unclassified basic physics research in university and college physics departments within the United States and its territories during the Fiscal Year 1953 (July 1, 1952 to June 30, 1953) was $17.1 million. It should be emphasized that this includes only unclassified research. It is estimated by the author that this sum is correct to within about five or ten percent. This sum may be too low because of the omission of some applied and development contracts which carry a certain amount of basic research. On the other hand, it may be high by virtue of our including some contracts that are more applied than basic in nature.

No attempt was made to differentiate between funds used for construction of equipment and funds used directly for the research. For high-energy nuclear research the current accelerator construction cost appears to be about $2.5 million. Some uncertainty is likewise introduced in the above figure because it is not always clear that the Federal contracts tabulated in the above analysis were administered within the department as part of its education and research program. I estimate that this latter uncertainty does not exceed five or ten percent.

Universities Receiving Funds

It is not surprising to learn that most of the Federal contracts are made with the large departments. This is shown in Table I along with the average number of PhD's produced by the departments in each size group per year. (It should be remembered that the PhD data were obtained for a period preceding the year in which the fund data were collected.) This is partly due to the large nuclear accelerator programs which are concentrated in the large departments. When the funds used to support the large accelerator programs are subtracted from the total funds, one obtains the distribution in Table II. These tables emphasize the high cost of

TABLE II. Federal Funds for Unclassified Basic Research in Physics Departments at Colleges and Universities, Excluding Funds for Large Accelerator Programs, Year Ending June 30, 1953

Size of Physics Department	Federal Funds for Physics Research (Millions)	(Percent)
Large	4.4	54
Medium	2.5	31
Small	0.7	9
No PhD's	0.5	6
Total	8.1	100

[2] *Earned Degrees Conferred by Higher Educational Institutions*, Federal Security Agency, Circular 282, 333, 360.

[3] *Federal Funds for Scientific Research and Development at Non-Profit Institutions 1950–51 and 1951–52*, National Science Foundation (1953). *The Federal Research and Development Budget, Fiscal Years 1952 and 1953*, National Science Foundation (1953).

maintaining a research program in nuclear physics. With the accelerator programs deducted, the Federal funds show less concentration in the seventeen large departments. There is considerable arbitrariness involved in the separation of nuclear funds into large and small accelerator programs so that the figure for the total in Table II is believed to be uncertain by about one-half million dollars.

Agency Source of Funds

Most of the funds in the academic year 1952–1953 came from the Division of Research of the Atomic Energy Commission. This is shown in Table III. (Contributions to research through the Oak Ridge Institute, Brookhaven, Argonne, and similar AEC enterprises are not included in this survey.) The Office of Naval Research is the next largest contractor with the Office of Scientific Research (Air Research and Development Command of the Air Force) and the Office of Ordnance Research (Army) following in that order.

Distribution of Funds by Subject

It is difficult to say how the distribution of Federal funds by research subject compares with the pattern of research-desires possessed by the physicists. Presumably, the amount of basic research money going into the various areas such as nuclear physics, cosmic rays, and solid state reflect the desires of our research physicists. The distribution of funds by research subject is shown in Table IV and Table V. While only five catagories of research subjects were summarized for the table, information was obtained on the following additional areas: electromagnetic radiation including x-rays, optics, and radio waves; fluid state physics including kinetic theory and statistical mechanics; surface physics including thermionics and field emission; electricity-magnetism (about $200 000) including gas discharge; mechanics including fluid dynamics and elasticity; heat including conduction capacity and thermodynamics; acoustics (about $200 000) including propagation and physical effects; biophysics; electronics physics (about $1 400 000); and atmospheric physics.

Funds are probably not the most satisfactory way of measuring the amount of research activity, but some features of the percentage data of Table V bear comment. One observes that contracts in the largest departments are predominantly for nuclear research. This concentration in the nuclear field falls off as one goes to smaller departments. Solid state research obviously has a greater appeal to medium-sized departments and atomic-molecular research is found in greater proportion in the smaller-sized departments.

It is hoped that in subsequent years a more complete analysis may be realized. In the meantime, the data presented here for the year beginning July 1, 1952, give us a first glimpse of the role played by the Federal Government in the financing of basic research in our physics departments.

TABLE III. Source of Federal Funds for Unclassified Basic Research in Physics Departments at Colleges and Universities, Year Ending June 30, 1953

Source	Percent of Total Funds
AEC	55
ONR	27
OSR	7
OOR	4
Other	7
Total	100

TABLE IV. *Type of Unclassified Basic Research in Physics* Departments Supported by Federal Funds at Colleges and Universities by Size of Physics Departments, Year Ending June 30, 1953. (In Thousands of Dollars)

Size of Department	Nuclear	Solid State	Atom-Molecule	Cosmic Rays	Low Temperature	All Other
Large	8 415	715	525	750	100	1 770
Medium	2 050	830	80	215	40	400
Small	315	65	130	15	20	155
No PhD's	100	100	65	15	15	170
Total	10 880	1 710	800	995	175	2 495
Grand Total	17 055					

NUCLEAR. Includes: nuclear structure, radioactivity, nuclear reactions. Possible overlap: elementary particles in cosmic rays, positron annihilation, radiation damage in solid state. Excludes: nuclear moments in spectroscopy.

SOLID STATE. Includes: magnetic materials, crystals, semiconductors, metallurgy. Possible overlap: low temperature measurements.

ATOMIC-MOLECULAR. Includes: spectroscopy, structure. Possible overlap: microwaves, chemical physics. Excludes: gas discharge, kinetic theory.

COSMIC RAYS. Includes: high energy elementary particles, distribution, terrestrial absorption. Possible overlap: elementary particles in nuclear physics. Excludes: nuclear theory.

LOW TEMPERATURE. Includes: solid superconductivity, helium transport phenomena. Excludes: low temperature solid state measurements.

REMAINDER. Includes: acoustics, optics, mechanics, theory, surface physics, astrophysics, atmospheric physics, thermodynamics, kinetic theory, fluid state, chemical physics.

TABLE V. Percent of Federal Funds for Unclassified Basic Research in University Physics Departments Going into Fields of Research, Arranged by Size-Groups of Universities, Fiscal Year 1953

Subject	Total	Size Groups: Large	Medium	Small	Remainder
Nuclear	64	69	57	45	22
Solid State	10	6	23	9	22
Atomic	5	4	2	19	14
Cosmic Rays	6	6	6	2	3
Low Temperature	1	1	1	3	3
Remainder	14	14	11	22	36
Total	100	100	100	100	100