
Research Contracts in the Physical Sciences



**Energy Research
And Development Administration**

Division Of
Physical Research

October 1, 1976

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FOREWORD

The research programs under the cognizance of the Division of Physical Research consist primarily of fundamental theoretical and experimental investigations designed to support the objectives of ERDA. These programs are directed toward discovery of natural laws and new knowledge, and to improved understanding of the physical sciences as related to the development, use, and control of energy. The ultimate goal is to develop a scientific underlay for the overall ERDA effort and the fundamental principles of natural phenomena so that these phenomena may be understood and new principles formulated.

The Director of the Division of Physical Research reports to ERDA's Assistant Administrator for Solar, Geothermal and Advanced Energy Systems. The scientific and technical activities of the Division are organized into four functional areas: (1) high energy physics, (2) nuclear sciences, (3) materials sciences, and (4) molecular, mathematical and geo-sciences, each headed by an Assistant Director. Taken together, the physical research programs represent about 30 percent of the Nation's Federal support of basic research in the physical sciences. The research activities of the Division involve more than 6,000 scientists and engineers working in Federal, university, and industrial laboratories throughout the United States.

Starting October 1, 1976, the Government Fiscal Year was changed to cover an October 1-September 30, period. Fiscal Year 1977 thus covers the year ending September 30, 1977. For 1976 a one-time "transition quarter" (TQ: July 1-September 30, 1976) was authorized to accomplish this change. Amounts and figures in this report reflect a 15-month period (FY 1976 plus the transition quarter), which should be borne in mind if comparisons with prior or future years or annual levels are made.

SUMMARY

Approximately four-fifths of the total physical research program costs are associated with research conducted in ERDA-owned, contractor (non-Federal)-operated, Federally Funded Research and Development Centers (FFRDC's). The major portion of these costs are spent at the well known multi-program "national" laboratories at Argonne, Illinois; Berkeley, California; Brookhaven, New York; Los Alamos, New Mexico; and Oak Ridge, Tennessee; and at the high energy physics research centers at Batavia, Illinois; and Stanford, California.

A little less than one-fifth of the costs are associated with the support of research conducted in other laboratories (designated "off-site"). Virtually all of the off-site research is conducted at educational institutions, and is based almost entirely on unsolicited proposals.

There is no clear line of demarcation between National Laboratories, other Federally Funded Research and Development Centers, and off-site laboratories. The ERDA investment in facilities ranges from zero for some contractors to tens of millions of dollars for others, and the annual level of ERDA support ranges from a few thousand dollars for some contractors, to tens of millions of dollars for others--the spectrum is broad with no significant breaks.

Some of the FFRDC's research and development activities include programs in, e.g., solar energy, biomedical and environmental research, reactor research and development, waste management and transportation or controlled thermonuclear research. These activities are funded from sources other than the Division of Physical Research. The physical research program at these FFRDC laboratories provides, in varying degrees, some of the basic investigations underlying the more applied or developmental activities of such laboratories. Other FFRDC's include laboratories that are engaged in research in a single, well-defined area. All FFRDC's have the following common characteristics:

1. They are operated for the Federal Government by universities, not-for-profit organizations or private industry.
2. They are treated as national facilities.
3. They represent large investments (several millions of dollars) in ERDA-owned capital facilities.
4. They have large annual levels (several millions of dollars) of ERDA support.

The objective of the basic research program is to search for and discover new knowledge within the mission-oriented framework of ERDA. It is from this expanding reservoir of knowledge that developmental accomplishments are ultimately achieved. The off-site program complements the FFRDC's in the advancement of science in those disciplines that are fundamental to ERDA's programs.

The off-site contract-research program has a number of distinct benefits:

1. When the amount provided by ERDA is added to other funds available to the contractor, the effectiveness of the contractor's program, as well as the basic research effort of ERDA is increased.
2. ERDA receives the services, in basic research activities fundamental to ERDA's future capabilities, of highly qualified scientists who prefer employment at outside laboratories or who prefer to teach and to do research at educational institutions.

3. The contract-research program, by providing for the conduct of research at educational institutions, contributes to the education and training of scientists in fields relevant to ERDA's programs.

Funds provided by the Division of Physical Research for construction and for miscellaneous research-support activities, such as for other Federal agencies, National Academy of Sciences committees, special analyses, awards, exhibits, conferences, book translations, certain computers and general purpose equipment at some of the major research centers, etc., have been excluded from this report.

The following table summarizes the level of effort of the physical research programs as of October 1, 1976 (excluding items discussed above). No attempt has been or should be made to add the dollar levels of FFRDC's to those of the off-site program in this analysis since they are not arrived at on comparable bases. The funding levels of FFRDC's reflect FY 1976 plus transition quarter (15 months) outlays for operations and capital equipment while the dollar figures for the off-site program generally represent the contract amounts authorized, as distinguished from costs incurred, for all contracts in effect as of October 1, 1976, including funds provided for equipment regardless of who retains title. Under ERDA's split appropriations system, a separate appropriation is provided for the acquisition of capital equipment, title to which remains in the Government.

	<u>FFRDC'S</u>	<u>Off-Site Contract Research</u>	
	Amount (in thousands)*	No. of Projects	Amount (in thousands)*
High Energy Physics	\$ 175,676	55	\$ 32,234
Nuclear Sciences	84,139	82	25,046
Materials Sciences	50,781	100	8,716
Molecular, Mathematical & Geo-Sciences	41,585	119	11,574
TOTAL	\$ 352,181	356	\$ 77,570

*Operations and Equipment, FY 1976 and Transition Quarter (TQ).

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

For purposes of this report, the following may be considered FFRDC's operated for ERDA (including only those supported in whole or in part under the physical research program). The listing is consistent with "Federally Funded Research and Development Centers" as defined by the National Science Foundation.

<u>Name of Laboratory, Contractor and Principal Staff*</u>	<u>Level of Division of Physical Research Support - FY 1976 & TQ (in thousands)</u>	
	<u>Operations</u>	<u>Equipment</u>
AMES LABORATORY, Iowa State University of Science and Technology, Ames, Iowa	\$ 10,220	\$ 682
Director Robert S. Hansen Deputy Director Velmer A. Fassel		
ARGONNE NATIONAL LABORATORY, University of Chicago and Argonne Universities Association, Argonne (Lemont), Illinois	49,848	3,354
Director Robert G. Sachs Deputy Directors: Research Michael V. Nevitt Operations Robert V. Laney Associate Directors: High Energy Physics Thomas H. Fields Physical Research Michael V. Nevitt (Actg.) Biomedical & Environmental Research Warren K. Sinclair Engineering Research and Development Jack A. Kyger Energy & Environment E. Gale Pewitt Administrative and Technical Support Paul E. Neal		
BARTLESVILLE ENERGY RESEARCH CENTER, Bartlesville, Oklahoma	48	0
Director John S. Ball		
BROOKHAVEN NATIONAL LABORATORY, Associated Universities, Inc., Upton, Long Island, New York	57,213	5,531
Director George H. Vineyard Associate Directors: Life Sciences, Chemistry, and Safety Victor P. Bond High Energy Physics R. Ronald Rau Administration Vincent R. O'Leary Isabelle Project James R. Sanford Energy Warren E. Winsche		

*Individuals listed are generally those with the rank of Associate Laboratory Director or higher, plus certain others who are involved with the physical research programs.

Name of Laboratory, Contractor
and Principal Staff

Level of Division of Physical
Research Support - FY 1976 & TQ
(in thousands)

Operations

Equipment

FERMI NATIONAL ACCELERATOR LABORATORY, Universities Research Association, Batavia, Illinois	\$ 53,752	\$ 12,349
Director	Robert R. Wilson	
Deputy Director	Edwin L. Goldwasser	
Associate Directors:		
Administration	John McCook	
Technical Services	Henry Hinterberger	
IDAHO NATIONAL ENGINEERING LABORATORY, Aerojet Nuclear Company, Idaho Falls, Idaho	341	3
President & General Manager ..	C. K. Leeper	
LAWRENCE BERKELEY LABORATORY, University of California, Berkeley, California	39,052	3,590
Director	Andrew M. Sessler	
Deputy Director	Earl K. Hyde	
Associate Directors:		
Accelerator Division	Edward J. Lofgren	
Biology & Medicine Division.	Edward L. Alpen	
Chemical Biodynamics Div. ..	Melvin Calvin	
Energy & Environment Div. ..	Robert J. Budnitz (Actg.)	
Materials & Materials		
Research Division	David A. Shirley	
Nuclear Science Division ...	Bernard G. Harvey	
Physics, Computer Science & Mathematics Division ...	Robert W. Birge	
Administration	George L. Pappas	
Engineering & Technical Services	Walter D. Hartsough	
Employee and Information Services Division	Ray K. Wakerling	
LAWRENCE LIVERMORE LABORATORY, University of California, Livermore, California	1,162	37
Director	Roger E. Batzel	
Deputy Director	Duane C. Sewell	
LOS ALAMOS SCIENTIFIC LABORATORY, University of California, Los Alamos, New Mexico	27,162	1,935
Director	Harold M. Agnew	
Associate Directors:		
Research	Richard F. Taschek	
Weapons	Robert N. Thorn	
Administration	Charles I. Browne	
MOUND LABORATORY, Monsanto Research Corporation, Miamisburg, Ohio	1,037	195
Director, Vice President, Monsanto Research Corp.	Richard K. Flitcraft	
Director, Nuclear Operations .	William T. Cave	

<u>Name of Laboratory, Contractor and Principal Staff</u>	<u>Level of Division of Physical Research Support - FY 1976 & TQ</u> (in thousands)	
	<u>Operations</u>	<u>Equipment</u>
OAK RIDGE ASSOCIATED UNIVERSITIES, Oak Ridge, Tennessee	\$ 146	\$ 54
Executive Director Philip L. Johnson		
Director, UNISOR Project E. H. Spejewski		
Head, University Programs		
Office Alfred Wohlpart		
OAK RIDGE NATIONAL LABORATORY, Union Carbide Corp., Oak Ridge, Tennessee	39,720	2,478
Director Herman Postma		
Deputy Director Floyd L. Culler		
Associate Directors:		
Administration F. R. Bruce		
Basic Physical Sciences A. Zucker		
Biomedical & Environmental . C. R. Richmond		
Advanced Energy Systems N. W. Rosenthal		
Reactor & Engineering D. B. Trauger		
Assistant Director for		
Services M. E. Ramsey		
PACIFIC NORTHWEST LABORATORY, Battelle Memorial Institute, Richland, Washington	3,463	347
Director Tommy W. Ambrose		
SANDIA LABORATORIES, Western Electric-Bell, Albuquerque, New Mexico and Livermore, California	1,161	56
President Morgan Sparks		
Vice President, Research, Albuquerque A. Narath		
Vice President, Livermore T. B. Cook, Jr.		
STANFORD LINEAR ACCELERATOR CENTER, Stanford University, Palo Alto, California	34,543	2,702
Director W. K. H. Panofsky		
Deputy Director Sidney D. Drell		
Associate Directors:		
Research Division J. Ballam		
Technical Division R. B. Neal		
Business Services F. V. L. Pindar		
Administrative Services R. H. Moulton, Jr.		

Level of Support by Functional Area
FY 1976 & TQ - Operations & Equipment
(in thousands)

<u>Laboratory</u>	<u>TOTAL</u>	<u>High Energy Physics</u>	<u>Nuclear Sciences</u>	<u>Materials Sciences</u>	<u>Molecular, Mathematical & Geo-Sciences</u>
Ames Laboratory	\$ 10,902	\$ 679	\$ 873	\$ 6,570	\$ 2,780
Argonne National Laboratory	53,202	20,059	8,587	14,756	9,800
Bartlesville Energy Research Center	48	0	0	0	48
Brookhaven National Laboratory	62,744	39,403	8,275	6,398	8,668
Fermi National Accelerator Laboratory .	66,101	66,101	0	0	0
Idaho National Engineering Laboratory .	344	0	161	91	92
Lawrence Berkeley Laboratory	42,642	11,602	19,790	5,569	5,681
Lawrence Livermore Laboratory	1,199	11	136	486	566
Los Alamos Scientific Laboratory	29,097	103	26,270	771	1,953
Mound Laboratory	1,232	0	121	152	959
Oak Ridge Associated Universities	200	0	200	0	0
Oak Ridge National Laboratory	42,198	473	19,460	14,537	7,728
Pacific Northwest Laboratory	3,810	0	201	1,146	2,463
Sandia Laboratories	1,217	0	65	305	847
Stanford Linear Accelerator Center	37,245	37,245	0	0	0
TOTAL	\$352,181	\$175,676	\$ 84,139	\$ 50,781	\$ 41,585

OFF-SITE CONTRACT-RESEARCH PROGRAM

In conducting this program, ERDA typically uses a special research support agreement. Under this type of agreement, the ERDA will contribute to the cost of performing the research, up to a specified amount (referred to as the "support ceiling"), in consideration for the performance of proposed research activities broadly defined in the agreement and in accordance with the provisions of the agreement.

When the special research support agreement is used for not-for-profit organizations other than educational institutions, ERDA's commercial cost principles may be used in determining actual cost, or the contract provisions may be revised to provide for a lump-sum payment to the contractor in consideration for its commitment to perform particular research at a specified level of effort.

Very large projects, and in all cases those with an estimated cost in excess of \$500,000 annually, are financed by means of a cost-type contract which permits closer ERDA surveillance of the work in accordance with appropriate contractual provisions not included in the special research support agreement. This type of contract is generally used for large-scale research programs performed in laboratories using equipment or facilities that are usually either partially or wholly ERDA owned or controlled and/or for projects that do not lend themselves to accurate cost estimates. The total costs of the research may be shared by the contractor and ERDA.

Occasionally, no-fund contracts are used in the contract-research program when ERDA loans property to an outside organization as ERDA's support to the research project or when the organization wishes to enter into a study contract in a certain area of research before it actually undertakes the research. Also, contracts are frequently extended without additional funds being added when the research project is being completed or terminated and additional time is required to bring that project to an orderly close.

In most cases, the contractor proposes to share in the cost of the work conducted under the contract. In order to support the maximum number of important and worthwhile projects within the limits of available funds and to have tangible evidence of a university's interest in the proposed research, it is ERDA policy to encourage cost-sharing by the universities. Although sharing by the institution in the cost of the project is desirable, such sharing is not a prerequisite for ERDA support, which, in the final analysis, is determined by the prospective quality of the proposed research, the relative interest of ERDA and the institution in the research, and availability of funds on the part of both ERDA and the contractor. Thus, ERDA will pay up to the full cost of a research project.

Most research contracts are written for terms of one year, renewable for additional annual terms. Sometimes contract terms may run somewhat more or less than one year (e.g., 9 or 15 months), usually for the purpose of establishing a different renewal date. There may also be cases where the contract may be written for several (usually three) years, but with the legal commitment for funding remaining on an annual basis. Occasionally, multi-year contracts with full funding are executed, generally where procurement of a major piece of equipment is involved, or where the nature of the research project is such that a clearly defined, fixed term can be established within which the entire research can be carried out.

In practice, contracts tend to run for several years, some for as much as ten years or more. Most research projects are not of the type that can be completed in one year, or in any specified longer time period that can be estimated in advance with reasonable accuracy. This is informally recognized by the parties concerned, whenever a new research project is approved for support and the customary one year contract written.

An examination of the age at termination of contracts that have terminated in recent years shows that about 15% had been in effect for less than 3 years, some 25% for 3 to 5 years, 30% for 5 to 10 years, and about 30% for 10 years or more, and that the average age at termination was $7\frac{1}{2}$ years.

Proposals for research contracts are usually initiated by the scientist interested in doing the work and are submitted through administrative channels of his institution to ERDA Headquarters.

Those interested in submitting proposals for research support under this program may obtain a copy of a "Guide for the Submission of Research Proposals" from ERDA Headquarters, Washington, D. C. 20545, or from an ERDA field office.

Scientific reports on basic research investigations are usually published in the open literature. Special reporting of results in detail before they are ready for publication generally is not required of the contractors. ERDA supports open publication and wide dissemination as the normal and most desirable means for reporting the findings of fundamental research.

During Fiscal Year 1976 and transition quarter (15 months), the Division of Physical Research received 518 formal unsolicited proposals for new research, representing requests for a total of \$44.2 million. On hand at the beginning of FY 1976 pending reviews were 190 new proposals requesting \$13.0 million, for a total of 708 proposals representing requests for \$58.1 million (\$ in millions):

	<u>On Hand 7/1/75</u>	<u>Received in FY 1976 & TQ</u>	<u>Total</u>
High Energy Physics	29 - \$ 1.9	37 - \$ 3.7	66 - \$ 5.6
Nuclear Sciences	43 - 5.3	57 - 6/1	100 - 11.4
Materials Sciences	31 - 1.9	200 - 20.5	231 - 22.4
Molecular, Mathematical and Geo-Sciences	87 - 4.8	224 - 13.9	311 - 18.7
TOTAL	190 - \$13.9	518 - \$44.2	708 - \$58.1

	<u>Approved in FY 1976 & TQ</u>	<u>Declined, Etc. in FY 1976 & TQ</u>	<u>On Hand 9/30/76</u>
High Energy Physics	11 - \$.6	23 - \$ 1.3	32 - \$ 3.7
Nuclear Sciences	7 - .4	67 - 6.7	26 - 4.3
Materials Sciences	17 - 1.0	135 - 7.6	79 - 13.8
Molecular, Mathematical and Geo-Sciences	19 - 1.0	182 - 10.6	110 - 7.1
TOTAL	54 - \$ 3.0	407 - \$26.2	247 - \$28.9

The severity of the competition for available funds for new research projects can be seen if new award amounts are compared with the requests received during the past 10 years (\$ in millions):

<u>Fiscal Year</u>	<u>On Hand at Beginning of Year</u>	<u>Received During Year</u>	<u>Approved During Year</u>	<u>Declined, etc. During Year</u>	<u>On Hand at End of Year</u>
1967	161	391 - \$ 42.1	56 - \$ 3.2	292 - \$ 16.2	204
1968	204	358 - 41.7	58 - 2.2	356 - 36.4	148
1969	148	417 - 42.3	76 - 2.6	270 - 41.8	219
1970	219	412 - 46.6	31 - 1.5	421 - 68.7	179
1971	179	326 - 14.4	18 - .9	321 - 14.6	166
1972	166	200 - 8.7	21 - .7	205 - 11.5	140
1973	140	222 - 11.1	21 - .9	214 - 8.5	127
1974	127	301 - 15.1	20 - 1.0	226 - 11.9	182
1975	182	365 - 23.7	51 - 2.4	306 - 17.4	190
1976 & TQ	190	518 - 44.2	54 - 3.0	407 - 26.2	247

Under ERDA's annual review and renewal system, the yearly turnover rate, i.e., numbers of new projects approved and existing contracts terminated, during the 1960's tended to be in the 10-15% range, with an average of some 60 new contracts written and a corresponding number of old contracts terminating each year. In the early 1970's however, numbers of new projects started were sharply lower and terminations higher, resulting in a significant reduction in numbers of active contracts. New contracts, for administrative reasons, sometimes are written as separate new tasks under an existing contract; likewise, existing contracts occasionally may be split into two or more separate contracts, or several contracts may be combined into one. The following table illustrates the situation FY 1967-1976 (\$ in millions):

<u>Fiscal Year</u>	<u>New Contracts</u>	<u>Contract Terminations</u>	<u>No. of Contracts at End of Year</u>
1967	56 - \$ 3.2	41 - \$.9	516 - \$ 71.0
1968	58 - 2.2	48 - 1.5	525 - 71.1
1969	76 - 2.6	58 - 1.2	543 - 71.1
1970	31 - 1.5	59 - 2.1	515 - 68.5
1971	18 - .9	40 - 1.5	484 - 61.7
1972	21 - .7	142 - 9.8	368 - 50.2
1973	21 - .9	57 - 2.5	330 - 51.1
1974	20 - 1.0	30 - 1.5	315 - 52.2
1975	51 - 2.4	27 - 1.0	332 - 55.6
1976 & TQ	54 - 3.0	25 - 1.6	356 - 77.6

Again here, it is important to note that dollar figures pertaining to the off-site program generally represent contract amounts authorized, as opposed to costs incurred, and include funds provided for equipment regardless of who takes title. Contract research projects in effect as of October 1, 1976 and supported by the ERDA Headquarters Division of Physical Research are listed on pp. 15-35 by functional area, and including the name and location of the contractor, the name(s) of the principal investigator(s), a short descriptive title of the research, and the level of ERDA support (i.e., contract amount authorized) during the most recent funding period. The amounts listed are for one year unless otherwise indicated. A summary of contracts by State appears on pp. 11-14.

SUMMARY OF OFF-SITE CONTRACTS

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1976 & TQ Funding* (in 1000's)</u>
<u>Alabama</u>	<u>1</u>	<u>\$ 0</u>
Alabama, University of, University	1	0
<u>Alaska</u>	<u>2</u>	<u>124</u>
Alaska, University of, Fairbanks	2	124
<u>Arizona</u>	<u>4</u>	<u>248</u>
Arizona State University, Tempe	3	196
Arizona, University of, Tucson	1	52
<u>Arkansas</u>	<u>1</u>	<u>23</u>
Arkansas, University of, Fayetteville	1	23
<u>California</u>	<u>56</u>	<u>10,586</u>
Aerospace Corporation, Los Angeles	1	0
Atomics International, Canoga Park	1	232
California Institute of Technology, Pasadena	7	2,968
California, University of, Berkeley	3	341
California, University of, Davis	2	232
California, University of, Irvine	5	1,246
California, University of, Los Angeles	11	2,059
California, University of, Riverside	2	425
California, University of, San Diego	3	1,024
California, University of, Santa Barbara	3	347
California, University of, Santa Cruz	2	358
Physics International Company, San Leandro	1	45
Southern California, University of, Los Angeles	3	131
Stanford Research Institute, Menlo Park	1	135
Stanford University, Stanford	10	973
Varian Associates, Palo Alto	1	70
<u>Colorado</u>	<u>5</u>	<u>1,036</u>
Colorado School of Mines, Golden	1	46
Colorado, University of, Boulder	3	914
Denver, University of/Colorado Seminary, Denver	1	76
<u>Connecticut</u>	<u>8</u>	<u>4,127</u>
Connecticut, University of, Storrs	3	121
Yale University, New Haven	5	4,006
<u>Delaware</u>	<u>1</u>	<u>82</u>
Delaware, University of, Newark	1	82
<u>District of Columbia</u>	<u>6</u>	<u>233</u>
Georgetown University	1	39
George Washington University	1	32
Howard University	4	162
<u>Florida</u>	<u>9</u>	<u>711</u>
Florida State University, Tallahassee	4	554
Florida, University of, Gainesville	5	157

*Dollar figures are based on obligations made specifically from FY 1976 & TQ funds, for operations and equipment, for the 356 contracts in effect as of October 1, 1976.

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1976 & TQ Funding (in 1000's)</u>
<u>Georgia</u>	<u>5</u>	<u>\$ 260</u>
Georgia Institute of Technology, Atlanta	2	107
Georgia, University of, Athens	3	153
<u>Hawaii</u>	<u>3</u>	<u>499</u>
Hawaii, University of, Honolulu	3	499
<u>Illinois</u>	<u>15</u>	<u>5,549</u>
Chicago, University of, Chicago	4	385
Illinois Institute of Technology, Chicago	1	279
Illinois, University of, Urbana	5	4,251
Northwestern University, Evanston	5	634
<u>Indiana</u>	<u>9</u>	<u>3,701</u>
Indiana University, Bloomington	1	385
Notre Dame, University of, Notre Dame	1	1,828
Purdue University, Lafayette	7	1,488
<u>Iowa</u>	<u>1</u>	<u>0</u>
Iowa, University of, Iowa City	1	0
<u>Kansas</u>	<u>3</u>	<u>250</u>
Kansas State University, Manhattan	1	145
Kansas, University of, Lawrence	2	105
<u>Louisiana</u>	<u>3</u>	<u>124</u>
Louisiana State University, Baton Rouge	3	124
<u>Maryland</u>	<u>14</u>	<u>2,403</u>
Johns Hopkins University, Baltimore	4	390
Maryland, University of, College Park	10	2,013
<u>Massachusetts</u>	<u>24</u>	<u>19,187</u>
Boston University, Boston	2	70
Brandeis University, Waltham	3	389
Harvard University, Cambridge	3	1,974
Massachusetts Institute of Technology, Cambridge	11	16,148
Massachusetts, University of, Amherst	3	281
Tufts University, Medford	1	325
Worcester Polytechnic Institute, Worcester	1	0
<u>Michigan</u>	<u>10</u>	<u>1,526</u>
Michigan State University, East Lansing	3	77
Michigan Technological University, Houghton	1	56
Michigan, University of, Ann Arbor	3	1,231
Wayne State University, Detroit	3	162
<u>Minnesota</u>	<u>9</u>	<u>1,632</u>
Minnesota, University of, Minneapolis	9	1,632
<u>Mississippi</u>	<u>1</u>	<u>30</u>
Mississippi, University of, University	1	30
<u>Missouri</u>	<u>4</u>	<u>306</u>
Missouri, University of, St. Louis	1	94
Washington University, St. Louis	3	212

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1976 & TQ Funding (in 1000's)</u>
<u>Montana</u>	<u>1</u>	<u>\$ 43</u>
Montana, University of, Missoula	1	43
<u>Nebraska</u>	<u>3</u>	<u>196</u>
Nebraska, University of, Lincoln	3	196
<u>Nevada</u>	<u>1</u>	<u>20</u>
Nevada, University of, Reno	1	20
<u>New Hampshire</u>	<u>2</u>	<u>56</u>
Dartmouth College, Hanover	2	56
<u>New Jersey</u>	<u>7</u>	<u>2,163</u>
Institute for Advanced Study, Princeton	1	189
Princeton University, Princeton	6	1,974
<u>New Mexico</u>	<u>2</u>	<u>210</u>
New Mexico State University, Las Cruces	1	40
New Mexico, University of, Albuquerque	1	170
<u>New York</u>	<u>42</u>	<u>7,074</u>
Adelphi University, Garden City	1	15
Clarkson College of Technology, Potsdam	1	23
Columbia University, New York	7	1,039
Cornell University, Ithaca	10	921
New York, City University of, Brooklyn College	2	110
New York, State University of, Albany	2	40
New York, State University of, Stony Brook	4	469
New York University, New York	1	1,927
Rensselaer Polytechnic Institute, Troy	4	179
Rochester, University of, Rochester	7	1,715
Rockefeller University, New York	1	400
Syracuse University, Syracuse	2	236
<u>North Carolina</u>	<u>6</u>	<u>1,377</u>
Duke University, Durham	2	1,045
North Carolina State University, Raleigh	2	154
North Carolina, University of, Chapel Hill	2	178
<u>Ohio</u>	<u>18</u>	<u>1,436</u>
Case Western Reserve University, Cleveland	5	413
Cincinnati, University of, Cincinnati	3	98
Denison University, Granville	1	11
Kent State University, Kent	1	45
Ohio State University, Columbus	6	742
Ohio University, Athens	1	97
Wright State University, Dayton	1	30
<u>Oklahoma</u>	<u>3</u>	<u>33</u>
Oklahoma State University, Stillwater	2	33
Oklahoma, University of, Norman	1	0
<u>Oregon</u>	<u>4</u>	<u>137</u>
Oregon State University, Corvallis	2	13
Oregon, University of, Eugene	2	124

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1976 & TQ Funding (in 1000's)</u>
<u>Pennsylvania</u>	<u>20</u>	<u>\$ 4,175</u>
Carnegie-Mellon University, Pittsburgh	5	1,480
Drexel University, Philadelphia	1	43
Lehigh University, Bethlehem	2	63
Pennsylvania State University, University Park	4	172
Pennsylvania, University of, Philadelphia	4	2,151
Pittsburgh, University of, Pittsburgh	2	50
Temple University, Philadelphia	1	141
U. S. Steel Corporation, Monroeville	1	75
<u>Rhode Island</u>	<u>4</u>	<u>723</u>
Brown University, Providence	4	723
<u>South Carolina</u>	<u>1</u>	<u>0</u>
South Carolina, University of, Columbia	1	0
<u>Tennessee</u>	<u>8</u>	<u>386</u>
Tennessee State University, Nashville	1	0
Tennessee, University of, Knoxville	6	306
Vanderbilt University, Nashville	1	80
<u>Texas</u>	<u>19</u>	<u>1,720</u>
Baylor University, Waco	1	30
Houston, University of, Houston	2	219
Rice University, Houston	4	563
Texas A & M University, College Station	8	450
Texas Southern University, Houston	1	27
Texas, University of, Austin	3	431
<u>Utah</u>	<u>3</u>	<u>126</u>
Utah, University of, Salt Lake City	3	126
<u>Vermont</u>	<u>1</u>	<u>22</u>
Vermont, University of, Burlington	1	22
<u>Virginia</u>	<u>5</u>	<u>592</u>
Virginia Polytechnic Institute & State Univ., Blacksburg	2	142
Virginia, University of, Charlottesville	2	405
William and Mary, College of, Williamsburg	1	45
<u>Washington</u>	<u>4</u>	<u>1,755</u>
Washington, University of, Seattle	4	1,755
<u>Wisconsin</u>	<u>7</u>	<u>2,715</u>
Marquette University, Milwaukee	1	46
Wisconsin, University of, Madison	6	2,669
<u>Wyoming</u>	<u>1</u>	<u>113</u>
Wyoming, University of, Laramie	1	113

HIGH ENERGY PHYSICS

Adelphi University, Garden City, New York. John P. Dooher, Theoretical Studies and Analysis of High Multi Gamma Ray Events in pp Collisions at ISR. \$15,000.

Brandeis University, Waltham, Massachusetts. Lawrence E. Kirsch and Howard J. Schnitzer, Research in Elementary Particle Physics. \$229,000 (14 months).

Brown University, Providence, Rhode Island. David Feldman, Anatole M. Shapiro, and Robert E. Lanou, Jr., Experimental and Theoretical High Energy Physics. \$514,000 (16 months).

California Institute of Technology, Pasadena, California. Robert L. Walker, Experimental, Theoretical and Phenomenological Research. \$2,005,000 (15 months).

California, University of, Davis, California. Richard L. Lander and John F. Gunion, High Energy Particle Physics Research. \$168,000.

California, University of, Irvine, California. Frederick Reines, Research Program in Neutrino Physics, Cosmic Rays and Elementary Particles. \$620,000 (18 months).

California, University of, Irvine, California. Jonas Schultz and Paul E. Condon, Study of Elementary Particle Interactions. \$300,000 (18 months).

California, University of, Los Angeles, California. Harold K. Ticho and Donald H. Stork, Research in High Energy Physics. \$613,000 (18 months).

California, University of, Riverside, California. Robert T. Poe and Anne Kernan, High Energy Physics. \$425,000 (19 months).

California, University of, San Diego, California. Oreste Piccioni and Norman Kroll, Experimental and Theoretical Particle Physics. \$685,005 (15 months).

California, University of, Santa Barbara, California. David O. Caldwell, High Energy User Group. \$278,000.

California, University of, Santa Cruz, California. Clemens A. Heusch, Experimental Elementary Particle Research. \$325,000 (11 months).

Carnegie-Mellon University, Pittsburgh, Pennsylvania. Roger B. Sutton, High Energy Physics Users and Theoretical Research. \$1,095,000 (15 months).

Cincinnati, University of, Cincinnati, Ohio. Peter Suranyi, Inelastic Strong Interactions at High Energies. \$15,000.

Colorado, University of, Boulder, Colorado. Uriel Nauenberg and David F. Bartlett, Elementary Particles and High Energy Phenomena. \$270,000 (19 months).

Columbia University, New York, New York. T. D. Lee and Robert Serber, Theoretical High Energy Physics. \$330,000 (13 months).

Duke University, Durham, North Carolina. William D. Walker, Interactions between Elementary Particles and Nuclei, and Development of Detection Methods. \$370,000 (20 months).

Florida State University, Tallahassee, Florida. Joseph E. Lannutti, Elementary Particle Physics. \$278,149 (13 months).

Georgia, University of, Athens, Georgia. T. T. Chou, High Energy Hadron-Hadron Collisions. \$15,800 (17 months).

HIGH ENERGY PHYSICS

- Harvard University, Cambridge, Massachusetts. F. M. Pipkin and R. J. Glauber, High Energy Physics Research. \$1,858,519 (15 months).
- Harvard University, Cambridge, Massachusetts. Tai Tsun Wu, High Energy Collision Processes. \$55,000.
- Hawaii, University of, Honolulu, Hawaii. Vincent Z. Peterson and San Fu Tuan, Research in High Energy Nuclear Physics. \$429,000 (11 months).
- Illinois, University of, Urbana, Illinois. A. Wattenberg, High Energy Physics Users. \$1,657,715 (15 months).
- Indiana University, Bloomington, Indiana. Richard M. Heinz, Homer A. Neal, Archibald W. Hendry and Don B. Lichtenberg, Research in Experimental and Theoretical High Energy Physics. \$385,000.
- Institute for Advanced Study, Princeton, New Jersey. Roger F. Dashen and Stephen L. Adler, Problems in Particle Theory. \$189,000 (14 months).
- Johns Hopkins University, Baltimore, Maryland. Gabor Domokos, Research in Theoretical Physics. \$66,000 (19 months).
- Lehigh University, Bethlehem, Pennsylvania. Alvin Kanofsky, Study of Multiparticle Jet Production Using Calorimeters. \$20,000.
- Maryland, University of, College Park, Maryland. George A. Snow, High Energy Accelerator and Colliding Beam User Group. \$985,000 (17 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Martin Deutsch, High Energy Physics Research. \$3,995,295 (15 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Herman Feshbach, Study Group on the Very Big Accelerator. \$28,000 (3 years).
- Massachusetts, University of, Amherst, Massachusetts. Janice B. Shafer, High Energy Physics. \$110,000.
- Michigan, University of, Ann Arbor, Michigan. Daniel Sinclair and Donald Meyer, High Energy Physics Users and Theoretical Research. \$1,140,904 (15 months).
- Minnesota, University of, Minneapolis, Minnesota. Stephen Gasiorowicz and Hans W. J. Courant, Theoretical and High Energy Physics Research. \$375,000.
- Northwestern University, Evanston, Illinois. Jerome L. Rosen, Donald H. Miller, and Martin M. Block, High Energy Experimental Physics. \$377,000.
- Ohio State University, Columbus, Ohio. Thomas A. Romanowski, K. Tanaka and W. W. Wada, High Energy Physics. \$490,000 (16 months).
- Oklahoma State University, Stillwater, Oklahoma. Mark A. Samuel, Higher-Order Corrections to the Anomalous Magnetic Moment of the Muon. \$10,000.
- Oregon, University of, Eugene, Oregon. Michael J. Moravcsik, Theory of Elementary Particles. \$117,000.
- Pennsylvania, University of, Philadelphia, Pennsylvania. Alfred K. Mann, High Energy Physics Research. \$1,950,671 (15 months).

HIGH ENERGY PHYSICS

- Physics International Company, San Leandro, California. Sidney D. Putnam, Linear Collective Ion Acceleration. \$44,770.
- Princeton University, Princeton, New Jersey. Frank Shoemaker, High Energy Physics Research. \$1,514,000 (15 months).
- Purdue University, Lafayette, Indiana. Frank J. Loeffler, Masao Sugawara, Earle C. Fowler, and D. Duane Carmony, Fundamental Particle Physics. \$1,084,000 (17 months).
- Rice University, Houston, Texas. Gerald C. Phillips, High Energy Physics. \$90,000.
- Rochester, University of, Rochester, New York. A. C. Melissinos and S. Okubo, High Energy Physics Users and Theoretical Research. \$1,103,794 (15 months).
- Rockefeller University, New York, New York. Rodney L. Cool and N. N. Khuri, Research in Experimental and Theoretical High Energy Physics. \$400,000.
- Stanford University, Stanford, California. Richard H. Pantell, Laser Particle Accelerator. \$65,000.
- Stanford University, Stanford, California. Alan Litke, Study of Photon Electron Production in e^+e^- Annihilation. \$8,686 (11 months).
- Stanford University, Stanford, California. David M. Ritson, High Energy Physics. \$360,000 (11 months).
- Syracuse University, Syracuse, New York. K. C. Wali, Research Program in Elementary Particle Theory. \$235,720 (16 months).
- Tennessee, University of, Knoxville, Tennessee. William M. Bugg, Elementary Particle Interactions. \$115,000.
- Texas, University of, Austin, Texas. E. C. G. Sudarshan and Yuval Ne'eman, Research in Elementary Particle Theory. \$265,000 (22 months).
- Tufts University, Medford, Massachusetts. Allan M. Cormack, Experimental High Energy Physics Research. \$325,000.
- Washington, University of, Seattle, Washington. Jere J. Lord, High Energy Physics Studies of Particle Interactions in Heavy Elements. \$70,000.
- Wayne State University, Detroit, Michigan. Suraj N. Gupta, Quantum Theory of Fields. \$32,000.
- Wisconsin, University of, Madison, Wisconsin. Don D. Reeder, High Energy Physics Users and Theoretical Research. \$1,970,472 (15 months).
- Yale University, New Haven, Connecticut. F. Gursev, V. W. Hughes and J. Sandweiss, High Energy Physics Users and Theoretical Research. \$1,680,000 (15 months).

NUCLEAR SCIENCES

- Arkansas, University of, Fayetteville, Arkansas. Paul K. Kuroda, Nuclear Chemistry. \$23,100 (18 months).
- Brown University, Providence, Rhode Island. Stavros Fallieros and Frank S. Levin, Nuclear Excitations and Reaction Mechanisms. \$66,000.
- California Institute of Technology, Pasadena, California. Felix Boehm, Research in Nuclear Physics at Low and Intermediate Energies. \$355,000 (13 months).
- California, University of, Berkeley, California. Paul B. Price, Jr., Relativistic Heavy Ion Studies \$101,000 (26 months).
- California, University of, Los Angeles, California. George J. Igo, Intermediate Energy Nuclear Physics Users Group. \$205,000.
- California, University of, Los Angeles, California. Roy P. Haddock and B. M. K. Nefkens, Particle Physics. \$230,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Albert A. Caretto, Jr., Research on High Energy Nuclear Reactions. \$52,004 (15 months).
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Peter D. Barnes, Experimental Nuclear Physics. \$255,000 (15 months).
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Morton Kaplan, Research in Nuclear Chemistry. \$46,500 (15½ months).
- Case Western Reserve University, Cleveland, Ohio. Harvey B. Willard, Medium Energy Nuclear Physics Research. \$192,000 (15 months).
- Chicago, University of, Chicago, Illinois. Nathan Sugarman and Anthony Turkevich, Nuclear Chemistry Research. \$210,000.
- Colorado, University of, Boulder, Colorado. C. D. Zafiratos, Peter D. Kunz and R. J. Peterson, Study of Fundamental Nuclear Interactions. \$585,000.
- Columbia University, New York, New York. W. W. Havens, Jr., Research Program in Neutron Spectroscopy. \$209,280 (15 months).
- Columbia University, New York. Herbert Goldstein and L. J. Lidofsky, Relations Between Neutron Cross Sections and Neutron Transport Phenomena. \$60,000 (15 months)
- Columbia University, New York, New York. J. M. Miller, Studies of Nuclear Reactions. \$127,552 (15 months).
- Denison University, Granville, Ohio. Ron R. Winters, Determination of Neutron Capture Cross Sections and Resonance Parameters. \$10,792 (11 months).
- Duke University, Durham, North Carolina. Henry W. Newson, E. G. Bilpuch, N. R. Roberson and R. L. Walter, Studies of Nuclear Structure using Neutrons and Charged Particles. \$675,000.
- Florida State University, Tallahassee, Florida. Gregory R. Choppin, Research in Nuclear Chemistry. \$48,000.
- Florida State University, Tallahassee, Florida. Raymond K. Sheline, Experimental Study of Nuclear Models - Decay Schemes and Nuclear Reactions. \$103,000 (11 months).

NUCLEAR SCIENCES

- Florida, University of, Gainesville, Florida. M. Luis Muga, Development and Applications of Thin Film Detectors. \$34,000 (21 months).
- Georgia Institute of Technology, Atlanta, Georgia. Richard W. Fink, Nuclear Spectroscopy with Radioactive Sources. \$65,000.
- Houston, University of, Houston, Texas. John C. Allred, B. W. Mayes, II and Ed V. Hungerford, III, Pion Interactions at Medium Energies. \$165,000 (15 months).
- Illinois, University of, Chicago, Illinois. Lester Winsberg, Recoil Study of Reactions Induced in Light Elements by High Energy Protons (3 to 300 GeV). \$20,000.
- Johns Hopkins University, Baltimore, Maryland. Leon Madansky and Y. K. Lee, Nuclear Moments and Nuclear Structure. \$219,538 (15 months).
- Louisiana State University, Baton Rouge, Louisiana. R. W. Huggett and Paul N. Kirk, Two-Body Dissociation of Light Nuclei in Nuclear Fields. \$53,000.
- Louisiana State University, Baton Rouge, Louisiana. Edward F. Zganjar, Rotation-Aligned Coupling and Axial Asymmetry in the Neutron Deficient Lanthanum Nuclei. \$17,000.
- Maryland, University of, College Park, Maryland. W. M. MacDonald and James J. Griffin, Theoretical Studies in Nuclear Reactions and Nuclear Structure. \$154,000 (5 months).
- Maryland, University of, College Park, Maryland. Harry D. Holmgren, Cyclotron Laboratory Nuclear Research and Accelerator Operations. \$500,000 (13 months).
- Maryland, University of, College Park, Maryland. Victor E. Viola, Studies of Heavy-Ion Induced Nuclear Reactions. \$40,000 (5 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Fred J. Eppling, Nuclear Physics Research. \$10,892,961 (15 months).
- Massachusetts, University of, Amherst, Massachusetts. Gerald A. Peterson, Fabrication of 180° Electron Scattering Facility for the Bates Linac. \$229,000 (27 months).
- Massachusetts, University of, Amherst, Massachusetts. Gerald A. Peterson, Nuclear Structure Studies by the Scattering of High Energy Electrons. \$42,000.
- Michigan, University of, Ann Arbor, Michigan. Glenn F. Knoll, Absolute Fission Cross Section Measurements. \$90,000.
- Michigan, University of, Ann Arbor, Michigan. W. C. Parkinson and R. S. Tickle, 83-Inch Cyclotron Research Program. \$313,000 (30 months).
- Minnesota, University of, Minneapolis, Minnesota. J. Morris Blair, George W. Greenlees and Norton M. Hintz, Experimental Nuclear Physics. \$775,000.
- Montana, University of, Missoula, Montana. Mark J. Jakobson, Total Pion Cross Section Measurements. \$42,760.
- New Mexico State University, Las Cruces, New Mexico. George R. Bureson, Experimental Measurement of Large-Angle Pion-Nucleus Scattering. \$40,196.
- New Mexico, University of, Albuquerque, New Mexico. Howard C. Bryant, Byron D. Dieterle, Christopher P. Leavitt and David M. Wolfe, Nucleon Physics Studies at Intermediate Energies. \$170,000 (15 months).

NUCLEAR SCIENCES

- New York, State University of, Albany, New York. Hassaram Bakhru, Nuclear Spectroscopy and Nuclear Reaction Work. \$15,461 (18 months).
- New York, State University of, Albany, New York. Jagadish B. Garg, Measurement and Analysis of Neutron Cross Sections. \$24,937.
- New York, State University of, Stony Brook, New York. Gerald E. Brown, Andrew D. Jackson, Jr., and Thomas T. S. Kuo, Research in Theoretical Nuclear Physics. \$310,000 (15 months).
- New York, State University of, Stony Brook, New York. John M. Alexander, Nuclear Reaction Studies. \$65,000.
- North Carolina State University, Raleigh, North Carolina. L. W. Seagondollar, Nuclear Structure Research at the Triangle Universities Nuclear Laboratory. \$112,000 (19 months).
- North Carolina, University of, Chapel Hill, North Carolina. Eugen Merzbacher, Studies of Nuclear Processes. \$130,000 (19 months).
- Northwestern University, Evanston, Illinois. Kamal K. Seth, An Experimental Program in Medium Energy Physics. \$48,500 (9½ months).
- Ohio University, Athens, Ohio. Raymond O. Lane, Study of Structure of Light Nuclei with Neutrons. \$97,000 (15 months).
- Oregon State University, Corvallis, Oregon. Walter D. Loveland, Studies of Low Energy Induced Nuclear Fission. \$12,500.
- Pennsylvania, University of, Philadelphia, Pennsylvania. Fay Ajzenberg-Selove, Compilation of Information on the Energy Levels of the Light Nuclei. \$99,622 (22 months).
- Pittsburgh, University of, Pittsburgh, Pennsylvania. Robert L. Wolke, Recoil Studies of Nuclear Reactions. \$10,000.
- Princeton University, Princeton, New Jersey. Robert A. Naumann, Nuclear Chemistry Project. \$125,000 (15 months).
- Purdue University, Lafayette, Indiana. Norbert T. Porile, Deexcitation Processes in Nuclear Reactions. \$103,000 (15 months).
- Purdue University, Lafayette, Indiana. Patrick J. Daly, Radiochemical Investigations of Nuclear Properties. \$60,000.
- Purdue University, Lafayette, Indiana. Rolf M. Steffen, Study of Muonic Atoms. \$83,309 (2 years).
- Rensselaer Polytechnic Institute, Troy, New York. Robert C. Block and Robert W. Hockenbury, High-Intensity Neutron Spectroscopy. \$71,900 (15½ months).
- Rensselaer Polytechnic Institute, Troy, New York. Daniel Sperber, Heavy Ion Nuclear Reaction Mechanisms. \$34,000.
- Rice University, Houston, Texas. Gerald C. Phillips, Intermediate Energy Nuclear Physics Studies. \$280,000.
- Rochester, University of, Rochester, New York. J. Bruce French and Daniel S. Koltun, Nuclear Structure Theory. \$157,340 (15 months).

NUCLEAR SCIENCES

Rochester, University of, Rochester, New York. H. Marshall Blann, Nuclear Reaction Mechanisms. \$103,000 (15 months).

Rochester, University of, Rochester, New York. John R. Huizenga, Study of Heavy Ion Reactions and Transuranic Nuclei. \$163,000 (15 months).

Temple University, Philadelphia, Pennsylvania. W. Kenneth McFarlane, L. B. Auerbach and V. L. Highland, Experimental Investigation of Nuclear and Particle Physics. \$141,000 (15 months).

Tennessee, University of, Knoxville, Tennessee. Joseph R. Peterson, Physical-Chemical Studies of the Transuranium Elements. \$43,000.

Tennessee, University of, Knoxville, Tennessee. Carrol R. Bingham and Leo L. Riedinger, Nuclear Spectroscopic Studies. \$25,000.

Texas A&M University, College Station, Texas. Ronald D. Macfarlane, On-Line High-Resolution Mass Spectroscopy. \$65,000.

Texas A&M University, College Station, Texas. Joseph B. Natowitz, Angular Momentum Effects in Nuclear Reactions. \$65,000.

Texas A&M University, College Station, Texas. Thomas T. Sugihara, Nuclear Spectroscopy. \$55,000.

Texas A&M University, College Station, Texas. Rand L. Watson, Ionization Phenomena. \$50,000.

Texas A&M University, College Station, Texas. L. C. Northcliffe, Study of Neutron Proton Interaction in the 300-700 MeV Energy Region. \$110,000.

Texas A&M University, College Station, Texas. Ronald A. Bryan, Medium Energy Phenomenology. \$24,940.

Texas, University of, Austin, Texas. Taro Tamura and Peter J. Riley, Research in Nuclear Physics. \$130,015.

Texas, University of, Austin, Texas. Wilfred J. Braithwaite, Gerald W. Hoffman, and C. Fred Moore, Research in Medium Energy Experimental Nuclear Physics. \$35,707 (9 months).

Vanderbilt University, Nashville, Tennessee. Joseph H. Hamilton, Experimental Nuclear Structure Research. \$80,000 (11 months).

Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Richard A. Arndt and L. David Roper, Partial Wave Analyses of K-N, π -N and N-N Scattering. \$60,000.

Virginia, University of, Charlottesville, Virginia. Ralph C. Minehart, Stanley E. Sobottka, Klaus O. H. Ziock, and James S. McCarthy, Experiments on Nuclear Interactions of Pions and Electrons. \$310,000 (15 months).

Washington University, St. Louis, Missouri. Edward S. Macias, Arthur C. Wahl, and Demetrios G. Sarantites, Investigations of Nuclear Structure, Reactions and Fission. \$120,000.

Washington University, St. Louis, Missouri. Demetrios G. Sarantites, Investigations of Nuclear Structure and Nuclear Reactions. \$42,000 (7 months).

Washington, University of, Seattle, Washington. Fred H. Schmidt, Ernest Henley, and David Bodansky, Experimental and Theoretical Nuclear Physics. \$1,606,000 (15 months).

NUCLEAR SCIENCES

Washington, University of, Seattle, Washington. Gene L. Woodruff, Delayed Neutron Spectra from Fast Fission. \$79,200 (15 months).

Wisconsin, University of, Madison, Wisconsin. H. T. Richards and L. W. Anderson, Research in Nuclear Physics and Atomic Collisions. \$507,100.

Wisconsin, University of, Madison, Wisconsin. Henry H. Barschall and Robert R. Borchers, Charged Particle Production Induced by 14 MeV Neutrons. \$95,791 (17 months).

Wyoming, University of, Laramie, Wyoming. Glen A. Rebka, Jr. and Raymond Kunselman, Pion-Nucleon Interactions and Mesonic Atoms. \$113,230.

Yale University, New Haven, Connecticut. D. Allan Bromley, MP Tandem Van de Graaff Research Program. \$1,553,201 (15 months).

Yale University, New Haven, Connecticut. Vernon W. Hughes and Howard L. Schultz, Studies in Nuclear Physics. \$675,228 (15 months).

MATERIALS SCIENCES

Arizona State University, Tempe, Arizona. LeRoy Eyring, Solid State Chemistry of Rare Earth Oxides. \$115,000 (22 months).

Arizona State University, Tempe, Arizona. James T. Stanley, Study of Ferrite Formation in Neutron Irradiated Austenitic Stainless Steels. \$28,938.

Arizona State University, Tempe, Arizona. John M. Cowley, Imaging Surfaces and Defects in Crystals. \$52,244.

Brown University, Providence, Rhode Island. Joseph Gurland and James R. Rice, A Combined Macroscopic and Microscopic Approach to the Fracture of Metals. \$85,000.

California Institute of Technology, Pasadena, California. Pol Duwez, Studies of Alloy Structures and Properties. \$170,000.

California Institute of Technology, Pasadena, California. Robert W. Vaughan, Metal Hydrides with Multiple Pulse Nuclear Magnetic Resonance Techniques. \$53,379.

California, University of, Los Angeles, California. Alan J. Ardell, High Temperature Irradiation of Nickel Base Alloys. \$75,000.

California, University of, Los Angeles, California. Didier de Fontaine, Fourier Space Computer Simulation of Crystalline Imperfections. \$38,800.

California, University of, Riverside, California. Eugen Simanek, Theoretical Aspects of Superconductor Behavior. \$77,000 (2 years).

California, University of, San Diego, California. John C. Wheatley, Research on the Properties of Materials at Very Low Temperatures. \$213,417.

California, University of, San Diego, California. M. Brian Maple, The Response of Superconductors to Variations in Impurity Content and Applied Pressure. \$125,122.

California, University of, Santa Barbara, California. Vincent Jaccarino, Resonance Studies of Superionic Conductors. \$41,392.

Carnegie-Mellon University, Pittsburgh, Pennsylvania. Robert F. Sekerka, Generalization of Internal Centrifugal Zone Growth of Metal-Ceramic Composites. \$31,889.

Case Western Reserve University, Cleveland, Ohio. Ronald Gibala, Dislocation-Solute Atom Interactions in Alloys. \$53,000.

Case Western Reserve University, Cleveland, Ohio. Terence E. Mitchell, Experiments in High Voltage Electron Microscopy. \$77,000.

Case Western Reserve University, Cleveland, Ohio. Alexander R. Troiano, Elastic and Plastic Strains and the Stress Corrosion Cracking of Austenitic Stainless Steels. \$39,400.

Case Western Reserve University, Cleveland, Ohio. A. R. Cooper, Study Coupled Diffusion Phenomena in Multicomponent Glasses and Glass Forming Liquids. \$51,500.

Chicago, University of, Chicago, Illinois. Stuart A. Solin, The Study of Phonons and Electronic Processes in Ordered and Disordered Solids. \$55,000.

Cincinnati, University of, Cincinnati, Ohio. John Moteff, Radiation Effects to BCC Refractory Metals and Alloys. \$44,000.

MATERIALS SCIENCES

- Cincinnati, University of, Cincinnati, Ohio. William C. H. Joiner, Flux Pinning and Flux Flow Studies in Superconductors Using Flux Flow Noise Techniques. \$39,000.
- Clarkson College of Technology, Potsdam, New York. Joseph L. Katz, Nucleation of Voids. \$22,682.
- Colorado School of Mines, Golden, Colorado. David L. Olson and David Matlock, Liquid Lithium Corrosion Research. \$46,094.
- Colorado, University of, Boulder, Colorado. Richard C. Mockler and William J. O'Sullivan, Critical Scattering of Laser Light by Bulk Fluids and Thin Fluid Films. \$59,255.
- Columbia University, New York, New York. Charles F. Bonilla, High Temperature Transport Properties and Processes of Gases and Alkali Metals. \$47,000 (14 months).
- Connecticut, University of, Storrs, Connecticut. James M. Galligan, Electron-Dislocation Interactions at Low Temperatures. \$41,075.
- Connecticut, University of, Storrs, Connecticut. John E. Morral, Cluster Carburizing. \$39,097.
- Connecticut, University of, Storrs, Connecticut. Owen F. Devereux, Electrode Polarization Studies in Hot Corrosion Systems. \$41,200.
- Cornell University, Ithaca, New York. Che-Yu Li, Mechanical Properties of Crystalline Solids. \$63,077.
- Cornell University, Ithaca, New York. Lutgard C. DeJonghe, Reduction of Mixed Spinel Oxides. \$42,375.
- Cornell University, Ithaca, New York. Robert W. Balluffi, Structure and Properties of Grain Boundaries. \$90,000.
- Cornell University, Ithaca, New York. Richard H. Lance, Mechanical Behavior of Materials and Structural Elements at Elevated Temperatures. \$60,000.
- Cornell University, Ithaca, New York. Dieter G. Ast, Influence of Grain Boundaries on the Electrical Transport Properties of Polycrystalline Si Films. \$25,000.
- Cornell University, Ithaca, New York. R. O. Pohl and A. J. Sievers, Experimental Phonon Physics. \$250,000 (2 years).
- Cornell University, Ithaca, New York. David N. Seidman, Defects in Metal Crystals. \$180,000.
- Cornell University, Ithaca, New York. James A. Krumhansl, Theory of Structure and Dynamics in Condensed Matter. \$120,000 (2 years).
- Cornell University, Ithaca, New York. H. H. Johnson, Environment and Fracture. \$59,000.
- Cornell University, Ithaca, New York. S. Leigh Phoenix, Probabilistic Models of the Stress-Rupture of Composite Materials. \$31,500.
- Dartmouth College, Hanover, New Hampshire. P. Bruce Pipes, Experimental Determination of the Temperature Dependence of Metallic Work Functions at Low Temperatures. \$28,323.
- Dartmouth College, Hanover, New Hampshire. Walter E. Lawrence, Theory of Electron-Phonon Scattering Effects in Metals. \$28,097.

MATERIALS SCIENCES

- Drexel University, Philadelphia, Pennsylvania. George Langford, Strain Hardening and Ductility of Iron: Axisymmetric vs. Plane Strain Elongation. \$43,400 (12½ months).
- Florida, University of, Gainesville, Florida. Robert E. Reed-Hill, Deformation Processes in Refractory Metals. \$40,000.
- Florida, University of, Gainesville, Florida. John J. Hren and Craig S. Hartley, Quantitative Analysis of Solute Segregation in Alloys by Transmission Electron Microscopy. \$42,500.
- Georgetown University, Washington, D. C. William D. Gregory, The Study of Very Pure Metals at Low Temperatures. \$39,000.
- Georgia Institute of Technology, Atlanta, Georgia. Billy R. Livesay, Investigation of Relationships Between Microstructure, Magnetic Properties and the Hydriding Processes in Intermetallic Compounds of Rare Earth and Transition Metals. \$60,000 (10 months).
- Hawaii, University of, Honolulu, Hawaii. William Pong, Photoelectric Emission from Thin Films in the Vacuum Ultraviolet Region. \$32,506.
- Hawaii, University of, Honolulu, Hawaii. Murli H. Manghnani, Pressure Derivatives of Elastic Moduli in B.C.C. Transition Metals and Their Solid Solutions. \$37,084.
- Houston, University of, Houston, Texas. Simon C. Moss, Microstructural Studies of Hydrogen and Other Interstitial Defects in BCC Refractory Metals. \$53,500.
- Howard University, Washington, D. C. Arthur N. Thorpe, Radiation Damage in Optically Transparent Materials (Zircons). \$40,000 (2 years).
- Illinois Institute of Technology, Chicago, Illinois. Harold Weinstock, Thermal and Electrical Measurements on Solids at Low Temperatures. \$279,316 (3 years).
- Illinois, University of, Urbana, Illinois. Robert J. Maurer, The Science of Materials. \$2,059,423 (15 months).
- Kansas, University of, Lawrence, Kansas. Paul W. Gilles, High Temperature Chemistry. \$60,000.
- Lehigh University, Bethlehem, Pennsylvania. Michael R. Notis, Pressure Sintering and Creep Deformation - A Joint Modeling Approach. \$42,795.
- Marquette University, Milwaukee, Wisconsin. Robert N. Blumenthal, Defect Structures in Nonstoichiometric Oxides. \$45,832.
- Maryland, University of, College Park, Maryland. R. J. Arsenault, An Investigation of Irradiation Strengthening of BCC Metals and Solid Solutions. \$52,000.
- Maryland, University of, College Park, Maryland. M. J. Marcinkowski, Alloy Strengthening Due to Atomic Order. \$30,900.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. W. D. Kingery and R. L. Coble, Basic Research in Crystalline and Noncrystalline Ceramic Systems. \$738,000 (23 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. James L. Gole, The Luminescence Process in Chemical Reactions. \$57,235.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Clifford G. Shull, Low Temperature and Neutron Physics Studies. \$93,598.

MATERIALS SCIENCES

- Massachusetts Institute of Technology, Cambridge, Massachusetts. Sow-Hsin Chen and Sidney Yip, Thermal Neutron Scattering Studies of Molecular Dynamics and Critical Phenomena in Fluids and Solids. \$80,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Harvey K. Bowen and Bernhardt J. Wuensch, High Temperature Properties and Processes in Ceramics. \$92,000.
- Michigan State University, East Lansing, Michigan. Gerald Pollack, Properties of Rare-Gas Solids. \$99,607 (2 years).
- Michigan Technological University, Houghton, Michigan. Dale F. Stein and Lloyd A. Heldt, A Study of Grain Boundary Segregation using the Auger Electron Emission Technique \$56,252.
- Minnesota, University of, Minneapolis, Minnesota. William Zimmermann, Jr., Walter V. Weyhmann, and Allen M. Goldman, Experimental Investigations in Solid-State and Low Temperature Physics. \$176,877.
- Minnesota, University of, Minneapolis, Minnesota. William W. Gerberich, Analysis of the Ductile-Brittle Transition Temperature in Fe-Binary Alloys. \$41,600.
- New York, State University of, Stony Brook, New York. Patrick J. Herley, Preparation, Characterization and Use of Metal Hydrides for Fuel Systems. \$40,000.
- New York, State University of, Stony Brook, New York. John C. Bilello, Applications of Microdynamics and Lattice Mechanics to Problems in Plastic Flow and Fracture. \$54,000.
- North Carolina State University, Raleigh, North Carolina. Lloyd R. Zumwalt, Sorption of Cesium by Graphites at High Temperatures. \$42,000.
- North Carolina, University of, Chapel Hill, North Carolina. James H. Crawford, Jr., Investigation of Defect Structures by Electric Polarization and Relaxation Methods. \$75,000 (2 years).
- Northwestern University, Evanston, Illinois. M. Meshii, Effect of Point Defects on Mechanical Properties of Metals. \$51,500.
- Northwestern University, Evanston, Illinois. Donald H. Whitmore, Basic Research on Ceramic Materials for Energy Storage and Conversion Systems. \$65,000.
- Ohio State University, Columbus, Ohio. Roger W. Staehle and Arun K. Agrawal, Corrosion, Stress Corrosion Cracking, and Electrochemistry of the Iron and Nickel Base Alloys in Caustic Environments. \$52,500.
- Ohio State University, Columbus, Ohio. Robert A. Rapp, Fundamental Studies of Metal Fluorination Reactions. \$54,200.
- Ohio State University, Columbus, Ohio. Paul G. Shewmon, Hydrogen Attack of Steel. \$39,821.
- Oklahoma State University, Stillwater, Oklahoma. Geoffrey P. Summers, Electronic Structure of Defects in Oxides. \$23,400.
- Oklahoma, University of, Norman, Oklahoma. Ronald R. Bourassa, Thermoelectric Size Effect in Noble Metals. \$60,000 (30 months).
- Pennsylvania State University, University Park, Pennsylvania. Peter A. Thrower, Studies of Mechanical Properties and Irradiation Damage Nucleation of HTGR Graphites. \$29,800.

MATERIALS SCIENCES

- Pennsylvania State University, University Park, Pennsylvania. William B. White, Structure of Glasses Containing Transition Metal Ions. \$50,000.
- Pennsylvania State University, University Park, Pennsylvania. Richard C. Bradt and John H. Hoke, Ceramic Research. \$36,953.
- Purdue University, Lafayette, Indiana. Richard E. Grace, Transport and Thermodynamic Properties of Solids. \$40,000.
- Purdue University, Lafayette, Indiana. Alvin A. Solomon, High Temperature Effects of Internal Gas Pressures in Ceramics. \$52,421.
- Rensselaer Polytechnic Institute, Troy, New York. Warren F. Savage and David J. Duquette, The Effect of Welding Variables on the Solidification Substructure, Mechanical Properties and Corrosion Behavior of Austenitic Stainless Steel Weld Metal. \$43,300.
- Rensselaer Polytechnic Institute, Troy, New York. Norman S. Stoloff, Fatigue Behavior of BCC Metals. \$29,700.
- Rochester, University of, Rochester, New York. James C. M. Li, Diffusional Creep of Multi-component Systems. \$37,500.
- Rochester, University of, Rochester, New York. Stephen J. Burns, The Materials and Mechanics of Rate Effects in Brittle Fracture. \$40,000.
- Southern California, University of, Los Angeles, California. Terence G. Langdon, Grain Boundary Sliding During High-Temperature Creep. \$69,500.
- Southern California, University of, Los Angeles, California. Ferdinand A. Kroger, Electrical and Mechanical Properties of Oxide Ceramics. \$41,195.
- Stanford Research Institute, Menlo Park, California. Daniel Cubicciotti, Chemistry of Zirconium Related to the Behavior of Nuclear Reactor Fuel Cladding. \$134,952 (2 years).
- Stanford University, Stanford, California. William D. Nix, Structure Dependence of High Temperature Deformation of Metals. \$60,000.
- Stanford University, Stanford, California. David A. Stevenson, Diffusion of Oxygen in Liquid Metal Systems. \$41,309.
- Stanford University, Stanford, California. Richard H. Bube, Photovoltaic Materials Research - II-VI Heterojunctions and Cu_2S/CdS Thin Films. \$80,000 (10 months).
- Tennessee, University of, Knoxville, Tennessee. E. E. Stansbury and C. R. Brooks, Application of Adiabatic Calorimetry to Metal Systems. \$37,000 (14 months).
- Tennessee, University of, Knoxville, Tennessee. Joseph E. Spruiell, Microstructure-Property Relationships in Austenitic Stainless Steels. \$26,000 (9 months).
- U.S. Steel Corporation, Monroeville, Pennsylvania. J. V. Mahoney, Studies of Fundamental Factors Controlling Catalyzation of Reactions of Gases with Carbonaceous Solids. \$75,000.
- Utah, University of, Salt Lake City, Utah. Ronald S. Gordon, Impurity Effects on the Creep of Polycrystalline Magnesium and Aluminum Oxides at Elevated Temperatures. \$35,684.
- Utah, University of, Salt Lake City, Utah. J. Gerald Byrne, Positron Lifetime Measurements as a Non-destructive Technique to Monitor Fatigue Damage. \$48,677.

MATERIALS SCIENCES

Varian Associates, Palo Alto, California. Ronald L. Bell, Research Towards a 35% Efficient Concentrator Solar Cell Using III-V Compounds. \$70,000.

Vermont, University of, Burlington, Vermont. John S. Brown, Thermodynamic and Transport Properties of Interstitial Hydrogen Isotopes in Metal Systems. \$21,518.

Virginia, University of, Charlottesville, Virginia. Robert V. Coleman, Electronic Properties of Metals, Alloys and Molecules. \$95,000.

Washington, University of, Seattle, Washington. Robert L. Ingalls, Mössbauer Studies at High Pressure. \$63,000 (27 months).

Wisconsin, University of, Madison, Wisconsin. Gerald L. Kulcinski, Void Nucleation and Growth in Heavy Ion and Electron Bombarded Pure Metals. \$65,874.

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

The Aerospace Corporation, Los Angeles, California. Paul F. Zittel, The Important Parameters in Two-Photon Isotope Enrichment. \$139,330 (2 years).

Alabama, University of, University, Alabama. Lowell D. Kispert, ELDOR Investigations of Radiation Processes. \$54,217 (18 months).

Alaska, University of, Fairbanks, Alaska. Syun-Ichi Akasofu, Magnetic Field Annihilation in Magnetosphere and Some Applications. \$92,352 (23 months).

Alaska, University of, Fairbanks, Alaska. Hans Pulpan, Operation of Telemetered Seismic Network on Alaskan Peninsula. \$31,473.

Arizona, University of, Tucson, Arizona. Henry Freiser, Chelating Extractants of Improved Selectivity. \$52,413 (14 months).

Atomics International, Canoga Park, California. H. L. Recht and S. I. Yosim, Molten Salt Interactions in Coal Processing. \$232,472 (15 months).

Baylor University, Waco, Texas. Malcolm Dole, Radiation Chemistry of High Polymers. \$30,000 (16 months).

Boston University, Boston, Massachusetts. Richard H. Clarke, Radiationless Energy Conversion of Photoexcited Triplet States of Organic Molecules. \$92,731 (2 years).

Boston University, Boston, Massachusetts. Norman N. Lichtin and Morton Z. Hoffman, Electron Transfer Reactions of Excited Dyes with Metal Complexes. \$50,000.

Brandeis University, Waltham, Massachusetts. Henry Linschitz, Photochemical Reactions of Complex Molecules in Condensed Phase. \$129,668 (2 years).

Brandeis University, Waltham, Massachusetts. Saul G. Cohen, Effects of Mercaptans and Disulfides on Photochemical and High Energy Radiation Induced Reactions. \$30,067.

Brown University, Providence, Rhode Island. E. F. Greene, A Study of Chemical Kinetics by Molecular Beam Techniques. \$58,000.

California Institute of Technology, Pasadena, California. Aron Kuppermann, Studies in Chemical Dynamics. \$175,000 (18 months).

California Institute of Technology, Pasadena, California. Jesse L. Beauchamp, Application of Ion Cyclotron Resonance Spectroscopy, Photoionization Mass Spectrometry and Photoelectron Spectroscopy to Study the Properties and Reactions of Ions in Gases. \$45,000.

California Institute of Technology, Pasadena, California. H. B. Keller and Philip G. Saffman, Numerical Methods and Studies of Energy and Mass Transfer in Fluids. \$165,000 (16 months).

California, University of, Berkeley, California. Carson D. Jeffries, Photo-Molecular Phenomena in Condensed Matter. \$110,000.

California, University of, Berkeley, California. John H. Reynolds, Isotopic Studies on Rare Gases in Terrestrial Samples and in Natural Nucleosynthesis. \$130,000.

California, University of, Davis, California. John W. Root, Nuclear Methods in High Energy Chemistry. \$50,000.

California, University of, Irvine, California. Frank S. Rowland, Research in Chemical Kinetics. \$275,933 (16 months).

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

- California, University of, Irvine, California. Max Wolfsberg, Theoretical Studies on Isotopic Mass Effects in Chemistry. \$100,000 (2 years).
- California, University of, Irvine, California. Edward K. C. Lee, Kinetic and Spectroscopic Studies of Electronic Energy Transfer Processes. \$51,000.
- California, University of, Los Angeles, California. Malcolm F. Nicol, Chemistry of Hydrocarbon Solids at High Pressures. \$56,000.
- California, University of, Los Angeles, California. M. A. El-Sayed, Mechanisms of Energy Transfer and Phosphorescence-Microwave Multiple Resonance Techniques. \$75,000 (14½ months).
- California, University of, Los Angeles, California. George C. Kennedy, Compressibility Measurements. \$60,000.
- California, University of, Los Angeles, California. Gerald Estrin, Methodology for Synthesis of Information Processing Systems. \$380,000 (15 months).
- California, University of, Los Angeles, California. Donald J. Cram, Multiheteromacrocycles that Complex Metal Ions. \$66,430.
- California, University of, Los Angeles, California. Orson L. Anderson, Relationship of Rock Physics and Petrology to Geothermal Energy Technology. \$55,000.
- California, University of, Santa Barbara, California. Robert G. Rinker, Transport and Reaction in Supported Liquid. \$27,990.
- California, University of, Santa Cruz, California. George S. Hammond, Photoinduced Electron Transfer in Mixed Organic-Inorganic Systems. \$33,522.
- Chicago, University of, Chicago, Illinois. Ugo Fano, Basic Studies of Atomic Dynamics. \$73,585.
- Chicago, University of, Chicago, Illinois. Michael D. Perlman, Methods in Probability and Statistical Inference. \$46,000.
- Columbia University/Lamont-Doherty Geological Observatory, Palisades, New York. Lynn R. Sykes and Klaus H. Jacob, A Comprehensive Study of the Seismotectonics of the Eastern Aleutian Arc and Search for a Magma Chamber Beneath Pavlof Volcano. \$200,000.
- Columbia University/Lamont-Doherty Geological Observatory, Palisades, New York. Christopher H. Scholz and James T. Engelder, Rock Fracture Permeability at High Pressure and Temperature. \$65,000.
- Delaware, University of, Newark, Delaware. James R. Katzer, Auger and Reaction Studies of Poisoning by Sulfur and Regeneration of Metal Synthesis Gas Catalysts. \$82,000.
- Denver, University of/Colorado Seminary, Denver, Colorado. Norman Bleistein, Inverse Problems in Remote Sensing. \$76,000 (27 months).
- Florida State University, Tallahassee, Florida. Russell H. Johnsen, Radiation Induced Effects in Organic Systems. \$41,600.
- Florida, University of, Gainesville, Florida. Robert J. Hanrahan, Radiation Chemistry of Hydrocarbon and Alkyl Halide Systems. \$42,000 (13 months).

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

Florida, University of, Gainesville, Florida. John C. Biery, Reaction Rates of Multistep Thermochemical Closed Cycles. \$17,442 (7 months).

George Washington University, Washington, D. C. Nicolae Filipescu, Lanthanide Ions as Sensitive Probes in Intermolecular Energy Transfer and Organic Photochemistry. \$32,000.

Georgia, University of, Athens, Georgia. L. B. Rogers, Fundamental Studies of Separation Processes. \$73,500 (15 months).

Georgia, University of, Athens, Georgia. Robert B. King and Allen D. King, Jr., Transition Metal Chemistry Under High Carbon Monoxide Pressure: An Infrared Spectroscopic Study of Catalysis in the Fischer-Tropsch Reaction. \$63,897.

Harvard University/Observatory, Cambridge, Massachusetts. Alexander Dalgarno and G. A. Victor, Theoretical Studies of Highly Ionized Species. \$60,000.

Howard University, Washington, D. C. Peter Hambright, Kinetic, Magnetic and Mössbauer Studies on Porphyrin Systems. \$22,000.

Howard University, Washington, D. C. Lue-Yung Chow Chiu, Theoretical Study of Radiative Interaction and Energy Transfer Processes of Molecular and Atomic Systems. \$27,500.

Howard University, Washington, D. C. William M. Jackson, LIPS Study of Free Radical Reactions. \$72,044 (2 years).

Illinois, University of, Urbana, Illinois. George H. Miley and Joseph T. Verdeyen, Advanced Coupling of Nuclear Reactor-Gas Laser Systems. \$210,000 (25 months).

Illinois, University of, Urbana, Illinois. C. W. Gear, Numerical and Non-Numerical Methods for Differential Equations. \$304,000 (16 months).

Iowa, University of, Iowa City, Iowa. William C. Stwalley, The Distribution of Energy in Bimolecular Chemiluminescent Reactions Involving Hydrogen Atoms. \$80,000 (2 years).

Johns Hopkins University, Baltimore, Maryland. Dean W. Robinson, Far Infrared Chemical Lasers. \$44,000.

Johns Hopkins University, Baltimore, Maryland. Walter S. Koski, Studies in Hot Atom and Radiation Chemistry. \$60,000.

Kansas State University, Manhattan, Kansas. James R. Macdonald and Patrick Richard, Atomic Physics with Highly Ionized Ions. \$145,000 (5 months).

Kansas, University of, Lawrence, Kansas. Ralph E. Christoffersen and Gerald M. Maggiora, Stereoelectronic Properties of Aggregated Chlorophyll Systems. \$44,708.

Kent State University, Kent, Ohio. Richard S. Varga, Use of Variational and Projectional Methods in Numerical Analysis. \$45,000 (14 months).

Louisiana State University, Baton Rouge, Louisiana. Joseph Callaway and Ronald J. W. Henry, Electron Excitation Cross Sections for Multiply Charged Ions. \$53,600.

Maryland, University of, College Park, Maryland. Joseph Silverman, Radiation-Induced Effects in Polymers and Related Compounds. \$84,969 (19 months).

Maryland, University of, College Park, Maryland. Ivo Babuska, Studies of the Numerical Solution of Elliptic and Parabolic Boundary Value Problems. \$53,000 (14 months).

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

- Maryland, University of, College Park, Maryland. Everett R. Johnson, Radiation Induced Decomposition of Inorganic Salts. \$20,869 (2 years).
- Maryland, University of, College Park, Maryland. Glen E. Gordon, William B. Walters, and William H. Zoller, Nondestructive Determination of Trace Element Concentrations. \$113,520 (9 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Elizabeth J. Campbell, Feasibility Study of a Collaboration between the Laboratory for Nuclear Science and the Information Processing Center at MIT. \$29,000 (17 months).
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Keiiti Aki, Seismological Investigation of Crack Formation in Hydraulic Rock Fracturing Experiments and in Natural Geothermal Environments. \$100,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. John Ross, Symmetry Rules in Chemical Kinetics. \$42,000.
- Michigan State University, East Lansing, Michigan. James L. Dye, Properties of Solvated Electrons, Alkali Anions and Other Species in Metal Solutions and Kinetics of Cation and Electron Exchange Reactions. \$42,000.
- Michigan State University, East Lansing, Michigan. Max T. Rogers, Electron Spin Resonance Studies of Radiation Effects. \$35,000.
- Minnesota, University of, Minneapolis, Minnesota. Sanford Lipsky, The Contribution of Electronically Excited States to the Radiation Chemistry of Organic Systems. \$73,000 (13 months).
- Minnesota, University of, Minneapolis, Minnesota. Robert W. Carr, Jr., Studies in Chemical Reactivity. \$39,857.
- Minnesota, University of, Minneapolis, Minnesota. William R. Gentry, Reactions of Ions with Atomic and Molecular Free Radicals. \$30,000.
- Minnesota, University of, Minneapolis, Minnesota. Rutherford Aris and Robert W. Carr, Jr., Continuous Chemical Reaction Chromatography. \$52,131 (2 years).
- Minnesota, University of, Minneapolis, Minnesota. H. J. Oskam, J. A. Carruthers, and L. M. Chanin, Photo-Induced Cataphoretic Isotope Separation. \$68,440.
- Mississippi, University of, University, Mississippi. Theodore J. Klingen, The Radiation Chemistry of Plastic Crystals. \$30,000.
- Missouri, University of, St. Louis, Missouri. Jacob J. Leventhal, Observation of Luminescent Spectra in Low Energy Ion-Neutral Collisions. \$94,000 (2 years).
- Nebraska, University of, Lincoln, Nebraska. Edward P. Rack, Halogen Atom Reactions Activated by Nuclear Transformations. \$69,000 (2 years).
- Nebraska, University of, Lincoln, Nebraska. Gerhard G. Meisels, Principal Processes in the Radiolysis of Gases with Fission Recoils and Gamma Rays. \$73,000.
- Nebraska, University of, Lincoln, Nebraska. James A. R. Samson and Anthony F. Starace, Photoionization of Atoms. \$54,000.
- Nevada, University of, Reno, Nevada. Richard D. Burkhart, A Measurement of Diffusion Coefficients of Short-Lived Species in Solution by Photochemical Space Intermittency. \$20,000.

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

- New York, City University of/Brooklyn College, Brooklyn, New York. Harmon L. Finston, Applications of Nuclear and Radiochemical Techniques in Chemical Analysis. \$45,108 (14 months).
- New York, City University of/Brooklyn College, Brooklyn, New York. Takanobu Ishida, Studies of Carbon Isotope Fractionation. \$65,054.
- New York University, New York, New York. Paul R. Garabedian, ERDA Mathematics and Computing Laboratory. \$1,927,447 (15 months).
- Northwestern University, Evanston, Illinois. Erwin H. Bareiss, Computational Complexity in Multidimensional Neutron Transport Theory Calculations. \$92,000 (15 months).
- Notre Dame, University of, Notre Dame, Indiana. Robert H. Schuler, Radiation Chemistry. \$1,828,342 (15 months).
- Ohio State University, Columbus, Ohio. Richard F. Firestone, Kinetics of Ionizing-Radiation Induced Reactions. \$49,106.
- Ohio State University, Columbus, Ohio. Leon M. Dorfman, Pulse Radiolysis Studies of Fast Reactions in Molecular Systems. \$56,719.
- Oregon State University, Corvallis, Oregon. Carroll W. DeKock, Synthesis of New Rare Earth Metallo-carboranes. \$7,000 (2 years).
- Oregon, University of, Eugene, Oregon. Richard M. Noyes, Diffusion Controlled Reactions and Exchange Reactions in Solution. \$7,389 (15 months).
- Pennsylvania State University, University Park, Pennsylvania. F. W. Lampe, The Radiation Chemistry of Volatile Silanes and Germanes. \$55,000 (15 months).
- Pennsylvania, University of, Philadelphia, Pennsylvania. Daniel D. Perlmutter and Alan L. Myers, Thermochemical Processes for Hydrogen Production by Water Decomposition. \$68,000.
- Pennsylvania, University of, Philadelphia, Pennsylvania. David White, Anisotropic Intermolecular Interactions and Rotational Ordering in Hydrogen Containing Solids. \$31,980.
- Pittsburgh, University of, Pittsburgh, Pennsylvania. David W. Pratt, Microwave-Optical Double Resonance Spectroscopy. \$40,000.
- Princeton University, Princeton, New Jersey. John W. Tukey and Geoffrey S. Watson, Research on Data Analysis in the Physical Sciences. \$75,000 (14 months).
- Princeton University, Princeton, New Jersey. Herschel A. Rabitz, Inelastic Molecular Collisions - Applications of Theoretical Methods to Problems in Relaxation Phenomena and Laser Operations. \$24,458.
- Princeton University, Princeton, New Jersey. John Turkevich, Supported Catalyst Synthesis and Characterization. \$212,671 (32 months).
- Princeton University, Princeton, New Jersey. Lincoln S. Hollister, Origin of Fluid Inclusions in Precambrian Rocks Near Los Alamos, New Mexico \$22,900 (17 months).
- Purdue University, Lafayette, Indiana. George T. Tsao, Kinetics of Cellulose Hydrolysis by Acids and Enzymes. \$65,000.

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

- Rice University, Houston, Texas. G. K. Walters and Neal F. Lane, Energetics of Atomic and Molecular Interactions. \$180,000.
- Rice University, Houston, Texas. Richard Tapia, Quasi-Newton Methods for Constrained Optimization Problems. \$12,500.
- Rochester, University of, Rochester, New York. Jacob Bigeleisen, Fundamental Studies in Isotope Chemistry. \$110,000 (14 months).
- South Carolina, University of, Columbia, South Carolina. Milton W. Davis, Jr., The Use of Polyethers in the Treatment of Acidic High Activity Nuclear Wastes. \$62,015 (2 years).
- Southern California, University of, Los Angeles, California. Richard E. Bellman, Mathematics in Energy Research. \$20,000.
- Stanford University, Stanford, California. George B. Dantzig, Robert B. Wilson and Richard W. Cottle, Systems Optimization Research. \$175,000 (13 months).
- Stanford University, Stanford, California. Gene H. Golub, Research in Numerical Analysis. \$60,000 (13 months).
- Stanford University, Stanford, California. Michael J. Flynn, Studies of the Organization of Computer Systems. \$63,500.
- Stanford University, Stanford, California. Amos M. Nur, Fluid Porosity and Physical Properties of Crustal Rocks. \$59,639.
- Syracuse University, Syracuse, New York. S. Alexander Stern, Separation of Krypton and Xenon from Reactor Atmospheres by Selective Permeation. \$68,145 (2 years).
- Tennessee State University, Nashville, Tennessee. Rubye P. Torrey, Caseous Ion Chemistry: Analytical Applications. \$21,800 (20 months).
- Tennessee, University of, Knoxville, Tennessee. T. Ffrancon Williams, Research Concerning Ionic and Free Radical Reactions in Radiation Chemistry. \$60,000.
- Texas A&M University, College Station, Texas. Yi-Noo Tang, Hot Atom Reactions Involving Multivalent and Univalent Species. \$30,000.
- Texas A&M University, College Station, Texas. Jack H. Lunsford, Catalytic Methanation. \$50,000 (16 months).
- Texas Southern University, Houston, Texas. Curtis W. McDonald, Solvent Extraction Studies Using High-Molecular-Weight Amines. \$27,000 (13 months).
- Utah, University of, Salt Lake City, Utah. Leonard D. Spicer, Dynamics and Mechanisms of Hot Chemistry Stimulated by Recoil Methods. \$42,000.
- Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Hans J. Ache, Reactions of Charged and Neutral Recoil Particles Following Nuclear Transformations. \$51,000.
- Washington University, St. Louis, Missouri. Peter P. Gaspar, Reaction Studies of Hot Silicon and Germanium Radicals. \$50,000.
- Wayne State University, Detroit, Michigan. Larry Kevan, Radiolysis Studies on Reactive Intermediates. \$85,000.

MOLECULAR, MATHEMATICAL AND GEO-SCIENCES

Wayne State University, Detroit, Michigan. Edward C. Lim, Electronic Relaxation Processes in Polyatomic Molecules. \$44,851.

William and Mary, College of, Williamsburg, Virginia. S. Peter Gary, Theory of Plasma Waves in the Earth's Bow Shock. \$45,400 (2 years).

Wisconsin, University of, Madison, Wisconsin. John E. Willard, Studies in Hot Atom and Radiation Chemistry. \$97,417 (13 months).

Wisconsin, University of, Madison, Wisconsin. Robert W. Conn, Inelastic Molecular Collisions - Applications of Theoretical Methods to Problems in Relaxation Phenomena and Laser Operation. \$29,010.

Worcester Polytechnic Institute, Worcester, Massachusetts. Alfred A. Scala, The Gas Phase Radiolysis and Vacuum Ultraviolet Photolysis of Heterocyclic Organic Compounds. \$64,000 (2 years).

Wright State University, Dayton, Ohio. Gordon B. Skinner, Atom and Radical Concentrations in Thermal Reactions of Hydrocarbon and Other Gases. \$30,000.

Yale University, New Haven, Connecticut. R. James Cross, Jr., Research on High Energy Chemical Reactions. \$17,734.

Yale University, New Haven, Connecticut. Kenneth B. Wiberg, Energies of Organic Compounds. \$80,000 (16 months).