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ABSTRACT

An overview of the membership of nine societies that comprise the American Institute of Physics is presented, with attention to demographic characteristics, employers, work activity, salaries, physics subfields, and differences among the societies. Comparisons are made to surveys since 1979, and highlights on 1983 salaries are included. One section is based only on employed Ph.D. physicists, with focus on physics research and interrelationships among physics employment subfields. Details are provided on the levels of research in each physics subfield, the mobility between subfield of degree and subfield of employment, and the overlap between employment subfields for physicists. The effects of employment sector and time since receipt of degree on the research career patterns of physicists are also examined. The societies are as follows: American Physical Society, Optical Society of America, Acoustical Society of America, Society of Rheology, American Association of Physics Teachers; American Crystallographic Association, American Astronomical Society, American Association of Physicists in Medicine, American Vacuum Society, and American Geophysical Union. Detailed statistical tables are appended. (SW)

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MEMBER SOCIETIES

The American Physical Society
Optical Society of America
Acoustical Society of America
The Society of Rheology
American Association of Physics Teachers
American Crystallographic Association
American Astronomical Society
American Association of Physicists in Medicine
American Vacuum Society
American Geophysical Union

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INTRODUCTION

A sluggish economy and the highest unemployment rate since World War II indicated that the United States was in the throes of a recession between March 1982 and March 1983. Although more than ten million people were out of work in the U.S., the economic downturn did slow the inflation rate. By March 1983 inflation the previous twelve months had fallen to 3.6%. Despite the recession, most members of the nine AIP member societies[1] enjoyed a positive year economically. Unemployment among society members continued at slightly under 1% and salary levels in most employment sectors increased at double the rate of inflation. The rapid decline observed between 1979 and 1981 in teaching as a work activity appears to have leveled off somewhat, with only a minor drop over the past two years. This fact in conjunction with healthy salary increases at universities may represent early signs that undergraduate and graduate institutions are beginning to recover from recent departures to industry. The number of industrially employed members, however, continued to increase and now nearly equals university employment.

The initial part of this profile consists of an overview of society membership. Demographic and employment characteristics are stressed with ample comparisons to past surveys dating back to 1979. While this section illustrates member salaries, it should be noted that 1982 marked the commencement of an annual publication devoted exclusively to member salaries. As a result, the salary data presented consist only of highlights from the full report "1983 Salaries".

The special focus of this society profile is on physics research and the interrelationships among physics employment subfields. While the section on membership composition includes the whole range of different professional self identifications, this portion of the profile focuses on physicists only. It details the levels of research in each physics subfield, describes the mobility between subfield of degree and subfield of employment, and discusses the overlaps that exist between employment subfields for physicists. It also examines the effects of employment sector and time since receipt of degree on the research career patterns of physicists.

The final section of the report highlights some of the similarities and differences among the societies, profiles the characteristics of new society members, and ends with a detailed picture of the distinctiveness of each society.

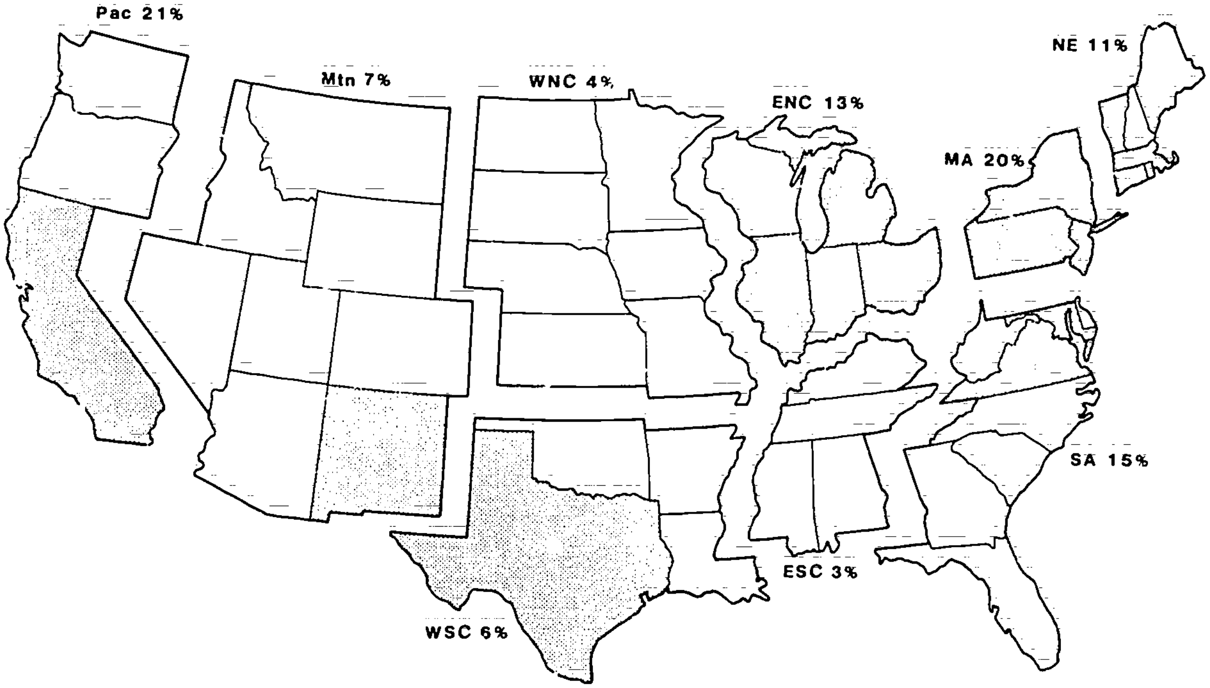

FIG. 1. Regional distribution of society members, 1983. Three-quarters of all members are concentrated in the shaded states.

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[1] While the American Geophysical Union is now a member society of AIP, it was not at the time of this survey.

In 1979 a membership sample of the nine AIP member societies was randomly selected to investigate demographic and employment characteristics. The original group queried was relatively small with approximately 2500 returning questionnaires. Since that inaugural survey, the same individuals have been sent update questionnaires on a yearly basis enabling the cross-sectional and longitudinal analysis of the data. Also, a sample of new society members have been added each year. To ensure a response pattern large enough to examine underrepresented groups such as women, minorities, and students, the 1981 sample was expanded to include one out of every six members. In addition, the three smaller AIP member societies were oversampled to include one out of every three members in order to examine their membership composition more accurately.

This 1983 report is based on the fifth annual sample and the largest respondent group to date. Over 6700 society members returned questionnaires during the summer of 1983. They represent 12% of the entire United States and Canadian membership. In addition nearly 300 individuals who are no longer society members responded in 1983. Their basic composition is discussed separately in Appendix A.

MEMBERSHIP COMPOSITION

Society members live across the United States, yet membership is highly concentrated geographically in California and the southwest, the Great Lakes states and the contiguous states between the District of Columbia and Boston. Figure 1 illustrates that more than 75 percent of all U.S. society members reside within one of fourteen states. This is in sharp contrast to the overall population of which only 56 percent dwell in these states.

While society members live predominantly in the United States, a substantial population, representing 15 percent of all society members, live around the world. This foreign component is approximately equivalent to the number of members living in California. Canada (3%), Japan (2%) and West Germany (1.5%) maintain the largest foreign populations of society members. The other countries presented in Table I each represent at least 0.5% of the total membership.

The remainder of this report will concentrate on society members living in the United States and Canada. Members living overseas and south of the United States were not mailed questionnaires during 1983.

TABLE I. Number of society members residing in selected foreign countries, 1983.

	Number
Canada	1940
Japan	1260
West Germany	830
England	600
France	520
Australia/New Zealand	450
Switzerland	390
Israel	310

The demographic composition of the nine AIP member societies has been relatively stable since 1979. Society members remain predominantly white (91%), male (94%), United States citizens (90%) and have a median age of 43. Subtle shifts, however, are evident. Between 1979 and 1983 the representation of women and Orientals increased slightly while the proportion of blacks and Hispanics has actually decreased. As depicted in Figure 3, a majority of society members identify themselves professionally as physicists (58%). This has decreased by two percentage points over the

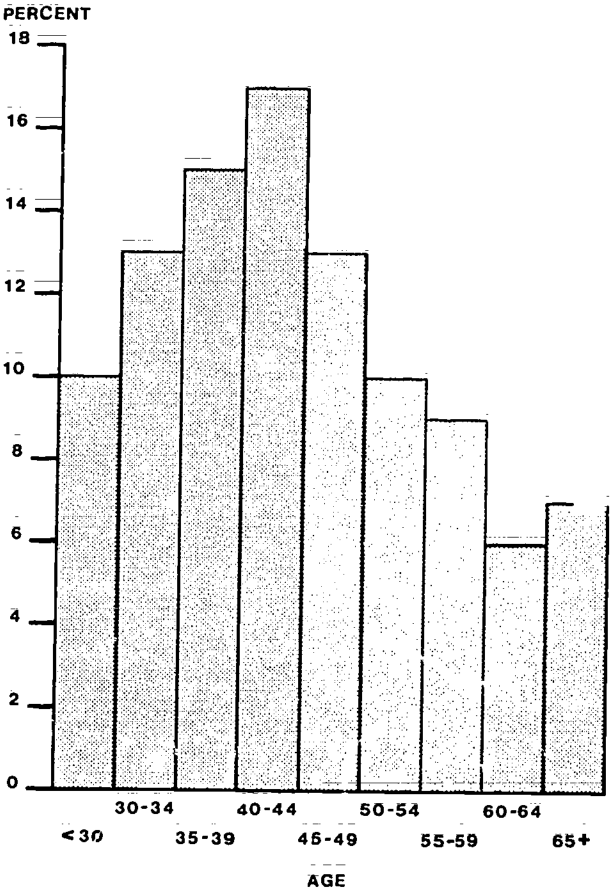

FIG. 2. Age distribution of society members, 1983.

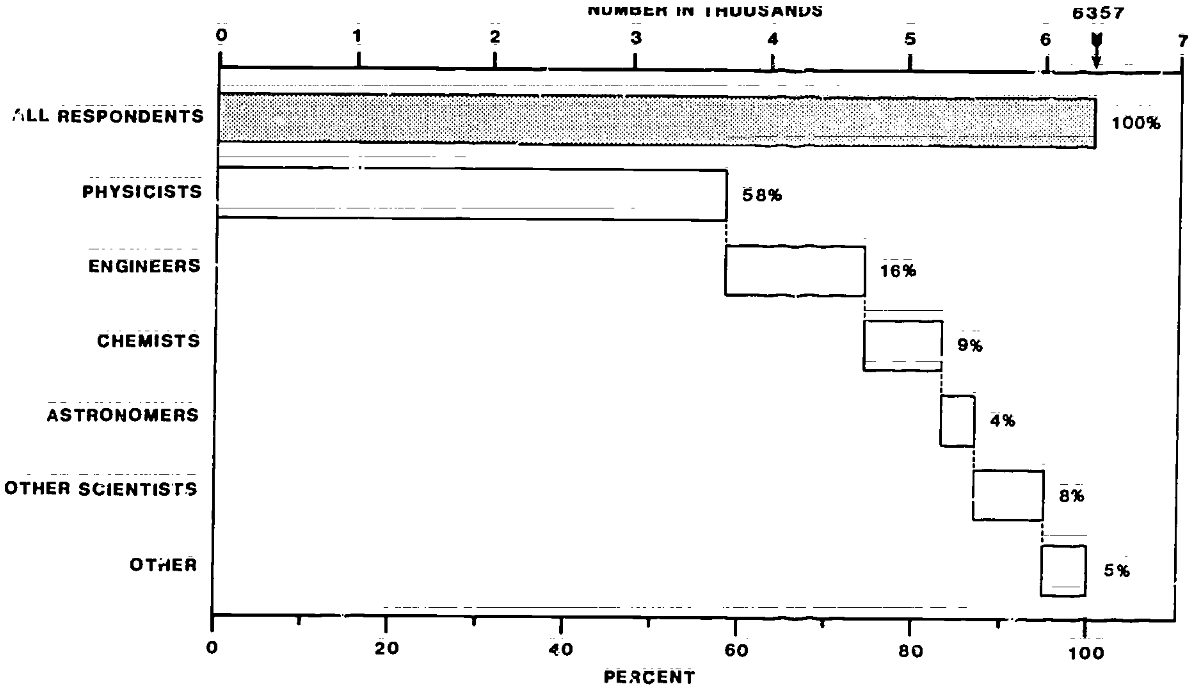

FIG. 3. Professional self-identification, 1983.

past four years while the number of computer and medical scientists has been increasing steadily over the same period. The representation of engineers, chemists, and astronomers has remained virtually unchanged.

The distribution of society members by highest degree illustrates the large amount of time society members spend in formal education. Nearly 70% of all members have received a doctoral degree while masters and bachelors degree holders make up 20% and 10% of the membership, respectively. The latter figures include individuals who are still students at the graduate level of study. Thus, only 8% of all society members have only a bachelors degree and have actually stopped their formal education. In addition, this small group of society members who have terminated their education at the bachelors level has a median age of 47, substantially older than individuals holding either masters (45) or doctoral (44) degrees.

Graduate students make up 8% [2] of the overall society membership and, as a group, are 27 years of age. The composition of this group closely tracks the overall membership, with a comparable representation of physicists. Engineers are slightly underrepresented among students since they tend to join professional societies after they have received their highest degree.

EMPLOYMENT

In March 1983, 84% of all society members were employed full-time while less than 1% were unemployed and actively seeking. The relatively low percentage of full-time employed individuals reflects a large

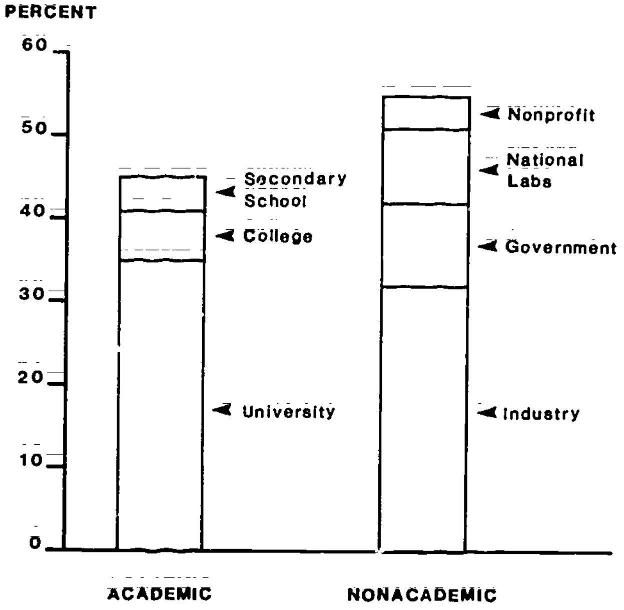

FIG. 4. Type of employer, 1983.

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[2] This number excludes those individuals who belong only to the Society of Physics Students.

population of advanced graduate students. Nearly 6% of the entire membership indicated that they were working part-time while pursuing an education. Upon removing students from the distribution, the full-time employed respondent group jumps to 90%. However, even when students are excluded, women are still four times more likely than their male colleagues to be working on a part-time basis.

Employer

Universities and industry remain the two predominant employers of society members with 35 and 32%, respectively (Figure 4). In addition, one out of every five members work under the auspices of the federal government either in the military, civil service or at federally funded national laboratories. The difference in employment levels observed between universities and industry was 8% in 1979 but has diminished since. While employment in the university system remained stable during the past two years, industry continued to gain ground. The observed shift is even more dramatic when considering that the number of individuals working at universities includes a substantial student population. The non-student contingent of university employed members actually experienced a decrease between 1981 and 1983. Thus, when students are not included, the number of members employed in industry equals the number in universities for the first time since 1979, when the annual membership surveys began.

This pattern is due, in large part, to both the increase in attractive industrial opportunities and the lack of academic ones. The latter are effected by the large proportion of tenured full and associate professors (nearly 85%) among the current faculty. As illustrated in Figure 6, the large bulk of these associate and full professors are still a number of years from retirement, thus limiting the number of openings and the opportunity for upward mobility of new assistant professors.

Those society members who are industrially employed are relatively concentrated. Over one-third of them are working in the 15 largest corporations.[3] As illustrated in Fig. 7, these companies each employ over one percent of the society members working in industry. While the 100 largest companies employ two-thirds of the members, the long tail on the curve reflects the large number of companies where only a few members are working.

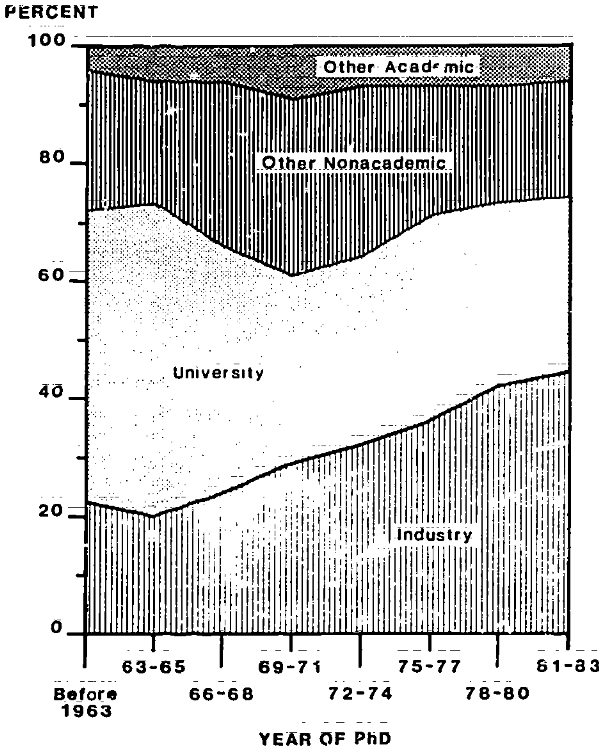

FIG. 5. Current employer type by year of PhD, 1983.

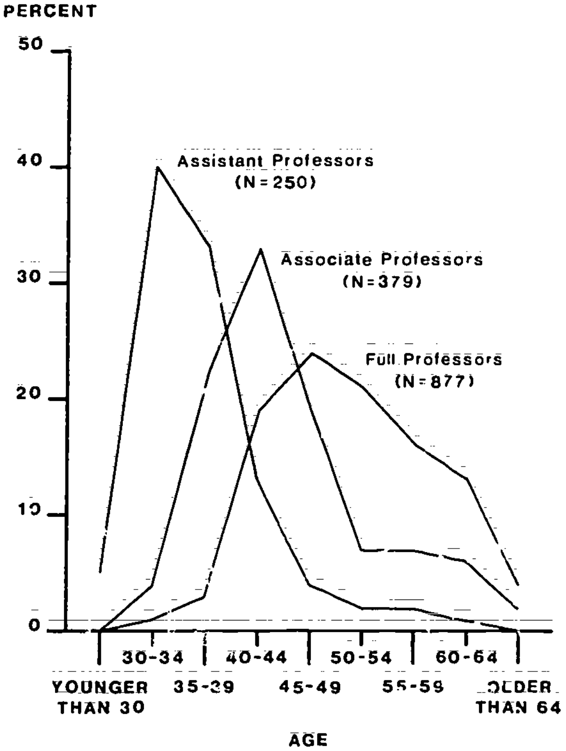

FIG. 6. Age profile by professorial rank, 1983.

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[3] A list of the fifteen largest industrial employers of society members can be found in Appendix C.

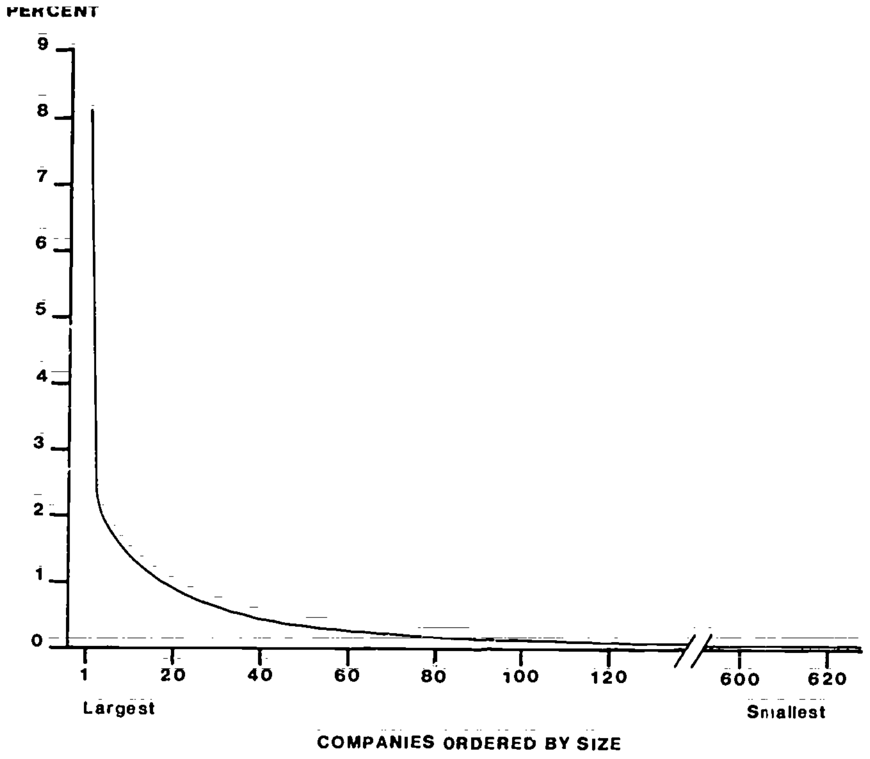

FIG. 7. Distribution of industrial companies, 1983. Companies were rank ordered by their share of the industrially employed members.

Government was the only other major employment sector to experience a shift, with a decrease of 1% between 1981 and 1983. The significance of this must be determined in future reports, since trend data for federal employees back to 1979 have been extremely stable. One additional note; since women make up only 6% of the entire membership, their unique employer distribution tends to be obscured by the the male majority. For example, women are nearly three times more likely than men to be employed in secondary schools. In contrast, women are dramatically underrepresented in industry as compared to their male colleagues.

The type of work activities performed and the potential salaries earned influence the degree distribution observed in each job sector. With basic research and teaching being the two primary concerns of university based employment, full-time openings for individuals with a masters or bachelors are often limited. Thus, the universities are the domain of the doctorate, with over 40% of all PhD members employed there. This also holds true for employment at national laboratories where the prospects of doing basic research combined with competitive salaries attract 11% of all PhDs. While demand for members with doctorates often keeps masters and bachelors away from universities and national laboratories, low salaries and the lack of basic research opportunities in junior colleges and secondary schools dissuades PhDs. Nearly 20% of all masters and 10% of all bachelors are employed in secondary schools; in addition there are a substantial number of masters employed at junior colleges. Industry with its high salaries has the widest range of work activities and, concurrently, it also has the greatest diversity of degree levels.

Professional self-identification is closely associated with the specific sphere of employment. Members who are employed as physicists and chemists are evenly divided between academe and areas outside of the academic sector: industry, government, national laboratories, and nonprofit. In contrast, engineers and computer scientists are heavily based in industry while astronomers primarily work for universities.

During 1983 more than 250 Canadians responded to the membership sample survey. Canadian members tend to be slightly younger than their United States colleagues, are more likely to call themselves physicists and are more highly concentrated in the university sector. This overrepresentation of university based employees explains the predominance of individuals doing basic research in Canada. Nearly 40% of those queried are engaged in basic research in comparison to one quarter of the United States membership. The underrepresentation of industrially employed individuals (14%) may indicate that engineers, chemists and other scientists are neither strongly attracted to nor heavily solicited by professional physics societies based in another country.

Work Activity

Society members are engaged in a wide variety of work activities. However, basic research, teaching and applied research predominate. Nearly 70% of the entire membership are employed in one of these activities while other members concentrate in areas such as administration, development and design/engineering. In 1979 the two primary work activities were teaching and basic research, each involving 26% of the membership. Since that date employment in basic research has remained constant while teaching has decreased by a dramatic four percentage points. This decrease along with the decline in the number of individuals employed in the university sector, reflects the curtailment of academic opportunities and illustrates the close relationship between the employment sector and the type of work an individual performs. As illustrated in Figure 8, society members employed in universities are primarily involved in basic research and secondarily in teaching. In contrast, teaching is by far the dominant work activity for those members employed at colleges and secondary schools with over 90% indicating it as their first responsibility. Members employed by the government or national laboratories are primarily engaged in basic and applied research. Industrial activities are widely distributed, except that very few members are engaged in teaching.

In addition to the relationship between employer and work activity, the level of highest degree also plays a major role in what an individual does. For example, PhDs carry out 90% of all the basic research and 80% of the applied research in the industrial work environment. By contrast, masters and bachelors perform 55% of all the design/engineering conducted by society members in industry. Industrially employed masters and bachelors are generally similiar in terms of work activities although masters are more likely to be doing applied research and development, while bachelors are more likely to be engaged in design/engineering and administration.

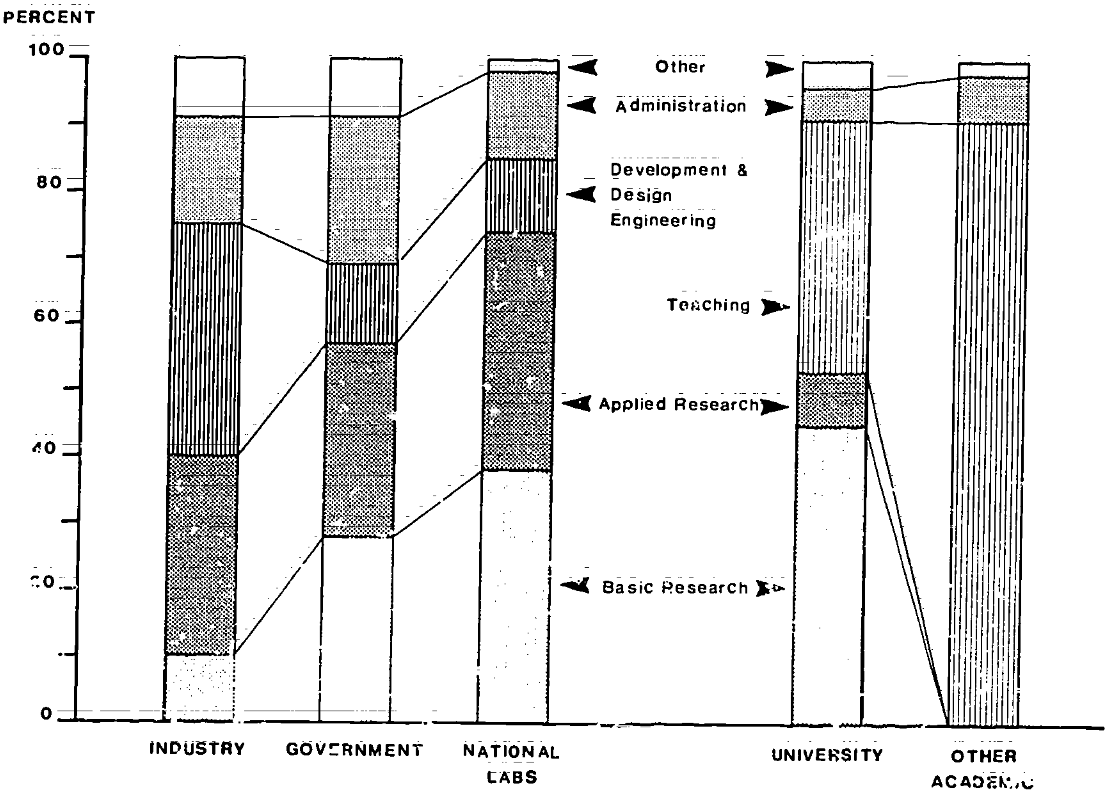

FIG. 8. Work activity by selected type of employer, 1983.

SALARY OVERVIEW

In past society membership profiles this section contained an in-depth analysis of member salaries. Due to frequent requests for salary information, a new series devoted to this topic was inaugurated in 1982. As a result of this new publication the following section has been abbreviated to include only the main highlights from "1983 Salaries". Individuals seeking a greater level of detail may contact the Manpower Statistics Division for a free copy of that report.

Since the first query for salary information back in 1979, annual increases in overall median salaries for PhD members have remained close to the observed inflation rate. This changed during the period between March 1982 and March 1983, with inflation slackening to 3.6% while the median salaries for full-time employed PhDs increased 7.0% ($38,300 to $41,000). This was positive news for members generally. Future data should establish whether or not the substantial difference between inflation and the median salary increase was an anomaly or the beginning of a new more prosperous trend for society members. Figure 9 compares actual PhD median salaries from 1979 to 1983 with salaries adjusted for inflation. The relative flatness of the "constant 1979 dollar" line from 1979 to 1982 illustrates members just keeping pace with inflation. The increase observed between 1982 and 1983 is the first "real" salary increase since 1979. Wide-ranging variations in salary levels and salary increases still existed in 1983. These were effected by factors such as geographic location, employer, type of work, position, degree level, years of experience, and sex.

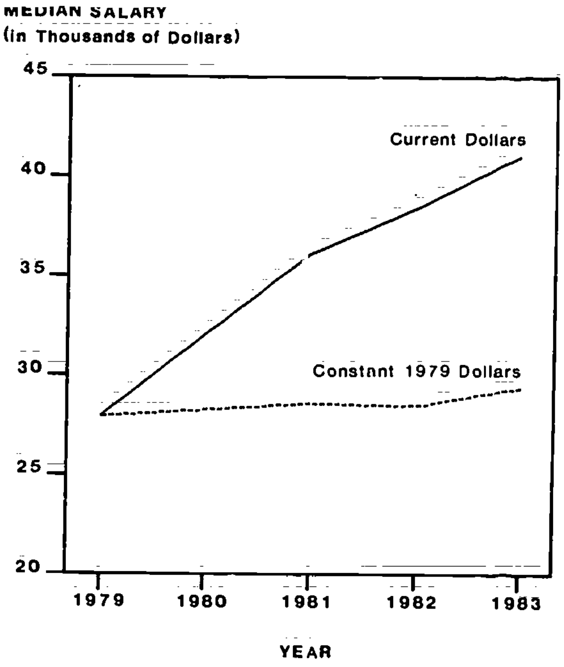

FIG. 9. Median salaries for PhDs, 1979-1983. Both reported salaries and salaries adjusted for inflation are presented.

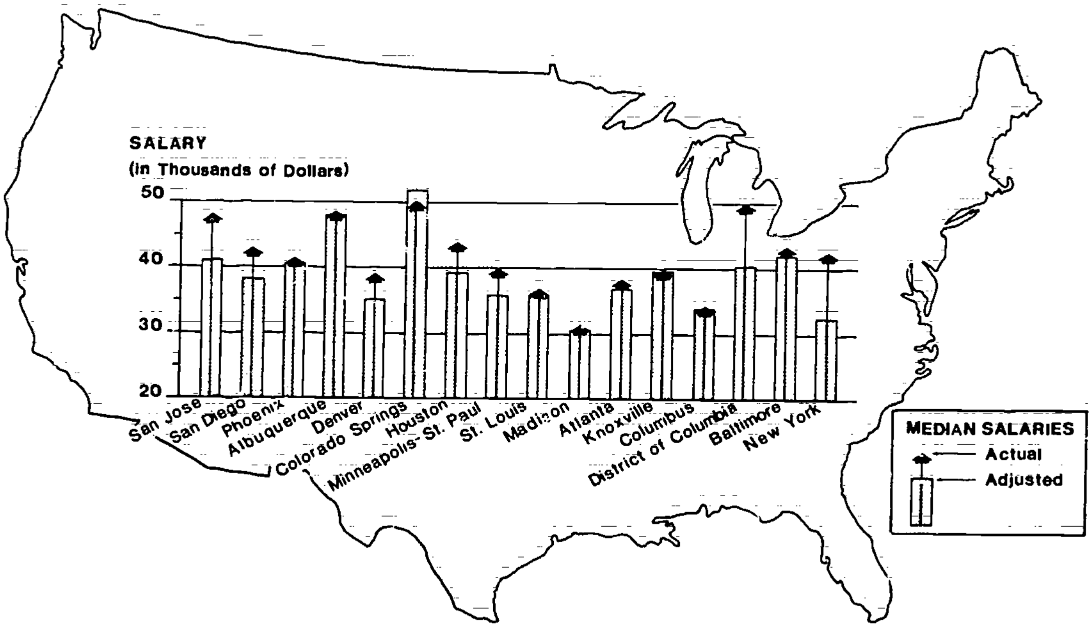

FIG. 10. Median salaries for PhDs in each of 16 metropolitan areas, 1983. Both actual salaries and salaries adjusted for cost of living are presented.

Salaries and Geographic Location for PhDs

The "1983 Salaries" report provides detailed member salary information by geographic divisions, states, and cities. To some extent observed salary differences can be attributed to varying regional age structures. However the dominant factor is the employer composition for each region and the corresponding salary structure found within each employment sector. Members living in the Sunbelt and along the east coast received the highest salaries in the nation due to the heavy concentration of industrially and federally employed individuals (national labs and government).

"1983 Salaries" also explores the relative cost of living in one city versus another and how these variations effect society members. For example Figure 10 illustrates that the apparent high salaries received in San Jose have approximately the same purchasing power as those earned by members living in Knoxville once salaries are adjusted for the local cost of living. New York City and Washington D.C. remain two of the most expensive cities in the continental United States. While Washington salaries, when adjusted for inflation, remain right around the national median for PhDs, New York's are nearly $9,000 less than the national median.

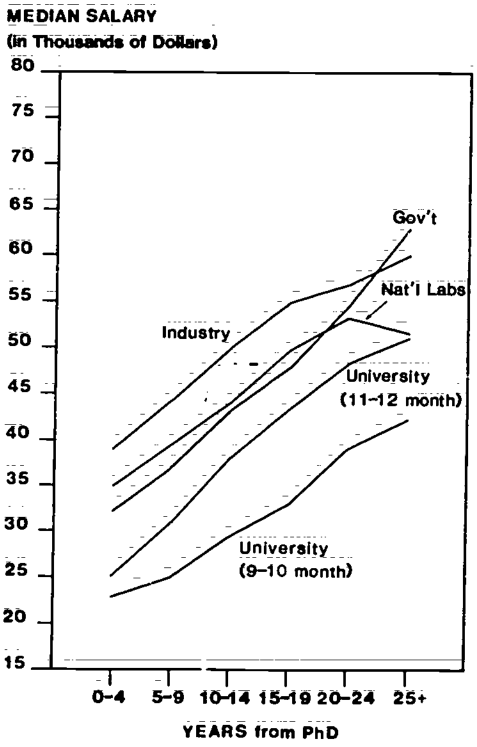

FIG. 11. Median salaries by type of employer and years from PhD, 1983.

Salaries, Employer Type and Degree Level

Figure 11 presents median salaries for PhDs based on their professional experience within the five largest employment sectors. PhDs employed in industry remained the highest paid members drawing an annual median salary of $48,000 in 1983. It is likely that in the near future the top 10% of industrially employed society members with over 25 years of experience will be making in excess of $100,000 annually. Government salaries continued to be restrained by federal salary ceilings. Nearly one half of the most experienced government employees found their salaries clustered around $63,000 in 1983. In marked contrast, their colleagues in industry with the same levels of experience had salaries ranging from $60,000 to $90,000. Although academic salaries remained substantially lower than those in the non-academic employment spheres, the 7.5% increase from 1982 to 1983 was twice that of the inflation rate. The notable exception was in postdoctoral positions at universities where salaries increased by only 2.2%.

The nearly 68% differential in median salary paid to society members employed in industry versus secondary schools ($45,100 and $26,900 respectively) represents one of the largest salary disparities observed for masters degree holders. Despite this inequity, these sectors remain the two predominant employers of mas-

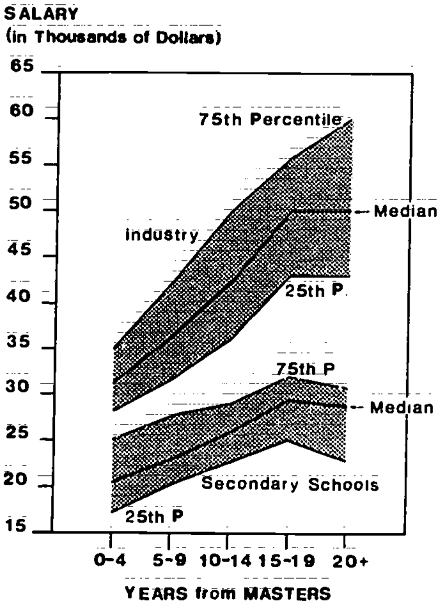

FIG. 12. Salary structure in industry and secondary schools by years from masters degree, 1983.

ters, 41% and 18% respectively. Figure 12 graphically presents the salary structure in industry and secondary schools for members at different levels of professional experience. It clearly illustrates that regardless of how long they have been in the labor force, the median salary paid to masters working in secondary schools is less than the median entry-level salary in industry.

Individuals holding bachelors as their highest degree represent only a small proportion of society members. The employment concentration for this group is even more pronounced than for masters; nearly two-thirds of all bachelors are employed in industry. In 1983, bachelors with less than 20 years of work experience received salaries $5,000 to $9,000 less than their industrial colleagues holding masters degrees.

Salaries and Primary Work Activity

Society members are involved in a wide range of work activities that directly influence their median salaries. PhDs, who accept industrial employment within four years of their degree, receive similar entry level salaries in the work areas of basic research, applied research, development and design/engineering (medians ranging from $38,000 to $39,300). Comparable salaries are maintained across these work activities as professional experience increases. The major exception is basic research, which pays substantially higher salaries to members who received their degrees 15 or more years ago. Mid-career shifts into administration are common and often very profitable, with median salaries as much as $22,000 higher than in other work activities.

Salaries and Employer Type for Males and Females

Only a small percentage of members of AIP member societies are women (5% of PhDs, 6–8% of bachelors and masters). In 1983 this group received salaries 11–28% lower than their male colleagues in the six major employment sectors. While part of this difference results from a younger population of female members, adjusting the salaries for age reveals that lower salary levels still exist for women across the board. Salary parity is nearly reached for men and women engaged as senior faculty at colleges and universities on 9–10 month contracts (3% difference). The greatest inequity exists for PhDs holding junior academic ranks at universities on 11–12 month contracts (20% difference). The large age difference between males and females employed in industry produces average salaries that are 28% higher for men than women. While salary adjustment for age draws salaries closer together, women in industry are still faced with salaries 7% lower than men.

PHYSICS SUBFIELDS

The special focus of this year's Society Membership Profile is the description of physics research and an analysis of the interrelationships among physics subfields. The previous discussion dealt with the broad spectrum of scientists, engineers and professionals who make up the society membership. In contrast the following section is based only on employed PhDs who identified themselves as physicists, the majority of society members.

This section will include a discussion of the mix of subfields that physicists use in describing their employment. Particular emphasis will be devoted to the strength of association between particular physics subfields of work as well as how these associations are influenced by employment sector and dissertation field. This section will examine what these associations tell us about both physics research and the normal career development patterns of physicists. The very close relationship that exists between physics and related science and engineering fields will also be apparent.

TABLE II. Fields and subfields of employment for PhD physicists, 1983.[a]

	Work Effort %
Solid State Physics	12.1
Plasma Physics	6.3
Elementary Particle Physics	6.1
Nuclear Physics	6.0
Optics	5.8
Atomic & Molecular Physics	5.0
Astrophysics/Astronomy	3.6
Medical/Radiological Physics	3.5
Chemical Physics/Chemistry	2.8
Mathematical Physics/Mathematics	2.5
Geophysics/Earth Science	2.5
Materials Science	2.3
Electronics	1.8
Biophysics/Biological Science	1.7
Acoustics	1.6
Low Temperature Physics	1.6
Electromagnetism	1.2
Fluid Dynamics	1.0
Other Physics Subfields	7.7
Engineering	8.2
Computer Science	1.9
Other Science	1.8
Education	8.0
Administration	4.9
Total Number Known	2304

[a] Work effort includes areas cited as either the primary or secondary subfield of work. When only a primary was cited, it was counted as both.

Employment Subfields for Physicists

The research that PhD physicists conduct is richly diversified and yet much of it is heavily concentrated in a few subfields of employment. Table II presents the distribution of work effort[4] for PhD physicists in 18 research subfields and 6 general employment areas. The former account for about two-thirds of the total work carried out by physicists. The work effort in each subfield may be viewed as one indicator of the labor market demand for specialized, doctoral-level, knowledge and skill.

Solid state physics is, by a wide margin, the largest subfield of physics employment. Solid state and three other core fields: plasma physics, elementary particles and nuclear physics, account for over 30% of the total work carried out by PhD physicists. The next four largest subfields of employment comprise both applied areas of high growth — optics and medical physics — and traditional core areas — atomic and molecular physics and astrophysics.[5] The remaining specific research subfields each account for at least one, but less than three, percent of the work effort. Most of the latter subfields represent interdisciplinary research such as: chemical physics, geophysics, materials science, biophysics and acoustics.

Beyond the physics research subfields, education and engineering are the two largest areas of employment, each with 8% of the work effort. Most of the engineering work is clustered in electronic, systems and electrical engineering. By comparison, administrative duties account for 5% of the work done by physicists and computer science provides only 2% of the doctoral level employment.

Research Effort and Employment Sector

The focus of the physics research effort differs widely within each employment sector. Universities with 40% of all physicists are the dominant employer and industry is the second largest, employing about one in four physicists. Another quarter are split between the national laboratories and other government employment.

In general, research carried out in the universities and at the national laboratories is spread across the traditional core subfields. By comparison, research done in the industrial sector is more highly concentrated, both in research focus and location. More than 40% of the research effort in industry is in either solid state physics or optics and approximately half of all industrially employed physicists work in the 25 largest corporations. The concentration of industrial work in solid state physics is particularly pronounced. Over one quarter of the effort in this area is carried out in only two companies: AT&T Bell Laboratories and IBM.

TABLE III. Predominant research fields in selected employment sectors, 1983.[a]

University	Industry	National Labs	Government
Solid State	Solid State	Plasma Physics	Solid State
Elementary Part.	Optics	Solid State	Optics
Nuclear Physics	Plasma Physics	Elementary Part.	Atomic & Mole.
Atomic & Mole.	Materials Sci.	Nuclear Physics	Geophysics
			Plasma Physics

[a] The subfields listed account for the majority of the physics research effort within each employment sector.

Table III provides a summary of those disciplines that account for over half of the physics research conducted within each of four major employment sectors. Solid state physics predominates in all employment spheres, with the exception of the national laboratories where nearly one fifth of the physics research effort is devoted to plasma physics. Four national laboratories: Lawrence Livermore, Oak Ridge, Los Alamos, and the Princeton Plasma Physics Laboratory, account for about 80% of the research effort in plasmas within the national laboratories.

The federal government is the fourth largest employer of physicists. Within this sector, one third of the PhDs work for the Department of the Navy, one out of six are employed by the National Bureau of Standards and another 10% each are in NASA and in the Department of the Army. Within the government, more than half of the research effort in plasma physics is carried out at the Naval Research Laboratory. Similarly, about a third of the atomic and molecular physics research is done at the National Bureau of Standards.

The pursuit of research opportunities in some physics subfields is confined to selected employment sectors. Basic research in elementary particle physics is an excellent example. It requires large facilities, is typically carried out by large teams, and has no definite links to a profitable product in the short term. Thus, it is not surprising that fundamental work in elementary particle physics is seldom conducted by private industry. Elementary particles is the most concentrated employment field. Nearly three-quarters of this research effort is in the universities and virtually all of the rest is carried out in the national laboratories, principally at Fermilab, Brookhaven and Lawrence Berkeley Laboratories.

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[4] Work effort includes both primary and secondary subfields of work. When only one subfield was indicated, as was done by 30% of the physicists, it was counted as both primary and secondary.

[5] Since this discussion is confined to self identified physicists, we have combined certain subfields as noted in Table II.

Similar concentrations of work effort can be found for materials science and geophysics. Although each represents less than 3% of the overall work effort, materials science and geophysics do provide major employment opportunities in industry and government, respectively. As one would expect, most engineering opportunities are in the industrial sector. However, it should be noted that one-sixth of all the engineering effort carried out by physicists is in the universities. This may reflect the difficulties that institutions have had in attracting a sufficient number of faculty with doctorates in engineering to keep up with undergraduate enrollment.

Those physics subfields clustered in academe or industry are often associated with the fields that reflect the mode of work within that employment sphere. Thus, those subfields that are most highly represented in the universities: elementary particles, nuclear physics, astrophysics, and atomic and molecular physics, are also most likely to occur in combination with education in the employment description. Conversely, many of those subfields displaying strong associations with engineering: optics, plasma physics and electromagnetism, reflect the applied perspective typical of their industrial base. Acoustics, although a comparatively small employment field, is unique in its strong overlap with both education and engineering. This may indicate that it is a fundamental component of physics curricula and that it also provides the instrumentation and methodology for a variety of industrial applications.

Associations between Research Subfields

In this section, we will take an in-depth look at the relationships that exist between research subfields. This discussion will focus on two main issues. First, we will consider those subfields that appear to be comparatively independent or self-contained. Second, we will examine the empirical associations between physics research subfields and, where possible, comment on the strength of those relationships.

From these perspectives we hope to provide a better understanding of those subfields that deal with discrete conceptual issues and those that have an overlap in subject matter or methodology. The goal of this analysis is to lay the groundwork for the development of a predictive model of the physics labor market that recognizes normal career development patterns and distinguishes them from abrupt changes in career direction.

Subfields vary by the degree to which any one of them provides a sufficient description of the scope of a physicist's work. The proportion of PhDs in each research field who list only a primary subfield of work can be used as an indicator of the degree to which that field is independent or well-bounded. At least one-third of the physicists working in elementary particles, medical physics, astrophysics and plasma physics feel that these fields circumscribe their full employment effort. These subfields apparently represent a distinct set of both characteristic ideas and methodological procedures. Although research in these fields is highly focused and often calls for no other field of specialization, it does not follow that the fields themselves are isolated from the rest of physics. In fact, when work is described as involving one of these subfields in conjunction with another area, that other subfield is usually within physics research. The specific patterns of association in each case will be highlighted later.

By contrast, some physics subfields rarely represent the sole focus of the work that physicists carry out. When two subfields are used to describe a physics position, those subfields may be seen as involving one of the following: a real interplay of the subject matter from two specializations; a subfield that is a specification of a broader area; or a subfield that is used to indicate a methodological approach within a research area.

While the borders between physics employment subfields are not always clear, several distinct patterns of interplay do emerge. Some physics research areas clearly exhibit strong associations, while others are rarely, or never, combined. Figure 13 depicts those subfield configurations that are most prominent in the physics labor market at the doctoral level. This illustration reflects the underlying similarities between physics research areas in both subject matter and methods.

The largest subfields of employment are centrally located within the figure. There are several reasons for this. These subfields are fundamental, core areas. They have strong associations with many other subfields and they generate research problems in a variety of related areas. Many of the smaller subfields associated with these core areas are often used to provide greater specificity. Also, the core areas often provide the instrumentation for tackling problems in other physics subfields.

The remainder of this section will focus on the associations among the core subfields as well as the specific relationships between each of the core research areas and the constellation of smaller physics subfields linked to them. Atomic and molecular physics is in the middle of Figure 13. Three quarters of its associations are within physics. It has strong associations with five of the six largest subfields of physics employment, the sole exception being elementary particle physics. Atomic and molecular, more than any other area within physics, appears to function as a point of contact among major research fields. The significance of atomic processes, research in common frontiers, instrumentation and methodology all contribute to this profile of atomic and molecular physics as an area of interface within physics.

Nuclear physics also has a prominent place in Figure 13. While nuclear physics has suffered a greater decline in employment than any other large physics subfield, it continues to exhibit an interesting and unique relationship with many areas of physics research. As noted earlier, there are four subfields that are often used alone by researchers as sufficient to circumscribe their employment: elementary particles, medical physics, astrophysics and plasmas. However, when the researchers in each of these comparatively, self-contained areas do use a second subfield in describing their work, it is often nuclear physics. Nuclear physics is apparently a significant component of very diverse research areas, ranging from the behavior of nuclei under extreme astrophysical conditions to the solution of pernicious health problems. Nuclear physics has contributed an important theoretical perspective and provided trained personnel for the inception and continued development of these physics research fields.

Solid state physics is the largest area of specialization. In fact, one in five physicists note that they spend

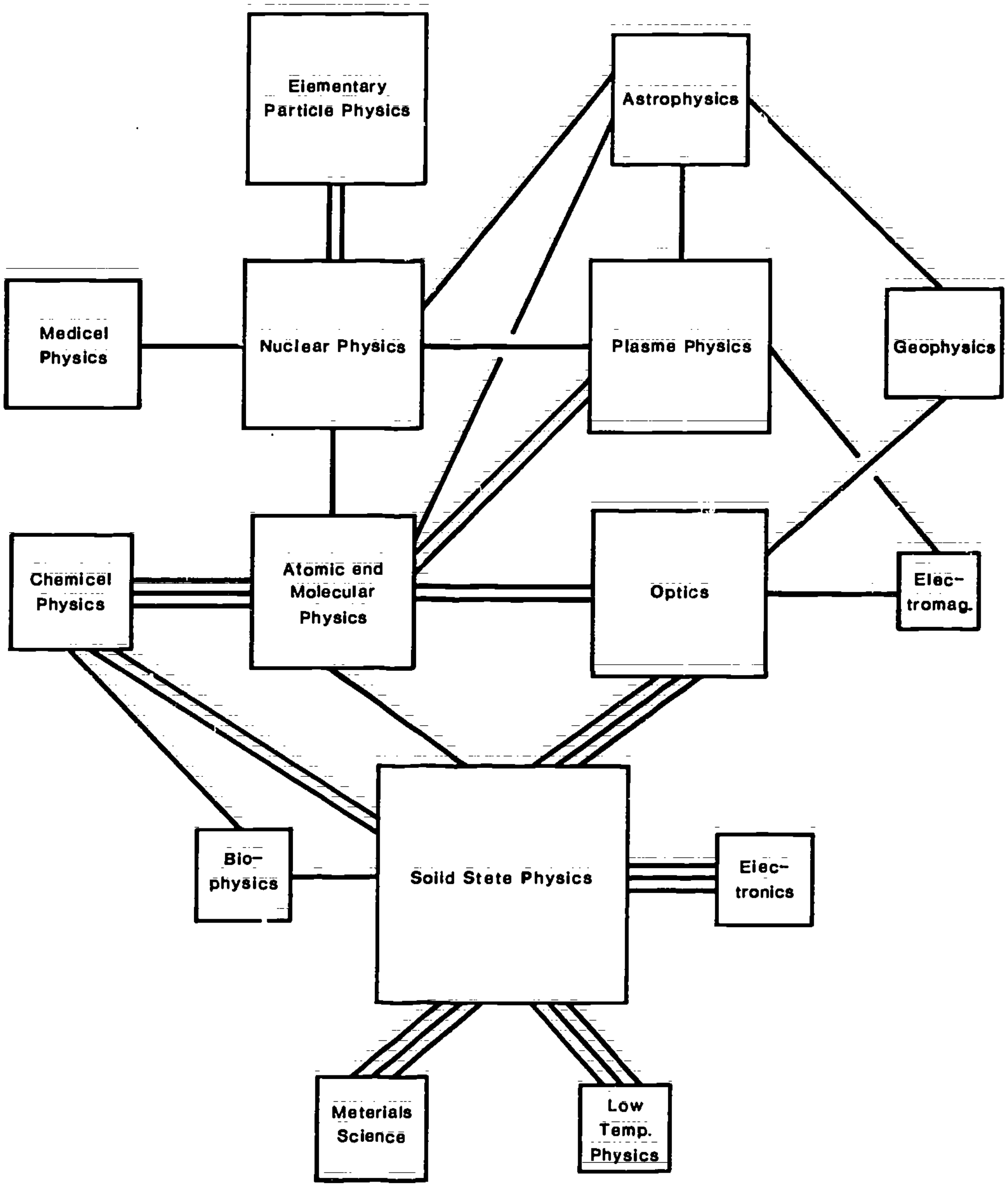

FIG. 13. Dominant overlaps between physics research subfields. The size of each square reflects the number of physicists working in the subfield. The number of connecting lines represents the strength of the association between the two research subfields.

17

a significant amount of time working in this area. It has strong associations with, and a major influence on, a wide range of physics research. As depicted in Figure 13, overlaps between solid state physics, optics and atomic and molecular physics form a triangular relationship. These pairings represent such ongoing efforts as laser research and the development of fiber optic technology. Solid state physics also forms a triangular relationship with chemical physics and biophysics. These associations reflect the large research effort in polymers, the importance of semiconductors in medical instrumentation, and the role that polymers play in implants and medical equipment.

Solid state is the only physics subfield that is often paired with low temperature physics, electronics and materials science. Over 95% of the physicists working in the latter three list them in combination with other areas. Fully two-thirds of these associations, however, are with solid state physics. These combinations are apparently used to specify research in such areas as superconductivity, semiconductors and the electronic properties of materials. While low temperature physics, electronics and materials science seldom provide a sufficient description by themselves of the full scope of current employment, all three are important components of the physics labor market.

Modern plasma physics began in the 1950's. Electromagnetism, fluids, and atomic and molecular physics all contributed to the development of plasma physics into a distinct discipline. Thus, it is not surprising that plasma physics still has strong associations with these areas. However, plasma physics is usually cited as the primary area of specialization and these other subfields are typically used to provide greater specificity. Plasma physics is also often combined with astrophysics as an employment description. These two areas share a set of similar theoretical issues and physical problems.

Elementary particle physics is, in some ways, the most self-contained of the large subfields. Nearly half of the physicists working in elementary particles cite it alone as a sufficient descriptor of their research effort. However, there is strong association with one other employment subfield: nuclear physics. Nuclear physics supplied much of the trained personnel for elementary particles when the latter was evolving after the second world war and the two areas continue to share many similar substantive concerns. Although elementary particles has a strong employment overlap with only one physics research subfield, there is an important exchange of advances in technology between elementary particles and many other areas. Thus, accelerators and instrumentation developed for use in elementary particle physics find applications in several other fields. Conversely, advances in superconductivity and computer technology are critical to the cutting edge discoveries made in elementary particles.

Mathematical physics, while not depicted in the figure, makes an essential contribution to fundamenta research. It has strong associations with many of the largest employment subfields: elementary particles nuclear physics, atomic and molecular physics and geophysics. However, when combined with these subfields, mathematical physics is usually cited as the secondary subfield and these associations are not, as a rule, used to reflect a sharing of subject matter. Rather the links with mathematical physics indicate the strong theoretical perspective of a substantial portion of the research in these areas.

Figure 13 does not illustrate all associations. A few are real but not common, while others are not real. Some apparent associations represent a splitting of work effort necessitated by special situations. In smaller academic departments or research organizations, for example, unlikely combinations of fields may appear because available resources must be used to provide coverage of a wide range of substantive areas. However, the net effect of special circumstances fades into the background when the overall pattern of associations is examined.

This section has pointed to both the diversity and the underlying unity of physics as an employment field. In addition to describing the field, the above discussion also tells us something about physicists and their careers. The dominant overlaps depicted by the subfield clusters may represent the possibility for the smooth transition from one area of specialization to another. Conversely, mobility between two areas that are rarely combined may reflect a dramatic change in research focus. It should be noted that in addition to the overlap in employment specialization discussed above, there is also an exchange among the physics areas of personnel and technological advances in instrumentation and methodology. Thus, major experimental breakthroughs in any one discipline are often associated with the introduction of new physical methods which, in turn, may have been borrowed from other areas.

Subfields of Degree

PhD physicists receive their degrees in a wide variety of different physics subfields. However, two-thirds of the degrees are awarded in only five subfields: solid state, nuclear, elementary particles, atomic and molecular, and plasma physics. Solid state physics alone accounts for nearly one-quarter of the degrees. Optics, which is a relatively large field of employment, is not dominant as a field of study. Rather many of the physicists who are working in optics received their training in atomic and molecular or solid state physics.

Most PhD physicists specialize in either experimental or theoretical topics in their dissertation work. The ratio over time has been five experimental dissertations to every two theoretical ones. This ratio, however, varies somewhat by physics subfield. Mathematical physics is the one subfield which is predominantly theoretical in perspective. In other areas the experimental composition varies from a low of around 60% in elementary particles, astrophysics, plasma physics and geophysics to a high of over 80% in nuclear physics, biophysics and low temperature physics. Medical physics is the only major physics subfield that has a large number of PhDs (nearly one-quarter) whose degrees were neither in experimental nor theoretical areas.

The decade of the nineteen-sixties was a period of rapid expansion in physics degree production. By the early 1970's the number of PhDs had peaked and then declined for the remainder of the decade. This roller-coaster in PhD production is reflected in the society membership. Nearly half of the physicists who are society members received their doctorates between 1962 and 1975. Roughly one-quarter earned their degrees prior to that period and one-quarter since.

This pattern can be observed in solid state physics, atomic and molecular physics, geophysics and many of the other physics subfields. The high production of the 1960's and early 1970's was perhaps most evident in elementary particles and low temperature physics. Over 60% of the PhDs in those areas earned their degrees during that period.

Deviations from this pattern, however, were also of significance. Over one-third of the doctorates in chemical physics, nuclear physics and acoustics were earned prior to 1962. Nuclear physics, in fact, had the highest production among physics degree fields during the 1950's, but was superseded by both solid state physics and elementary particle physics by the mid 1960's. While degree production in many of the traditional physics fields peaked and then declined by the mid 1970's, other areas were emerging with an ever increasing share of the total. Plasma physics, medical physics, optics, astrophysics, and biophysics played a more important role as the 1980's approached. Over 40% of the PhDs in these areas received their degrees in the past eight years.

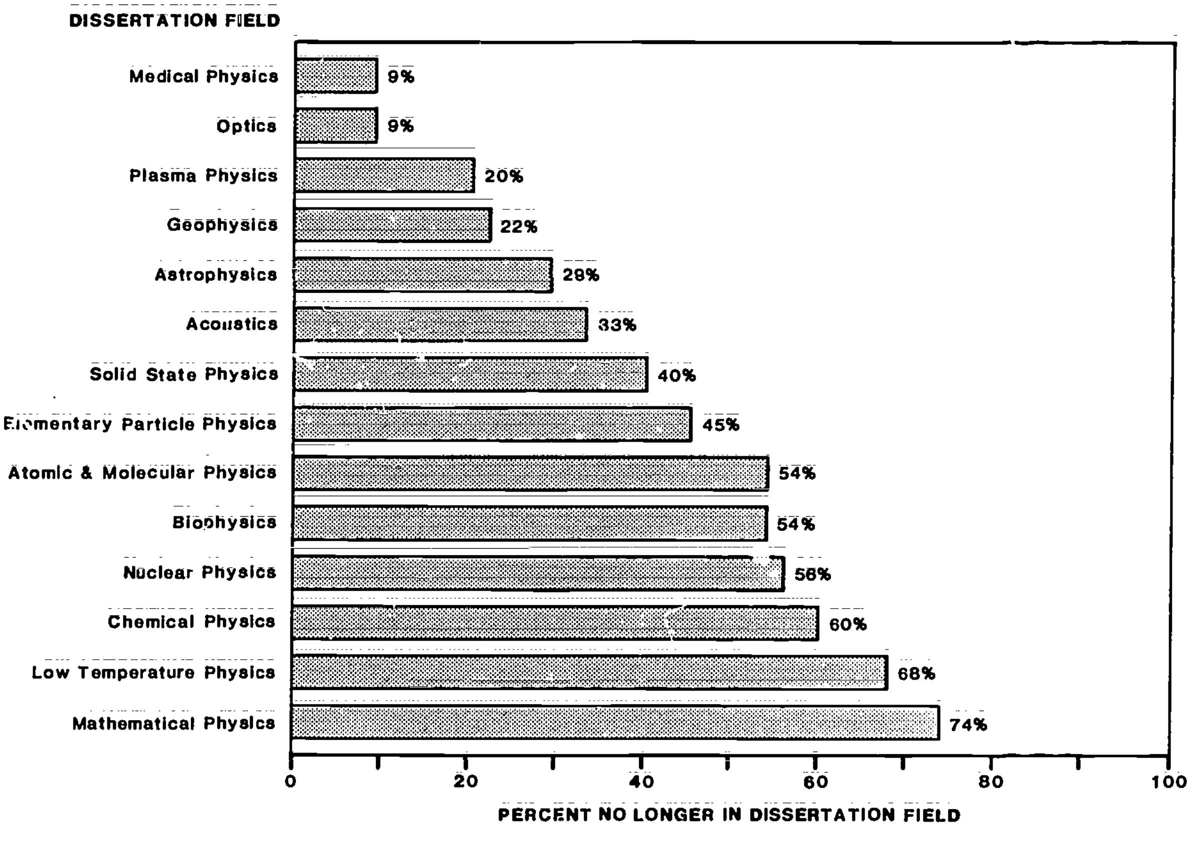

FIG. 14. Percent of physicists trained in selected physics subfields who are no longer working in their dissertation subfield, 1983.

Mobility

Once they move into the labor force, PhD physicists do not necessarily remain in the subfields in which they were trained. In fact among society members only slightly over one-half are still working in their degree subfield. Some physicists move to other subfields of physics, while many eventually leave for other areas of science, engineering and administration. Physics is a feeder field for a broad array of other disciplines. Continuing to work in one's degree subfield is related to the recency of degree, the specific subfield of degree and the sector in which one is employed. Thus, recent PhDs are more likely to be conducting research in their dissertation area than more experienced PhDs who have had the opportunity over time to make a variety of different career decisions; two thirds of the former group are working in their degree subfield in contrast to less than 45% of those with 25 years or more of experience.

Among physicists, those trained in the applied areas of optics and medical physics are most likely to continue working in their degree field. As illustrated in Figure 14, plasma physics also has a high retention rate. While there are relatively few older plasma physicists, those with over ten years of experience are considerably more likely than those trained in elementary particles, nuclear physics or solid state physics to be working in their degree field.

Industry with its broad diversity of tasks has become an increasingly important employment option for physics PhDs. Most PhDs who enter industrial employment work in areas other than the ones in which they were directly trained. Government employment also entails moving into other areas, particularly after the first ten years of work. In academe and the national laboratories, where basic research is more prevalent, physicists are considerably more likely to continue working in their dissertation subfields.

When they leave physics research, many physicists move into engineering and, to a lesser degree, a few related science areas. The fields of engineering that draw the most physicists are electronic and systems engineering. Electronic engineering draws strongly on those with a background in solid state physics and low temperature physics, while systems engineering attracts a substantial number of PhDs who were initially trained in elementary particles. Nuclear engineering, which is not a major engineering destination for physicists in general, does, however, draw a significant number of nuclear physicists and plasma physicists. Computer science, a high growth field, has pulled in many physicists whose dissertations were in elementary particle physics and nuclear physics. As noted in Figure 15, physicists from various backgrounds move into administration, particularly during the latter years.

There is also substantial mobility between the different subfields of physics themselves. As noted earlier, solid state physics and atomic and molecular physics serve as backgrounds for many working in the area of optics. In a similar manner, PhDs trained in nuclear physics and elementary particle physics have moved into a variety of other physics subfields with medical physics and plasma physics providing the major destinations. Medical physics has been particularly popular among the younger nuclear physicists. Materials

DEGREE SUBFIELDS	Nuclear Physics	Solid State Physics	Elementary Particle Physics	Atomic and Molecular Physics
	▽	▽	▽	▽
WORK FIELDS	Administration	Engineering	Engineering	Optics
	Engineering	Optics	Computer Science	Engineering
	Medical Physics	Materials Science	Plasma Physics	Solid State Physics
	Computer Science	Administration	Administration	Administration
	Plasma Physics		Medical Physics	Medical Physics
			Nuclear Physics	

FIG. 15. Dominant subfields of employment for physicists who left their dissertation field. The table notes the major employment destinations from selected subfields of degree. Each employment field listed accounts for at least 5% of the PhDs who are no longer working in their degree subfield.

science is also an area into which physics PhDs move, particularly those with training in solid state physics.

It should be noted that the previous discussion has concentrated on patterns of mobility from field of degree to field of work. Any levels of mobility out of physics which are cited should be treated as underestimates. While many individuals who leave physics to enter engineering and other fields remain members of AIP societies, some will drop membership, frequently moving their professional affiliation to other societies. More inclusive data from the National Academy of Sciences indicate that 40% of PhD physicists are no longer working in physics. Most are to be found in the related areas of science and engineering discussed above.

The special focus of this profile report has been a discussion of the relationship between subfield of degree and work as well as overlaps between employment subfields. The degree to which empirical associations between research subfields can be used to develop a predictive model of how a physicist's career evolves will be explored in future profiles of society membership.

SOCIETY MEMBERSHIP: COMPARISONS AND PROFILES

Common scientific and technological concerns unite the members of the nine AIP member societies. One indicator of this commonality of interest is the degree of multiple society affiliation as noted in Table IV. Cross membership, primarily with APS, is held by one-third of AAPT and approximately one-quarter of OSA, AVS and AAS members. Yet diversity also is a strong hallmark of society membership. As this report has illustrated, members hail from a broad spectrum of scientific and engineering backgrounds and are employed in all of the major sectors of the economy. Each society has its own special focus and unique characteristics.

The distinctiveness of each of the societies is reflected in the professional identification of its membership. As Figure 16 illustrates there is a rich admixture of scientists from varied backgrounds in most of the societies. Physicists predominate in AAPM, AAPT, APS, and OSA, engineers in ASA, AVS, and SoR, astron-

TABLE IV. Society cross membership, 1983.[a]

	APS %	AAPT %	OSA %	ASA %	AVS %	AAS %	AAPM %	ACA %	SoR %
APS	**81**[b]	29	19	6	18	17	12	13	12
AAPT	9	**66**	4	2	2	4	3	2	1
OSA	5	4	**75**	2	3	4	1	1	1
ASA	1	1	1	**91**	-	-	1	-	1
AVS	3	1	2	-	**79**	-	-	1	-
AAS	2	2	2	-	-	**78**	-	-	-
AAPM	1	1	-	-	-	-	**84**	-	-
ACA	1	-	-	-	-	-	-	**85**	-
SoR	-[c]	-	-	-	-	-	-	-	**86**
Total Membership	28544	8272	7307	4803	4343	3566	1933	1440	1025

[a] Data are based on all members current on 12/31/82 and residing in the U.S. or Canada.

[b] Diagonal percentages (in bold) represent single society membership.

[c] Dashes represent less than 1% of the society's membership. Each column will not sum to 100% because 2% of all members belong to three or more societies and thus are counted more than once.

TABLE V. International distribution of membership for each society, 1983.[a]

	AVS %	AAPM %	AAPT %	AAS %	APS %	ASA %	SoR %	OSA %	ACA %
United States	92	92	89	85	85	85	82	81	79
Europe	4	2	3	6	7	7	7	10	11
Canada	1	3	4	4	3	3	4	3	4
Asia	2	1	1	2	4	3	5	5	3
C/S America	-[b]	1	1	1	1	1	1	-	1
Australia	-	-	1	1	-	1	1	1	2

[a] Data are based on all members current on 12/31/82.

[b] Dashes indicate less than 1.0% of that society's membership.

omers in AAS, and chemists in ACA. In addition, a significant number of psychologists and audiologists can be found in ASA, crystallographers in ACA and educators in AAPT.

While all of the societies have members who reside outside of the United States, there is considerable variation in the degree to which their memberships are distributed internationally as well as the specific countries from which they draw (Table V). AVS and AAPM are the most strongly U.S.-based societies with over 90% of their members residing here. By contrast, ACA has the largest international membership. Over one-fifth of its members live abroad and, at 11%, it has the largest European contingent among the societies. Similarly, both OSA and SoR have a significant international membership and they have the largest proportion of

Table VI. Membership concentration within major states for each society, 1983.[a]

	OSA %	AVS %	APS %	ACA %	AAPT %	SoR %	ASA %	AAPM %	AAS %
California	23	27	18	11	10	8	15	12	20
New York	11	11	11	14	11	11	8	9	6
Massachusetts	8	8	7	6	-	7	8	5	9
New Jersey	5	6	6	6	-	11	-	-	-
Illinois	-[b]	-	5	-	6	5	-	7	-
Maryland	-	-	5	-	-	-	6	-	9
Pennsylvania	-	-	-	6	6	6	5	6	-
Ohio	-	-	-	5	-	9	-	5	-
Texas	-	-	-	-	-	-	6	6	-
Arizona	-	-	-	-	-	-	-	-	6

[a] Data are based on all members current on 12/31/82 and residing in the U.S.
[b] Dashes indicate less than 5.0%.

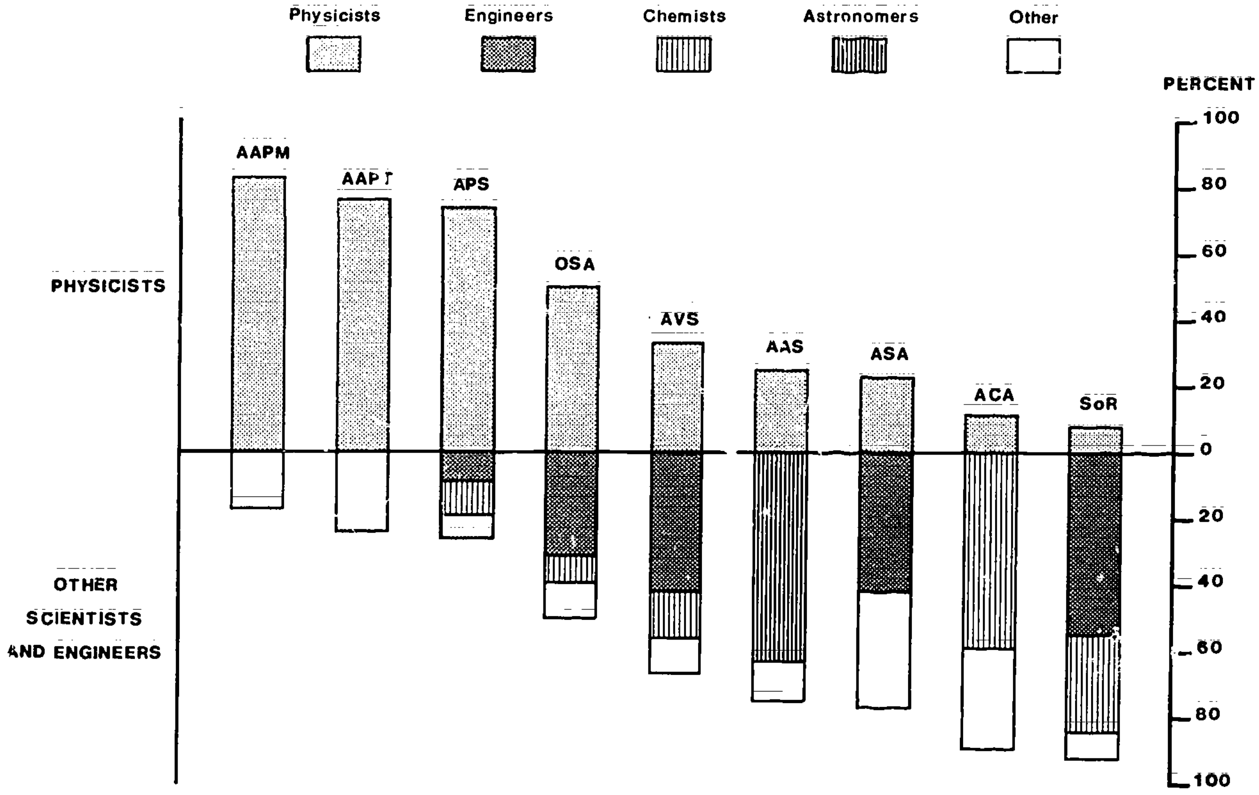

FIG. 16. Professional self-identification for each society, 1983.

Asian-based members.

The societies also vary according to geographic distribution within the U.S. However, in the case of most societies, half of the membership is concentrated in only five or six states (Table VI) with California and New York typically being the two largest. The major exception to this is the AAPT whose membership is broadly distributed among the 50 states. In addition, SoR has a strong presence in New Jersey and Ohio, while AAS has a comparatively large portion of its membership in Maryland.

The varied economic sectors in which society members work are illustrated in Figure 17. The industrial component of nearly every society has been increasing during the 1980's, while the academic one has been shrinking. With the notable exception of AAPT, half or more of the members in each society are now employed outside of academe. Industry is the dominant employer for AVS, SoR, OSA and ASA members. Employment at the national labs, such as Brookhaven and Argonne, is frequently found among APS and AAS members, while hospital employment is common within AAPM.

Some variation by society also exists in the type of work individuals are engaged in as indicated in Table VII. The extent of societal involvement in different work activities reflects members' educational backgrounds and their current sectors of employment. Thus basis research is the primary area of work for members of AAS, ACA and, although not quite as pronounced, APS. Each of these societies has a strong academic base and a very high PhD component, nearly 90% of their non-student members. PhDs also predominate in SoR but their heavy industrial orientation places more emphasis on applied research. In ASA, AVS and OSA, societies that also have a strong industrial base, the level of educational attainment of the members is more varied. While the PhDs in these societies are primarily engaged in applied research, those with masters and bachelors are concentrated in design, engineering and development. Members of AAPT, as the name of the society indicates, are primarily concerned with teaching. Unlike any other society, a significant proportion of their membership, nearly one-third, teaches at the high school and junior college level. The work activity structure of AAPM is also unique. In addition to PhDs conducting applied research, many members of this society at both the PhD and masters level are involved in dosimetry and varied clinical activities.

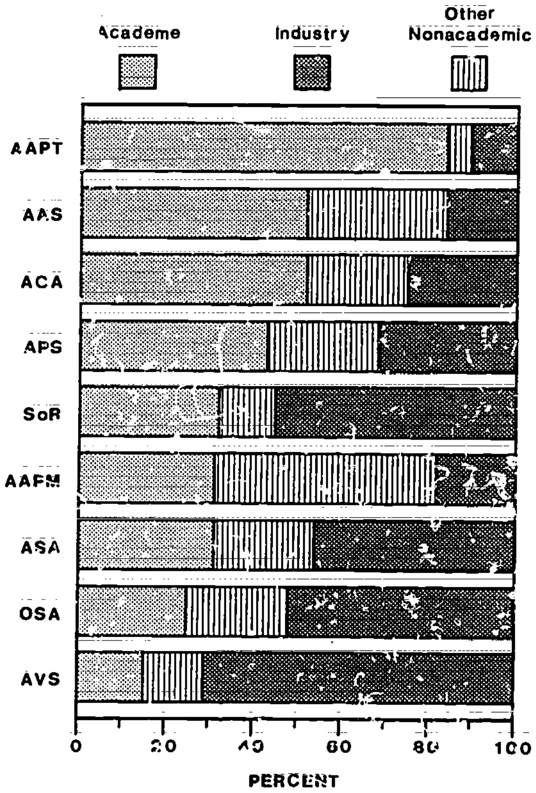

FIG. 17. Broad employer types for each society, 1983.

New Society Members

In addition to surveying a sample of the continuing

TABLE VII. Principal work activity for each society, 1983.

	AAPT %	AAS %	ACA %	APS %	SoR %	ASA %	OSA %	AVS %	AAPM %
Teaching	71	19	20	19	17	-	-	-	-
Basic Research	-[a]	47	44	31	17	-	-	-	-
Applied Research	-	-	17	21	39	25	28	23	22
DDE[b]	-	-	-	-	-	22	29	33	-
Administration	-	-	-	-	-	-	-	18	-
Other	-	-	-	-	-	-	-	-	41

[a] Dashes represent less than 17% of the society's members.
[b] DDE: Design, Development, Engineering.

membership of the nine societies, new members are also contacted each year. Data on these new members indicate some of the factors related to joining a society and, more subtly, suggest ways in which the actual composition of the societies may be expected to change in the future.

New members usually join a society either during their training or early in their careers. Nearly half of the individuals initially joining APS, AAS and ACA are either advanced graduate students or postdoctoral fellows. By contrast, new members of AVS, AAPM and AAPT, while young, are more likely to be professionally established when they assume society membership.

While there are some dramatic differences between the characteristics of new and continuing members, the composition of societies changes slowly. Nearly one quarter of the new society members, twice that of the ongoing membership, are foreign citizens residing in the U.S. on either permanent or temporary visas. While this may presage an eventual change in the composition of society membership, it is also true that a number of these individuals will eventually become U.S. citizens. Women are also more frequently represented among new members than continuing ones (12% vs 6%). However, their impact on the overall society composition is offset somewhat by a higher society drop rate than men.

Another possible change is suggested by the employer base of those new society members who are not still in the training process. A higher proportion of them are coming from industry. This reflects both the rapid growth of the more industrially based societies in the early 1980's and a shift within the remaining societies towards greater industrial representation. Both elements point to a stronger role for industry within the AIP societal structure in the coming decade. A related phenomenon is the increased prevalence of such areas of applied work as solid state physics, optics, materials science and vacuum science. Continued monitoring of the characteristics of both new society members and those who eventually drop society membership should point to patterns of change and how these changes may effect the professional societies of tomorrow, their composition and their members' needs for services.

These broad comparisons only begin to provide a picture of the rich diversity which exists both between the nine member societies and among their individual members. The brief profiles at the end of this section highlight the major demographic and employment-related characteristics of each of the societies separately. Readers who want further detail on either their own societies or other societies are encouraged to write us directly. The type of data available can be determined by examining the questionnaire instruments and subfield list provided in Appendix F.

SOCIETY MEMBERSHIP PROFILES

American Association of Physicists in Medicine (AAPM)

AAPM members are some of the youngest among the societies. They work primarily in medical physics and radiology, although many of them were originally trained through either the masters or PhD level in other physics areas such as nuclear physics and solid state. Employment at university-affiliated and private hospitals, non-profit research centers and private group practices dominate. Whether they work in these areas or in universities, members are heavily involved in applied research, dosimetry and varied aspects of clinical treatment. Women form a higher proportion of the membership than in most societies, with nearly one-fifth of the new members of the early 1980's being women. Although one of the smaller AIP member societies, AAPM has grown rapidly from about 600 members in 1970 to well over 2000 today.

American Association of Physics Teachers (AAPT)

AAPT members, the oldest among all of the societies, have a primary concern with the teaching of physics. They are located throughout the academic spectrum, not only in the universities and four year colleges, but also in two year institutions and secondary schools. AAPT is the only society to have a substantial representation of these latter two groups, many of whom identify themselves professionally as educators. The secondary school component of AAPT grew during the early 1980's, reflecting AAPT's continuing concern with the status of science education in the nation's schools. All but a small proportion of AAPT members hold graduate level degrees and typically join the society after completing at least the masters degree.

American Astronomical Society (AAS)

AAS members are some of the youngest among the societies. With only minor exceptions, they are PhDs or advanced graduate students. They identify themselves as astronomers and secondarily as physicists. Although the majority work in academe, a substantial number are also employed in government, the national labs and even industry. Except in the latter employment sector, basic research predominates coupled with teaching in the universities, applied research in the national labs and administration in government. New members most frequently join AAS when they are advanced graduate students or holding postdoctoral positions. Astronomy, astrophysics, geophysics, earth science and computer science are the major subfields in which society members are engaged.

American Crystallographic Association (ACA)

ACA members, over 35% of whom are PhDs, primarily identify themselves as chemists. Although mainly engaged in crystallographic and chemical research, a substantial number are also working in materials research, solid state physics and the biological and earth sciences. Most are employed in the universities, but a strong employment base also exists in industry and government. The total size of ACA has been stable for the past 15 years at around 1800 members. A substantial number of individuals join ACA while holding postdoctoral fellowships. Nearly one-quarter of their new members are women, providing ACA with the highest proportion of women among the nine member societies.

American Physical Society (APS)

APS, the largest of the AIP member societies, is a research-based society, most of whose members hold PhDs (88%). Research is conducted in a broad spectrum of employment spheres. With an increasing industrial representation, nearly one-third of APS members currently work in industry, almost as large a proportion as are employed by universities. Substantial numbers of APS members can also be found working in government and the national labs. While most APS members identify themselves as physicists, about one-quarter are chemists, engineers or other related scientists. Over half of the new APS members in the early 1980's were advanced graduate students; a significant number of other new members joined APS during their postdoctoral appointments. All of the major physics research areas are represented in APS, with solid state physics involving the largest number of members.

Acoustical Society of America (ASA)

ASA members predominantly identify themselves as engineers, secondarily as physicists. But a large number of ASA members also indicate other scientific identifications, primarily psychologist and audiologist. Along with acoustics, the other major fields in which ASA members work are: electrical, electronic and mechanical engineering, psychology, audiology and the bio-sciences. While industrial employment is typical, university and government employment also draw significant numbers of ASA members particularly among the PhDs. In industry, a broader mesh of degree levels — PhDs, masters and bachelors — are found working primarily in applied research and design. New members enter ASA both as advanced graduate students and as established professionals. ASA has one of the higher representations of women (12%) among the member societies.

American Vacuum Society (AVS)

Since the late 1970's, AVS has been the most rapidly growing of the AIP member societies. Its membership is heavily concentrated in industry (nearly three-quarters) where development, design and engineering activities dominate. This is particularly true among the bachelors who make up over one-third of the membership, the highest proportion among the nine member societies. Nearly half of the members, however, also hold PhDs and are more likely to be involved in applied and basic research. AVS members, who primarily consider themselves engineers and secondarily physicists and chemists, work in vacuum science, surface science, solid state physics, chemistry, materials science and electrical, electronic and mechanical engineering. Most new AVS members are established professionals rather than graduate students.

Optical Society of America (OSA)

OSA, currently the third largest AIP member society, has shown a relatively steady pattern of growth over the past 15 years. It is now nearly the same size as AAPT, the second largest member society. Half of the members consider themselves physicists, and one-third engineers. While PhDs predominate, a substantial proportion of the membership also hold bachelors or masters degrees. The latter typically work in design and development in the industrial employment sector where over half of OSA members are employed. PhDs, who are distributed across industry, government, and the universities, are primarily engaged in applied or basic research. In addition to optics, OSA members work in a broad variety of areas, the major ones being electrical and electronic engineering, chemical physics, atomic and molecular physics and systems engineering. Individuals join OSA both as advanced graduate students and as established professionals.

Society of Rheology (SoR)

SoR is the smallest of the AIP member societies, growing to about 1200 members by the mid 1980's. Its members, primarily PhDs, are most frequently employed as industrial engineers and chemists. Universities employ nearly one-third of the members. In addition to applied research in rheology, society members work in chemical engineering, high polymer physics, materials science, chemical physics and mechanics. While some SoR members enter as advanced graduate students most are established professionals. Women represent a low proportion of the overall SoR membership, although there are some indications among the more recent members that this may be shifting.

APPENDIX A: DROPPING OF SOCIETY MEMBERSHIP

This report has focused on the 1983 membership of the nine AIP member societies. Since 1979, when the original sample of society members was drawn, a number of individuals had dropped society membership. Although these individuals may not be as motivated to respond as current society members, we have developed a database on nearly 300 of them. In many respects their characteristics are quite different from those who continue their membership.

Many individuals first join a professional society when they are advanced graduate students. Most of them continue their membership as their careers in physics and related science and engineering fields develop. For some, however, society membership is a more transient phenomenon. A number of former members are students or recent PhDs who were studying in the U.S. on temporary visas and have since returned home.

Most individuals who drop society membership, however, do so later in their careers, in their mid 30's or early 40's. In addition to their comparative youth, they differ from the continuing membership in several other ways. As Tables A-1 and A-2 indicate they are considerably less likely to identify themselves as physicists or to be working in one of the subfields of physics. Rather they are more likely to be found among one of the other science or engineering disciplines. While most of these former members were engineers or related scientists when they joined an AIP member society, some of them were originally trained as physicists and then moved into other employment areas, particularly engineering, later in their careers. As their interests changed, so have their society affiliations. Several have noted that they are currently affiliated with one of the engineering societies, which more closely reflect their

TABLE A-1. Professional self-identification for dropped and current members, 1983.

	Dropped Members %	Current Members %
Physicist/Astronomer	41	62
Engineer	28	16
Other Scientist	18	17
Other	13	5
Total Number Known	290	6337
No Response	1	20

TABLE A-2. Major field of work for dropped and current members, 1983.

	Dropped Members %	Current Members %
Physics/Astronomy	39	66
Engineering	25	13
Other Sciences	24	16
Other Non-Science	12	5
Total Number Known	234	5420
No Response	29	469

TABLE A-3. Level of highest degree for dropped and current members, 1983.

	Dropped Members %	Current Members %
PhD	47	67
Masters	35	21
Bachelors[a]	18	12
Total Number Known	288	6338
No Response	3	20

[a] Includes technical and other degrees.

TABLE A-4. Type of employer for dropped and current members, 1983.

	Dropped Members %	Current Members %
Industry/Self-Employed	40	32
Other Nonacademic	23	23
University/College	25	40
Junior College/Secondary School	12	5
Total Number Known	262	5790
No Response	1	98

TABLE A-5. Primary work activity for dropped and current members, 1983.

	Dropped Members %	Current Members %
Teaching/Basic Research	29	49
Applied Research/Development	29	27
Design/Engineering	13	7
Administration/Other	29	17
Total Number Known	262	5767
No Response	1	122

current interests. This appears particularly true for those members whose highest degree is a bachelors or masters degree.

In addition to professional identification, the type of employment in which one is engaged is also likely to have an effect on maintenance or discontinuation of society membership. Individuals involved in industrial design, engineering and administration are more likely to drop their society membership than individuals engaged in university research and teaching. Secondary school teachers, who have been increasing their representation during the early 1980's, are also at greater risk of discontinuing society membership.

Membership drives have drawn individuals into the societies from a broad spectrum of traditional and non-traditional backgrounds. Many maintain their membership over the years, while some, particularly those from atypical backgrounds, sample the society activities and services for several years and then move on to other organizations that address their needs more directly.

APPENDIX B: Geographic Divisions

NEW ENGLAND
- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

MIDDLE ATLANTIC
- New Jersey
- New York
- Pennsylvania

SOUTH ATLANTIC
- Delaware
- District of Columbia
- Florida
- Georgia
- Maryland
- North Carolina
- South Carolina
- Virginia
- West Virginia
- Puerto Rico

EAST NORTH CENTRAL
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin

EAST SOUTH CENTRAL
- Alabama
- Kentucky
- Mississippi
- Tennessee

WEST NORTH CENTRAL
- Iowa
- Kansas
- Minnesota
- Missouri
- Nebraska
- North Dakota
- South Dakota

WEST SOUTH CENTRAL
- Arkansas
- Louisiana
- Oklahoma
- Texas

MOUNTAIN
- Arizona
- Colorado
- Idaho
- Montana
- Nevada
- New Mexico
- Utah
- Wyoming

PACIFIC
- Alaska
- California
- Hawaii
- Oregon
- Washington

APPENDIX C: Detailed Statistical Tables

Demographic Characteristics, 1983

Employment Characteristics, 1983

Salary Overview, 1983

Physicists and Physics Subfields

Society Membership Detail

TABLE C-1. Professional self-identification, 1983.

	%
Physicist	58
Engineer	16
Chemist	9
Astronomer	4
Other Scientist	8
Other	5
Total Number Known	6337
No Response	20

TABLE C-2. Geographic distribution of society members in the U.S., 1983 and total U.S. population.[a]

	Society Members %	U.S. Population %
New England	11	5
Middle Atlantic	20	16
South Atlantic	15	18
East North Central	13	18
East South Central	3	6
West North Central	4	8
West South Central	6	10
Mountain	7	5
Pacific	21	14
Total Number Known	52570[b]	230 Million

[a] Based on 1980 census records.
[b] Based on all society members as of 12/31/83.

TABLE C-3. Age profile of society members, 1983.

Age	%
<30	10
30–34	13
35–39	15
40–44	17
45–49	13
50–54	10
55–59	9
60–64	6
65 +	7
Total Number Known	6148
No Response	208

TABLE C-4. Level of highest degree by years from highest degree, 1983.

	Level of highest degree		
Years from highest degree	PhD %	Masters[a] %	Bachelors[a] %
0–4	14	12	8
5–9	17	17	14
10–14	19	16	12
15–19	17	15	10
20–24	12	12	11
25–29	8	9	10
30–34	7	8	15
35 +	6	10	20
Total Number Known	4240	997	470
No Response	17	12	8

[a] Advanced graduate students are not included in this table.

TABLE C-5. Race and minority status by citizenship, 1983.

	Citizenship			
	U.S. N.	Non-U.S. N.	Total	%
White	5142	413	5555	91.0
Oriental and Other Asian	220	205	425	7.0
Black, American Indian, and Hispanic	66	8	74	1.2
Other	37	14	51	.8
Total Number Known	5465	640	6105	
No Response	79	14	93	

TABLE C-6. Employment status, 1983.

	%
Employed Full-Time	84
Employed Part-Time	8[a]
Not Employed, Not Seeking[b]	7
Not Employed, Seeking Employment	1
Total Number Known	6247
No Response	109

[a] Two-thirds of those indicating part-time employment are advanced graduate students.
[b] Includes retired.

TABLE C-7. Type of employer, 1983.

	%
ACADEMIC	45
University	35
College	4
Junior College	2
Secondary School	4
NONACADEMIC	55
Industry/Self-Employed	32
Government	10
FFR&DC	9
Nonprofit	4
Other	-
Total Number Known	5714
No Response	64

TABLE C-10. Type of employer by highest degree, 1983.

	PhD %	Masters[a] %	Bachelors[a] %
ACADEMIC	48	36	14
University	42	8	3
College	5	4	-
Junior College	1	6	2
Secondary School	-	18	9
NONACADEMIC	52	64	86
Industry/Self-Employed	28	41	67
Government	10	12	10
FFR&DC	11	4	5
Nonprofit	3	6	3
Other	-	1	1
Total Number Known	3959	892	425
No Response	13	5	3

[a] Advanced graduate students are not included.

TABLE C-8. Principal work activity, 1983.

	%
Teaching	22
Basic Research	26
Applied Research	20
Development	8
Design/Engineering	7
Administration	11
Consulting/Other	6
Total Number Known	5691
No Response	87

TABLE C-11. Employer type by sex, 1983.

	Male %	Female %
ACADEMIC	44	55
University	35	38
Other Academic	9	17
NONACADEMIC	56	45
Industry/Self-Employed	33	22
Government	10	9
FFR&DC	9	7
Nonprofit/Other	4	7
Total Number Known	5361	347
No Response	57	7

TABLE C-9. Principal work activity by level of highest degree, 1983.

	PhD %	Masters[a] %	Bachelors[a] %
Teaching	23	30	11
Basic Research	31	5	4
Applied Research	21	15	17
Development	6	13	16
Design/Engineering	4	13	23
Administration	11	13	18
Consulting/Other	4	11	11
Total Number Known	3935	889	424
No Response	36	8	4

[a] Advanced graduate students are not included.

TABLE C-12. Work activity by degree level for members employed in industry, 1983.

	PhD %	Masters[a] %	Bachelors[a] %
Basic Research	14	2	2
Applied Research	38	21	16
Development	16	23	20
Design/Engineering	11	26	28
Administration	14	17	21
Consulting/Other	7	11	13
Total Number Known	1099	365	284
No Response	8	1	0

[a] Advanced graduate students are not included.

TABLE C–13. Type of employer by cohort year of PhD, 1983.*

	1981–1983 %	1978–1980 %	1975–1977 %	1972–1974 %	1969–1971 %	1966–1968 %	1963–1965 %	Before 1963 %
ACADEMIC	36	38	42	39	41	48	59	54
University	30	31	35	32	32	42	53	50
Other Academic	6	7	7	7	9	6	6	4
NONACADEMIC	64	62	58	61	59	52	41	46
Industry/Self-Employed	44	42	36	32	29	24	20	22
Other Nonacademic	20	20	22	29	30	28	21	24
Total Number Known	183	389	391	453	481	460	380	1045
No Response	1	1	0	0	0	2	0	8

*Postdocs are not included.

TABLE C-14. Type of employer by professional self-identification, 1983.

	Physicists %	Astronomers %	Engineers %	Chemists %	Computer Scientists %	Other Scientists %	Other %	Total %
ACADEMIC	49	61	21	52	34	52	52	45
University	38	56	19	47	26	43	13	35
Other Academic	11	5	2	5	8	9	39	10
NONACADEMIC	51	39	79	48	66	48	48	55
Industry/Self-Employed	25	11	65	28	52	26	36	32
Government	11	13	7	8	4	10	5	10
FFR&DC	11	9	4	10	3	5	1	9
Nonprofit	4	5	2	2	7	7	5	4
Other	-	1	1	-	-	-	1	-
Total Number Known	3269	247	944	530	67	374	266	5699
No Response	33	4	6	11	0	4	4	63

TABLE C-15. Principal work activity by type of employer, 1983.

	University %	Other Academic %	Industry %	Government %	FFR&DC %	Other %
Teaching	38	91	-	1	-	3
Basic Research	45	1	10	28	38	21
Applied Research	8	-	30	29	36	20
Development	1	-	18	8	6	5
Design/Engineering	1	-	17	4	5	5
Administration	5	7	16	22	13	13
Consulting/Other	2	1	9	8	2	33
Total Number Known	2003	545	1837	562	489	230
No Response	23	4	9	2	6	3

TABLE C-16. Age profile by academic rank, 1983.[a]

Age	Prof. %	Associate Prof. %	Assistant Prof. %	Research Assoc. %	Other[b] %
<30	-	-	5	12	9
30–34	1	4	40	41	15
35–39	3	22	33	25	17
40–44	19	33	13	13	19
45–49	24	19	4	6	12
50–54	21	7	2	3	8
55–59	16	7	2	-	13
60–64	13	6	1	-	6
65 +	4	2	0	-	1
Total Number Known	877	379	250	184	157
No Response	16	17	11	4	9

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[a] Includes university and college full-time employed only. Graduate students are not included.

[b] Includes administrators, lecturers, instructors, and others.

TABLE C-17. Age profile by tenure status, 1983.[a]

Age	Tenured %	Tenure-line %	Other %
< 30	-	5	9
30–34	1	35	30
35–39	7	30	26
40–44	23	18	14
45–49	22	8	10
50–54	18	2	4
55–59	15	1	4
60–64	10	1	3
65 +	4	-	-
Total Number Known	1215	245	335
No response	30	10	15

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[a] Includes university and college full-time employed only. Graduate students are not included.

TABLE C-18. Predominant fields and subfields of work by highest degree, 1983.[a]

	PhD %		Masters %		Bachelors %	
PHYSICS AND ASTRONOMY	68		61		52	
Predominant Physics Subfields of Work		Solid State Physics Astronomy/Astrophysics Physics Ed. (Coll)[b] Plasma Physics Nuclear Physics Optics		Physics Ed. (SS)[b] Optics Physics Ed. (Coll)[b] Medical Physics		Optics Acoustics Vacuum Science Physics Ed. (SS)[b]
ENGINEERING	11		19		28	
Predominant Subfields of Work		Electronic Electrical Systems		Electronic Systems Mechanical		Electronic Mechanical Systems
OTHER SCIENCE	17		14		13	
Predominant Fields of Work		Chemistry Materials Science Computer Science		Computer Science Mathematics/Statistics Materials Science		Materials Science Chemistry Computer Science
OTHER AREAS	4		6		7	
Total Number Known	3767		812		366	
No Response	205		85		62	

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[a] Advanced graduate students are not included.

[b] SS: Secondary School; Coll: College.

TABLE C-19. Detailed fields and subfields of work, 1983.

	N.	%
Physics and Astronomy Subfields	3525	66
Solid State Physics	432	
Optics	313	
Physics Education, College	298	
Nuclear Physics	204	
Plasma Physics	202	
Elementary Particles and Fields	194	
Chemical Physics	188	
Atomic and Molecular Physics	175	
Medical Physics	167	
Astronomy	154	
Acoustics	152	
Astrophysics	134	
Physics Education, Pre-College	133	
General Physics	118	
Geophysics	62	
Biophysics	58	
Electronics	52	
Mathematical Physics	51	
Low Temperature Physics	50	
Vacuum Science	50	
Fluid Dynamics	49	
High Polymer Physics	44	
Crystallography	42	
Electromagnetism	38	
Surface Science	23	
Thermal Physics	22	
Mechanics	22	
Rheology	16	
Radiological Physics	14	
Other Physics	68	
Engineering subfields	719	13
Electronic	166	
Systems	97	
Electrical	93	
Mechanical	80	
General Engineering	58	
Nuclear	50	
Aeronautical and Astronomical	46	
Chemical	35	
Environmental	12	
Metallurgy	6	
Other Engineering	77	
Other Science Fields	844	16
Chemistry	210	
Materials Science	152	
Computer Science	109	
Science Administration	66	
Earth and Environmental Science	48	
Biological Science	47	
Psychology	46	
Mathematics and Statistics	44	
Audiology and Speech Science	24	
General Science, Education	21	
Other Science	78	
Other Areas	262	5
Educational Administration	69	
Business Management	32	
Other Administration	94	
Other Nonscience	67	
Total Number Known	5351	
No Response	428	

TABLE C-20. Corporations employing the largest number of society members, 1983.

- AT&T Bell Laboratories
- IBM
- General Electric
- Hughes Aircraft
- TRW
- Rockwell International
- Honeywell
- Westinghouse
- Exxon
- Xerox
- Lockheed
- Hewlett Packard
- Perkin-Elmer
- GTE
- Texas Instruments

TABLE C-21. Professional self-identification for Canadians, 1983.

	%
Physicist	65
Engineer	11
Astronomer	9
Chemist	8
Other Scientist	4
Other	3
Total Number Known	237
No Response	2

TABLE C-22. Type of employer for Canadians, 1983.

	%
ACADEMIC	63
University	54
College	4
Other Academic	5
NONACADEMIC	37
Industry/Self Employed	17
Government	16
Other	4
Total Number Known	211
No Response	3

TABLE C-23. Primary work activity for Canadians, 1983.

	%
Teaching	30
Basic Research	36
Applied Research	16
DDE[a]	6
Administration	7
Other	5
Total Number Known	211
No Response	3

[a] DDE: Development, Design, and Engineering.

TABLE C-24. PhD median salaries, reported and adjusted for inflation, 1979–83.[a]

	Reported Salary	Salary in 1979 $'s
1979	28,000	28,000
1980	32,200	28,064
1981	36,000	28,382
1982	38,300	28,275
1983	41,000	29,206

[a] Salaries were adjusted using CPI-U for the inflation rate.

TABLE C-25. 1983 salaries by type of employer and years from PhD.

	Years from Degree	Median Salary	Mean Salary	Standard Deviation	Median Age	Total Number Known
		(in thousands of dollars)				
University (9–10 month salary base)	0–4	23.0	24.2	5.2	32	50
	5–9	25.1	26.4	5.2	36	91
	10–14	29.5	30.1	5.9	41	153
	15–19	33.0	34.5	7.5	45	191
	20–24	39.0	39.6	7.9	50	148
	25 +	42.2	42.8	9.5	59	215
University (11–12 month salary base)	0–4	25.2	27.6	8.4	31	44
	5–9	31.0	32.5	8.6	36	91
	10–14	38.0	39.4	11.5	41	77
	15–19	43.4	45.5	13.4	45	86
	20–24	48.5	49.5	9.3	50	51
	25 +	51.1	53.1	12.5	58	77
Industry	0–4	39.0	39.1	6.1	31	190
	5–9	44.3	45.3	9.2	36	240
	10–14	50.0	51.8	12.4	40	214
	15–19	55.0	56.4	15.0	45	149
	20–24	57.1	58.9	14.6	51	83
	25 +	60.0	63.8	21.2	59	137
Government	0–4	32.3	33.0	7.3	33	32
	5–9	37.0	37.0	6.1	37	64
	10–14	43.2	43.5	7.3	41	91
	15–19	48.0	48.6	8.4	45	67
	20–24	54.7	54.7	7.6	52	54
	25 +	63.1	59.5	6.9	59	52
National Labs	0–4	35.0	33.6	9.6	31	48
	5–9	39.6	39.0	6.8	35	68
	10–14	44.1	44.3	5.8	41	96
	15–19	49.7	50.7	9.9	45	74
	20–24	53.4	54.7	12.0	50	49
	25 +	51.7	55.5	12.6	58	68

TABLE C-26. 1983 median salaries adjusted for cost of living in selected metropolitan areas.[a]

	Cost of Living Index	Median Salary (in thousands of dollars)	Adjusted Salary (in thousands of dollars)	Median Age	Academic %	Non-Academic %	Total Number Known
Albuquerque	101.0	48.5	48.0	41	10	90	44
Atlanta	104.1	38.4	36.9	40	81	19	35
Baltimore	103.5	43.5	42.0	42	37	63	44
Colorado Springs	96.4	50.0	51.9	46	26	74	1[illegible]
Columbus	101.0	34.3	34.0	43	63	37	31
Denver	111.7	39.2	35.1	41	35	65	24
District of Columbia	124.1	50.0	40.3	45	8	92	120
Houston	111.8	44.0	39.4	38	36	64	50
Knoxville	100.3	39.7	39.6	43	18	82	65
Madison	102.9	31.4	30.5	39	84	16	32
Minn/St. Paul	111.1	40.0	36.0	39	48	52	44
New York	131.7	42.5	32.3	45	53	47	126
Phoenix	102.8	41.6	40.5	37	48	52	15
St. Louis, MO	103.2	36.9	35.8	40	55	45	21
San Diego	112.5	43.0	38.2	42	20	80	46
San Jose	117.1	48.0	41.0	40	21	79	43

[a] Cost of Living Index from the American Chamber of Commerce Researchers Association, national average = 100.0.

TABLE C-27. 1983 Salaries by selected type of employer and years from degree, masters.

	Years from Degree	QUARTILE SALARIES (in thousands of dollars) 25th	Median	75th	Mean Salary	Standard Deviation	Median Age	Total Number Known
Secondary School	0–4	17.2	20.5	25.0	21.6	5.6	34	12
	5–9	20.2	23.0	27.8	24.0	5.1	40	20
	10–14	22.7	25.9	29.0	26.6	4.9	42	46
	15–19	25.0	29.5	32.1	29.5	5.1	46	32
	20 +	23.0	28.9	30.9	28.4	6.6	55	34
Industry	0–4	28.2	31.4	35.0	32.1	7.8	30	45
	5–9	31.5	36.3	42.2	38.0	11.9	32	73
	10–14	36.0	42.2	50.0	45.2	16.6	39	44
	15–19	43.0	50.0	56.0	50.3	12.7	45	50
	20 +	43.0	50.0	60.0	52.2	15.4	55	120

TABLE C-28. Research subfields for physicists within selected employment sectors, 1983.

	University %	Industry %	Government %	Nat'l Labs %
Solid State Physics	17	24	18	14
Plasma Physics	8	9	7	19
Elementary Particles	15	-	2	13
Nuclear Physics	12	4	6	13
Optics	5	16	11	6
Atomic and Molecular	8	4	8	9
Astrophysics	8	1	7	4
Medical Physics	5	5	4	-
Chemical Physics	4	4	4	4
Mathematical Physics	4	3	5	2
Geophysics	2	6	8	3
Materials Science	1	7	4	4
Electronics	1	6	4	1
Biophysics	3	1	1	1
Acoustics	2	3	4	1
Low Temperature Physics	3	2	2	2
Electromagnetism	1	3	3	2
Fluid Dynamics	1	2	2	2

TABLE C-29. Employment sector distribution within selected physics research subfields, 1983.

	Employment Sector			
	University %	Industry %	Nat'l Labs %	Gov't %
Solid State Physics	42	32	12	11
Plasma Physics	36	22	30	9
Elementary Particle Physics	71	1	20	2
Nuclear Physics	58	10	21	8
Optics	24	44	11	15
Atomic & Molecular Physics	50	11	17	13
Astrophysics/Astronomy	56	4	10	15
Medical/Radiological Physics[1]	39	22	2	8
Chemical Physics/Chemistry	44	26	13	11
Mathematical Physics/Mathematics	44	17	9	16
Geophysics/Earth Science	23	35	10	24
Materials Science	20	46	18	13
Average for 18 Research Fields	42	23	15	11

[1] In medical physics, 27% of the work is in the hospital and non-profit sectors.

TABLE C-30. Patterns of employment field combination, 1983.

		Combined With	
	Primary Only %	Physics Field %	Residual Field %
Elementary Particle Physics	47	28	25
Medical/Radiological Physics	44	29	27
Astrophysics/Astronomy	34	46	20
Plasma Physics	33	39	28
Nuclear Physics	22	44	34
Biophysics/Biological Science	18	58	24
Solid State Physics	17	52	31
Atomic & Molecular Physics	13	67	20
Optics	12	57	31
Geophysics/Earth Science	12	60	28
Acoustics	11	49	40
Materials Science	8	59	33
Chemical Physics/Chemistry	6	73	21
Mathematical Physics/Mathematics	5	63	32
Electronics	4	77	19
Low Temperature Physics	4	81	15
Electromagnetism	2	77	21
Fluid Dynamics	2	77	21

TABLE C-31. Dominant associations between physics employment subfields, 1983.[a]

Primary Subfield	Secondary Subfield	Number of Combinations
Solid State	Optics	50
Solid State	Materials Science	42
Solid State	Low Temperature	39
Solid State	Electronics	32
Atomic & Molecular	Chemical Physics	30
Solid State	Chemical Physics	28
Atomic & Molecular	Optics	24
Plasma Physics	Atomic & Molecular	22
Nuclear Physics	Elementary Particles	21
Solid State	Atomic & Molecular	13
Nuclear Physics	Medical Physics	12
Nuclear Physics	Atomic & Molecular	12
Plasma Physics	Electromagnetism	11
Elementary Particles	Mathematical Physics	10
Plasma Physics	Nuclear Physics	10
Geophysics	Astrophysics	9
Plasma Physics	Astrophysics	9
Atomic & Molecular	Mathematical Physics	9
Nuclear Physics	Mathematical Physics	9
Geophysics	Mathematical Physics	8
Biophysics	Chemical Physics	8
Solid State	Biophysics	8
Optics	Electromagnetism	8
Optics	Geophysics	8
Optics	Mathematical Physics	8
Nuclear Physics	Astrophysics	8
Atomic & Molecular	Astrophysics	8

[a] The primary and secondary designations for each combination of subfields listed above are in the order used by most respondents.

TABLE C-32. Degree subfields of physicists, 1983.

	Number
Solid State Physics	544
Nuclear Physics	396
Elementary Particles	274
Atomic and Molecular Physics	208
Plasma Physics	140
Low Temperature Physics	92
Astrophysics	83
Chemical Physics	82
Optics	58
Mathematical Physics	58
Biophysics	45
Acoustics	37
Medical Physics	31
Geophysics	28
Electromagnetism	16
Fluid Dynamics	15
Materials Science	11
Electronics	10
General Physics	32
Other Physics	78
Engineering	46
Other Science Fields	17
Other Areas	23
Total Number Known	2324
No Response	111

TABLE C-33. Theory and experimental distribution for selected degree subfields of physicists, 1983.[a]

	Theory %	Exper %	Neither %
Mathematical Physics	78	18	4
Elementary Particles	40	60	0
Astrophysics	37	63	0
Plasma Physics	35	64	1
Geophysics	33	63	4
Chemical Physics	30	69	1
Atomic & Molecular Physics	24	76	0
Solid State Physics	23	76	1
Acoustics	23	68	9
Optics	21	74	5
Nuclear Physics	20	80	0
Biophysics	10	85	5
Low Temperature Physics	9	91	0
Medical Physics	6	71	23
Overall All Degree Fields	27	71	2

[a] Respondents indicating both theory and experimental are divided evenly between the two.

TABLE C-34. Percentage of degrees awarded over time for selected subfields, 1983.

	Year of PhD < 1962	1962–75	1976 +
Astrophysics	6	53	41
Medical Physics	6	52	42
Plasma Physics	8	47	45
Low Temperature Physics	14	61	25
Biophysics	17	42	41
Solid State Physics	19	55	26
Optics	19	40	41
Elementary Particles	21	60	19
Geophysics	25	50	25
Atomic & Molecular Physics	29	55	16
Acoustics	35	41	24
Mathematical Physics	35	49	16
Nuclear Physics	39	46	15
Chemical Physics	41	37	22
Overall All Degree Fields	25	51	24

TABLE C-35. Percentage of physicists no longer working in their degree subfields, 1983.

	%
Medical Physics	9
Optics	9
Plasma Physics	20
Geophysics	22
Astrophysics	29
Acoustics	33
Solid State Physics	40
Elementary Particles	45
Biophysics	54
Atomic & Molecular Physics	54
Nuclear Physics	56
Chemical Physics	60
Low Temperature Physics	68
Mathematical Physics	74
Overall All Degree Fields	46

TABLE C-36. Age structure for each society, 1983.

	25th	Quartile Age Median	75th
AAS	33	40	48
AAPM	36	41	48
AVS	33	41	52
APS	35	43	53
OSA	35	43	55
ASA	35	43	56
SoR	35	44	54
ACA	36	44	55
AAPT	40	46	56

TABLE C-37. Professional self-identification for each society, 1983.

	AAPM %	AAPT %	AAS %	ACA %	APS %	ASA %	AVS %	OSA %	SoR %
Physicist	84	76	25	14	74	23	33	50	9
Astronomer	-[a]	1	63	-	1	-	-	1	-
Engineer	5	4	3	4	9	42	42	31	52
Chemist	1	2	1	56	10	-	14	8	32
Biologist	1	1	1	6	1	3	-	1	1
Math & Comp. Sci.	1	3	3	3	2	3	-	2	1
Other Scientist	5	1	2	15	1	21	4	5	5
Other	3	12	2	2	2	8	7	2	-
Total Number Known[b]	384	1056	426	291	3637	533	427	761	180
No response	2	4	4	1	5	1	2	2	1

[a] Blanks indicate that less than 1.0% of a society's members identify themselves with the noted group.

[b] Note that respondent totals here reflect the stratified over-sampling of the three smallest societies: AAPM, ACA & SoR.

TABLE C-38. Type of employer for each society, 1983.[a]

	AAPM %	AAPT %	AAS %	ACA %	APS %	ASA %	AVS %	OSA %	SoR %
ACADEMIC	33	84	51	51	43	32	15	25	33
University	30	36	46	47	38	30	14	22	32
College	3	17	4	3	4	2	1	2	1
Junior College	-	8	1	1	1	-	-	1	-
Secondary School	-	23	-	-	-	-	-	-	-
NONACADEMIC	67	16	49	49	57	68	85	75	67
Industry/Self Employed	19	10	16	25	31	46	71	52	54
Government	10	4	14	13	11	15	5	13	7
FFR&DC	2	1	13	7	12	1	8	6	4
Non-profit and other	36	1	6	4	3	6	1	4	2
Total Number Known[b]	362	905	370	257	3037	444	382	632	156
No Response	2	4	2	-	11	1	2	6	-

[a] Students are not included.

[b] Note that respondent totals here reflect the stratified over-sampling of the three smallest societies: AAPM, ACA & SoR.

TABLE C-39. Level of highest degree for each society, 1983.[a]

	AAPM %	AAPT %	AAS %	ACA %	APS %	ASA %	AVS %	OSA %	SoR %
PhD	56	60	89	87	88	56	47	61	78
Masters	37	33	9	7	8	27	17	22	15
Bachelors	7	7	2	6	4	17	36	17	7
Total Number Known	370	1014	397	276	3314	499	393	695	171
No Response	-	-	1	2	3	1	5	5	-

[a] Advanced graduate students are not included.

TABLE C-40. Primary work activity for each society, 1983.

	AAPT %	ACA %	AAS %	APS %	SoR %	ASA %	OSA %	AVS %	AAPM %
Teaching	71	15	19	20	17	14	10	7	7
Basic Research	7	44	47	31	20	15	16	13	5
Applied Research	4	17	10	21	38	24	28	23	23
DDE[c]	5	7	9	12	13	23	29	33	13
Administration	10	8	11	12	10	14	13	18	13
Other	3	5	4	4	2	10	4	6	39
Total Number Known[b]	902	256	367	3017	156	445	630	381	359
No Response	7	1	5	31	-	-	8	3	5

[a] Students are not included.

[b] DDE: Design, Development and Engineering.

APPENDIX D: METHODOLOGY

In April of 1983, the Manpower Statistics Division conducted its fifth annual survey of a random sample of the U.S. and Canadian resident membership of the nine AIP member societies. A second questionnaire was sent in June to all nonrespondents to the initial questionnaire. Both first and second wave respondents were asked to indicate their employment status as of March 1983. Of the 9904 society members queried, 5220 responded to the first wave questionnaire and an additional 1509 responded to the second wave. The overall response rate was 68%.

Stratification

The original 1979 sample was expanded in 1981 to include 17% of the membership. In addition, the three smallest societies: American Association of Physicists in Medicine, American Crystallographic Association and the Society of Rheology, were oversampled by a factor of two to achieve a sample size large enough to permit a detailed analysis of their membership. This stratification was achieved by selecting 34% of the single society members in these societies. To compensate for the overrepresentation of these society members in the overall respondent group, their data was weighted by 0.5 for all analyses except the individualized society descriptions in the concluding section of the report. For the purposes of that section, all members responding from a given society were included.

New Members

The 1983 survey included the annual follow-up of individuals in both the original 1979 sample and the expanded 1981 sample. In addition, this survey was expanded to include 17% of the new members in each of the nine societies. New members are defined as those individuals who joined their first society during the previous calendar year. This procedure has been followed for each of the annual membership surveys since 1981 and includes the appropriate oversampling of the three smallest societies. Thus, the 1983 sample included 826 new society members.

TABLE D-1. Response rates for 1983 Sample Survey.

	Society Members	Dropped Members	Overall
Sample Size*	9954	1046	11 000
Postal Returns	50	130	180
Presumed Contacted	9904	916	10 820
Number Respondents			
Wave 1	5220	212	5 432
Wave 2	1509	97	1 606
Total	6729	309	7 038
Response Rate (%)	67.9	33.7	65.0

*Deceased and individuals requesting to be removed from the sample are not included.

APPENDIX E: DEFINITIONS AND TECHNICAL NOTES

Employment Status

All salary data are presented for individuals who are full-time employed and residing in the U.S. Where feasible, academic salaries reported on a 9–10 month and 11–12 month salary base are presented separately. When overall figures are given, there is no weighting for salary base. Other employment tables, which do not involve salary data, include both full-time and part-time employed U.S. and Canadian members unless otherwise noted.

Field and Subfield

The field and subfield list which was sent with the questionnaire was used by respondents to indicate the area in which they received their highest degree and their primary and secondary subfields of work. In addition, individuals provided their major professional self-identification: physicist, astronomer, engineer, chemist, biologist, mathematician, computer scientist, other scientist, and other.

Cost of Living Index

The cost of living index used in this report was developed by the American Chamber of Commerce Researchers' Association (ACCRA). Its purpose is to provide "a useful and reasonably accurate measurement of inter-city cost of living differences." The index measures "relative price levels for consumer goods and services in participating cities, as compared with the national average for all participating cities (metropolitan and nonmetropolitan)." Differences of more than three whole numbers in index can be considered to represent actual inter-city differences in the costs of consumer goods and services; but the percentage difference in such cases should be considered a reasonable indication, rather than a precise measure, of the extent of the differences.

Median

The median, a measure which is used in this report is that point in a distribution above and below which 50% of the values fall. Since it is less influenced by extreme values than the arithmetic mean it is the preferred descriptive measure of central tendency in typically skewed salary and age distributions. In Appendix C, both median and mean salaries are presented; observed differences reflect the skewness in the distributions.

Quantiles and Interquantile Ranges

Ninety percent of the values in a distribution fall below the ninth decile, seventy-five percent below the third quartile, twenty-five percent below the first quartile and ten percent below the first decile. The interdecile and interquartile ranges, which indicate differences between deciles and between quartiles, are measures of variation within distributions.

Quantile Calculations

The P-STAT statistical package was used to compute the medians and other quantiles presented in this report. It should be noted that this package works with an ordered distribution of value points. In such an ordered distribution, the median, for example, equals the central point in an odd-numbered distribution and a weighted value between the two middle points in an even-numbered distribution.

Sampling Error

The percentages and other measures presented in this report are based upon a small random sample. Thus, they are also subject to sampling error. The variability introduced by the sampling procedure depends both upon the size of the sub-group being examined and the variation of values in the population. The formulas below present conservative estimates of the standard error based on simple random sampling. When standard errors were calculated, taking into account the minor stratification used in the sampling, slightly lower estimates resulted. Confidence intervals for proportions, means and medians can be determined as follows:

Medians:

M_1, *that point below which* p_1^{th} *values fall,*
M_2, *that point below which* p_2^{th} *values fall,*

where

$$p_1 = p + Z\left(\frac{p(1-p)}{n}\right)^{1/2}, \; p_2 = p - Z\left(\frac{p(1-p)}{n}\right)^{1/2},$$

and

$p = 0.5$,
$n =$ sample size,
$z =$ coefficient of confidence, 1.96 at the 95% confidence level.

Means:

$\bar{x} \pm Zs/(n)^{1/2}$, *where*

$\bar{x} =$ the arithmetic mean,
$s =$ standard deviation,
$n =$ sample size, and
$Z =$ coefficient of confidence 1.96 at the 95% confidence level.

Proportions:

$$p \pm Z\left(\frac{p(1-p)}{n}\right)^{1/2}$$

$p =$ sample proportion observed.
$n =$ sample size, and
$Z =$ coefficient of confidence, 1.96 at the 95% confidence level.

APPENDIX F. Questionnaire Instruments and Subfield List

AIP MANPOWER STATISTICS DIVISION

1983 MEMBERSHIP SAMPLE SURVEY

PLEASE NOTE ADDRESS CHANGES IN COMMENT BOX ON FIELD/SUBFIELD LIST

PLEASE

Print numbers with pencil clearly in boxes as follows:

0123456789

Use the digit '|' in place of check marks.

IMPORTANT: PROVIDE INFORMATION DESCRIBING YOUR STATUS IN MARCH 1983

BACKGROUND INFORMATION

① MAJOR PROFESSIONAL SELF-IDENTIFICATION (SELECT ONE)

☐ PHYSICIST ☐ ASTRONOMER ☐ ENGINEER ☐ CHEMIST ☐ COMPUTER SCIENTIST ☐ MATHEMATICIAN ☐ BIOLOGIST ☐ OTHER SCIENTIST * ☐ OTHER*

② LEVEL OF HIGHEST DEGREE

☐ DOCTORATE ☐ MASTERS ☐ BACHELORS ☐ OTHER*

③ DATE OF DEGREE

MONTH | YEAR ☐☐☐☐

④ SUBFIELD OF DEGREE

(SEE ATTACHED LIST) ☐☐☐ ☐ EXPERIMENTAL ☐ THEORETICAL ☐ NEITHER

⑤ IF STUDENT

INDICATE: ☐ GRADUATE ☐ OTHER

⑥ DATE OF BIRTH

MONTH | DAY | YEAR ☐☐☐☐☐☐

⑦ SEX

☐ MALE ☐ FEMALE

⑧ CITIZENSHIP

☐ UNITED STATES ☐ CANADIAN ☐ NON-US PERMANENT VISA ☐ NON-US TEMPORARY VISA

⑨ RACE/ETHNIC

☐ WHITE ☐ BLACK ☐ ORIENTAL ☐ OTHER ASIAN ☐ NATIVE AMERICAN INDIAN ☐ MEXICAN AMERICAN ☐ PUERTO RICAN ☐ OTHER *

EMPLOYMENT STATUS, MARCH 1983

⑩ WERE YOU:

EMPLOYED: ☐ FULL TIME ☐ PART TIME

NOT EMPLOYED: ☐ SEEKING ☐ NOT SEEKING

☐ RETIRED

⑪ IF POSTDOC:

INDICATE ☐

⑫ FIELD OR SUBFIELD OF WORK (SEE ATTACHED LIST)

PRIMARY ☐☐☐ ☐ EXPERIMENTAL ☐ THEORETICAL ☐ NEITHER

SECONDARY ☐☐☐ ☐ EXPERIMENTAL ☐ THEORETICAL ☐ NEITHER

⑬ TYPE OF WORK ACTIVITY (INDICATE PRIMARY WITH "I" AND SECONDARY WITH "2".)

☐ ADMINISTRATION ☐ DESIGN/ENGINEERING ☐ DEVELOPMENT ☐ APPLIED RESEARCH ☐ BASIC RESEARCH ☐ TEACHING ☐ CONSULTING ☐ OTHER*

⑭ ANNUAL SALARY AS OF MARCH 1983

☐☐☐☐☐ (US/CDN $)

IF ACADEMIC INDICATE SALARY BASE: ☐ 9-10 MOS. ☐ 11-12 MOS.

⑮ PLEASE PRINT FULL NAME OF EMPLOYER

____

CITY _______________ STATE/COUNTRY

U.S. EMPLOYER ZIP CODE ONLY ☐☐☐☐☐

PLEASE DO NOT ☐☐☐☐☐☐ MARK THESE BOXES

⑯ TYPE OF EMPLOYER (INDICATE PRIMARY WITH "I" AND, IF APPLICABLE, SECONDARY WITH "2".)

☐ UNIVERSITY ☐ COLLEGE ☐ JUNIOR COLLEGE ☐ SECONDARY SCHOOL ☐ INDUSTRY ☐ GOVERNMENT ☐ FEDERALLY FUNDED R & D CENTERS (e.g. Argonne) ☐ NON-PROFIT ☐ SELF-EMPLOYED ☐ OTHER *

→ IF ACADEMIC, answer a and b

a) PRIMARY ACADEMIC RANK

☐ PROFESSOR ☐ ASSOC. PROF. ☐ ASST. PROF. ☐ LECTURER/INSTRUCTOR ☐ RESEARCH ASSOCIATE ☐ ADMINISTRATOR ☐ OTHER*

b) TENURE STATUS

☐ TENURED ☐ TENURE LINE ☐ OTHER *

* IF YOUR RESPONSE IS "OTHER," PLEASE SPECIFY IN COMMENT BOX ON FIELD/SUBFIELD LIST.

FORM A-4

AIP MANPOWER STATISTICS DIVISION

MEMBERSHIP SAMPLE SURVEY
1983 UPDATE

PLEASE NOTE ADDRESS CHANGES IN COMMENT BOX ON FIELD/SUBFIELD LIST

PLEASE

Print numbers with pencil clearly in boxes as follows:

0123456789

Use the digit '1' in place of check marks.

PLEASE INDICATE WITH "1" ANY STATUS THAT APPLIED IN **MARCH 1983.**

	EMPLOYED		NOT EMPLOYED		RETIRED		POSTDOC	STUDENT
	FULL TIME	PART TIME	SEEKING	NOT SEEKING				
a)	☐	☐	☐	☐	☐	b)	☐	☐

BASIC ANNUAL SALARY AS OF MARCH 1983: ☐☐,☐☐☐ (US/CDN $)

If ACADEMIC INDICATE SALARY BASE: 9-10 MOS. ☐ 11-12 MOS. ☐

HAVE YOU MADE ANY CHANGES IN AREAS 1-7 BELOW SINCE MARCH 1981?

IF **NO** SIMPLY RETURN FORM IN ENCLOSED ENVELOPE.

IF **YES** INDICATE *NEW* STATUS ONLY IN THE RELEVANT AREAS BELOW.

IMPORTANT: REPORT CHANGES MADE BETWEEN **MARCH 1981** AND **MARCH 1983** ONLY.

1 TYPE OF WORK ACTIVITY? (INDICATE PRIMARY WITH "1" AND SECONDARY WITH "2".)

ADMINISTRATION	DESIGN/ ENGINEERING	DEVELOPMENT	APPLIED RESEARCH	BASIC RESEARCH	TEACHING	CONSULTING	OTHER*
☐	☐	☐	☐	☐	☐	☐	☐

2 EMPLOYER?

PLEASE PRINT FULL NAME OF *NEW* EMPLOYER:

U.S. EMPLOYER ZIP CODE ONLY ☐☐☐☐☐

PLEASE DO NOT MARK THESE BOXES ☐☐☐☐☐☐

TYPE OF EMPLOYER:

UNIVERSITY	COLLEGE	JUNIOR COLLEGE	SECONDARY SCHOOL	INDUSTRY	GOVERNMENT	FEDERALLY FUNDED R & D CENTERS	NON-PROFIT	SELF-EMPLOYED	OTHER*
☐	☐	☐	☐	☐	☐	☐ (eg Argonne)	☐	☐	☐

3 FIELD OR SUBFIELD OF WORK? (SEE ATTACHED LIST)

PRIMARY	THEORETICAL	EXPERIMENTAL	NEITHER	SECONDARY	THEORETICAL	EXPERIMENTAL	NEITHER
1) ☐☐☐	☐	☐	☐	2) ☐☐☐	☐	☐	☐

4 ACADEMIC RANK?

a) PRIMARY ACADEMIC RANK: / b) TENURE STATUS:

PROFESSOR	ASSOC. PROF.	ASST. PROF.	LECTURER/ INSTRUCTOR	RESEARCH ASSOCIATE	ADMINISTRATOR	OTHER*	TENURED	TENURE-LINE	OTHER*
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5 NEW HIGHEST DEGREE?

A) LEVEL OF DEGREE				B) DATE OF DEGREE		C) PRIMARY SUBFIELD OF DEGREE			
DOCTORATE	MASTERS	BACHELORS	OTHER*	MONTH	YEAR	(SEE ATTACHED LIST)	EXPERIMENTAL	THEORETICAL	NEITHER
☐	☐	☐	☐	☐☐	☐☐	☐☐☐	☐	☐	☐

6 MAJOR PROFESSIONAL SELF-IDENTIFICATION?

PHYSICIST	ASTRONOMER	ENGINEER	CHEMIST	COMPUTER SCIENTIST	MATHEMATICIAN	BIOLOGIST	OTHER SCIENTIST*	OTHER*
☐	☐	☐	☐	☐	☐	☐	☐	☐

7 CITIZENSHIP?

UNITED STATES	CANADIAN	NON-US PERMANENT VISA	NON-US TEMPORARY VISA
☐	☐	☐	☐

* IF YOUR RESPONSE IS "OTHER," PLEASE SPECIFY IN COMMENT BOX ON FIELD/SUBFIELD LIST.

FORM C-4

FIELD/SUBFIELD LIST

PHYSICS & ASTRONOMY

001	ASTRONOMY
040	ASTROPHYSICS
070	ACOUSTICS
100	ATOMIC AND MOLECULAR PHYSICS
130	BIOPHYSICS
160	CHEMICAL PHYSICS
190	CRYSTALLOGRAPHY
220	ELECTROMAGNETISM
250	ELECTRONICS
280	ELEMENTARY PARTICLES & FIELDS
310	FLUID DYNAMICS
350	GEOPHYSICS
380	HIGH POLYMER PHYSICS
410	LOW TEMPERATURE PHYSICS
440	MATHEMATICAL PHYSICS
470	MECHANICS
500	MEDICAL PHYSICS
530	NUCLEAR PHYSICS
560	OPTICS
590	PLASMA PHYSICS
600	RADIOLOGICAL PHYSICS
620	RHEOLOGY
650	THERMAL PHYSICS
680	SOLID STATE PHYSICS
720	SURFACE SCIENCE
740	VACUUM SCIENCE
760	PHYSICS, GENERAL
790	PHYSICS EDUCATION, PRE-COLLEGE
800	PHYSICS EDUCATION, COLLEGE
820	PHYSICS, OTHER (Specify below.)

ENGINEERING

835	AERONAUTICAL & ASTRONAUTICAL
840	CHEMICAL
845	ELECTRICAL
850	ELECTRONIC
855	ENVIRONMENTAL
860	MECHANICAL
862	METALLURGY
865	NUCLEAR
870	SYSTEMS
890	ENGINEERING, GENERAL
891	ENGINEERING, OTHER (Specify below.)

OTHER SCIENCE

893	AUDIOLOGY AND SPEECH SCIENCE
895	BIOLOGICAL SCIENCE
900	CHEMISTRY
905	COMPUTER SCIENCE
910	EARTH & ENVIRONMENTAL SCIENCE
912	GENERAL SCIENCE, EDUCATION
915	MATERIALS SCIENCE
920	MATHEMATICS & STATISTICS
925	PSYCHOLOGY
945	SCIENCE ADMINISTRATION
950	SCIENCE, OTHER (Specify below.)

OTHER AREAS

952	BUSINESS MANAGEMENT
955	EDUCATIONAL ADMINISTRATION
975	OTHER ADMINISTRATION
999	NON-SCIENCE, OTHER (Specify below.)