

CHAPTER 6 – PHYSICS: A GLOBAL COMMUNITY

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The data included in this presentation come from surveys of American Institute of Physics (AIP) member societies and were collected by AIP staff Raymond Chu, Megan Henley, Michael Neuschatz, and Patrick Mulvey. Since these data come from surveys or from the physics community, they will show a different perspective than was shown to us in the earlier presentations by National Science Foundation (NSF) staff, but you will see some interesting similarities, especially with some of the things that Derek Hill presented earlier.

AIP conducts three different kinds of studies. One is on the education system, including everything from high school through the Ph.D. Another is a set of employment studies looking at first jobs, mid-career change, through the retirement process. The third set is society-specific surveys where we contract with an individual society to work on some set of issues that are of particular concern to their constituents. This presentation will focus exclusively on this third set of surveys.

AIP has 10 member societies. Physicists, however, are the minority in the combined membership. So, the very title of this presentation, "Physics: A Global Community," is misleading, because it really covers physics and a lot of related disciplines.

For example, while the members of the American Association of Physicists in Medicine are overwhelmingly individuals with physics degrees, members of the American Astronomical Society are overwhelmingly astronomers. Membership of the American Crystallographic Association is very diverse. The Acoustical Society of America has a significant number of engineers and a significant number of physicists, but they also have architects who design or fix concert halls. They have a variety of people who use acoustics as a tool, like oceanographers, petroleum geologists, and the U.S. Navy. And then, there are folks who do acoustics of human hearing in a medical environment, like psychologists, speech therapists, audiologists, etc.

Statistical Research Center of AIP Conducts Studies on:

Education

High school through the PhD

Employment

Initial job through the retirement process

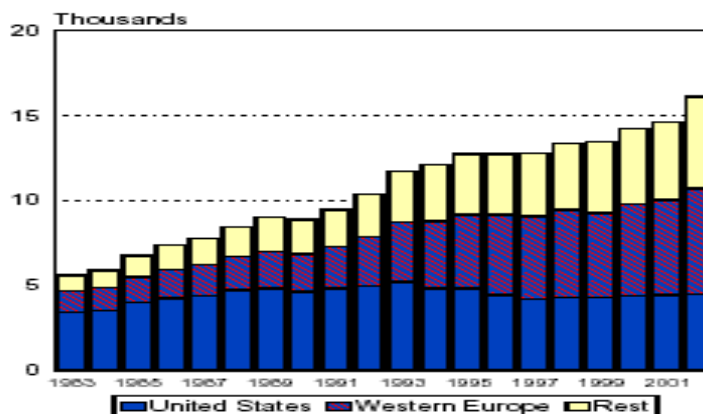
Society-Specific Studies

Membership dynamics, conference attendance, publications, outreach activities, salaries

AIP Member Societies

AAPM	Amer. Assoc. of Physicists in Medicine
AAPT	Amer. Assoc. of Physics Teachers
AAS	Amer. Astronomical Society
ACA	Amer. Crystallographic Assoc.
AGU	Amer. Geophysical Union
APS	Amer. Physical Society
ASA	Acoustical Society of America
AVS	Amer. Vacuum Society
OSA	Optical Society of America
SoR	Society of Rheology

Physical Review and Physical Review Letters Published 1983 - 2002



Domestic Membership Trends, 1986-2002			
	1986	2002	1986-2002
	N	N	Change %
AAPM	2220	3650	64
AAPT	9220	8740	-5
AAS	3780	5200	38
ACA	1340	1610	20
AGU	13200	23280	76
APS	31670	33500	6
ASA	4940	4640	-6
AVS	5250	3960	-25
OSA	7670	8980	17
SoR	950	990	4

International Membership Trends, 1986 and 2002			
	1986	2002	1986-2002
	N	N	Change %
AAPM	220	780	255
AAPT	1140	1300	14
AAS	570	840	47
ACA	360	450	25
AGU	4070	10760	164
APS	5160	8510	65
ASA	940	1990	112
AVS	520	1280	146
OSA	1690	4710	179
SoR	210	620	195

Membership Trends, Domestic versus International				
1986-2002				
	Change %		Change N	
	Int'l	US	Int'l	US
AAPM	255	64	560	1440
AAPT	14	-5	160	-480
AAS	47	38	280	1420
ACA	25	20	90	270
AGU	164	76	6700	10080
APS	65	6	3360	1820
ASA	112	-6	1050	-300
AVS	146	-25	770	-1290
OSA	179	17	3030	1300
SoR	195	4	410	40

Global distribution of the membership of AIP			
Member Societies, 2002			
	United States	Developed nations	Developing nations
AAPT	87%	9%	4%
AAS	85	12	3
AAPM	82	14	4
AVS	76	20	4
ACA	78	19	3
APS	78	17	5
ASA	70	24	6
AGU	68	27	5
OSA	65	26	9
SoR	61	32	7
M.S. Overall	75	20	5

Source: AIP Statistical Research Center

The data in the slide on the previous page were referenced by *The New York Times* in an article published in May. The article discussed the U.S. vs. the international community of scientists, and presented data on the percent of journal articles published by the American Physical Society where the senior author lived outside the U.S. The data shown here are a little bit different from what appeared in *The New York Times*. At the bottom of each column are the U.S. resident physicists who have published. That figure has held relatively steady at 4,500 to 5,000 articles per year. The articles submitted by authors in Western Europe and the rest of the world are all growing rapidly, as shown in the top two bars of each column. The end result is that they are publishing three times as many articles now as they did a mere 20 years ago.

I want to take a look at some of the implications and some of the reasons for this kind of growth, but first I want to step back and look at the U.S.-based societies in physics and related fields. U.S.-resident membership varies greatly by society as seen above, from 1,000 to tens of thousands. Some societies have experienced shrinking domestic membership, while membership in others has grown significantly by 60 to 75 percent.

If you look at the number of members who live outside of the U.S., the numbers are smaller but nontrivial, and in each case, the growth is significant.

Looking at that on one slide, you see that no matter whether the U.S. part has shrunk, stayed the same or increased, the rate of increase of international members in these ten U.S.-based societies has changed much faster. These societies are becoming more and more international with each passing year.

Where the members reside is spread across the world, but they are concentrated in developed countries, and in particular Japan, Canada, Germany, England and France. In Derek Hill's presentation, he showed some data on who is collaborating with the U.S., and of these five countries, the U.S. was number one. So it is not just a publication collaboration, it is also a membership issue.

In fact, half (52 percent), of all the international members of these ten societies live in those five countries. And the 13 countries that are listed to the right make up nearly three-quarters, with another 8,000 members spread across 80 or 100 countries.

Who are the international members? Are they different from domestic members? AIP recently conducted two surveys of international members for two of its member societies – the Optical Society of America (OSA) and the American Physical Society (APS).

As seen in the accompanying slide, the percentage of PhDs in the membership is virtually identical for U.S. versus international members. However, the international members are much more likely to be academically employed, and are twice as likely to be doing basic research as their primary activity. One should not draw the conclusion that this is true of those communities in those countries, but it is certainly true of the part of the community who are also members of U.S.-based societies.

Why do international members say they joined APS? The number one reason was to be part of a larger community. Staying abreast of the latest developments in the field is also a popular reason for joining APS, as seen below. *Physics Today*, which is AIP's monthly magazine sent to the entire membership, is also popular.

The Optical Society of America (OSA) used slightly different questions, so the numbers are somewhat different, but the themes are very similar. Respondents were given 10 or 12 choices in these two different surveys and were told to pick the three that are most important. Overwhelmingly, "to be part of a larger optics community" was number one. "Keep abreast of developments in the field" was ranked second.

Countries with the largest number of AIP Member Society members, 2002		
	Number of members	Cumulative percent of non-US members
Japan	5410	17%
Canada	3837	29
Germany	3087	39
England	2548	47
France	1650	52
Australia	1142	56
Switzerland	1067	59
South Korea	1032	62
Italy	982	65
Netherlands	885	68
Spain	723	70
Taiwan	664	72
Sweden	645	74
Total of all non-U.S. members	31,836	100%

Source: AIP Statistical Research Center

Profile of International Members

	OSA		APS	
	Int'l %	U.S. %	Int'l %	U.S. %
PhD	79	73	91	93
Academe	55	28	78	52
Basic Research	29	15	60	33

Based on employed members only

Why International Members Say That They Joined APS?

	1998 %
Be part of a larger community	53
Receive Physics Today	42
Receive research information	34
Participate in meetings	29
Keep abreast of U.S. physics Community	27
Journal Subscription discounts	24

Why International Members Say That They Joined OSA?

	2004 %
Be part of optics community	75
Keep abreast of developments in optics	51
Conference registration discounts	43
OPN & Physics Today	42
Opportunities to meet other scientists	41

Preliminary findings

Shown to the right is the extent to which APS international members say they read physics research in APS journals. About two out of three of the respondents said that half or more of all the research literature they read is published by the American Physical Society, so it has an international preeminence.

For the OSA survey, respondents were asked what other societies they belong to, and if they belong to more than one, how important is their affiliation with the OSA relative to the others. Whether they are international members or U.S. members, respondents said that OSA is their dominant society.

In the U.S., individuals who belong to another society often belong to a society that covers a different field, such as IEEE, the Materials Research Society, or the American Physical Society. In the international group, they belong to OSA in the U.S. and then a local or regional optical society. So, there is a difference, but the OSA membership is important to both groups.

Why are people members of the society, and what is the mobility? When we looked at individuals who are in industrialized countries, roughly 70 percent of the members had been in the U.S. to either study or work. Nearly half had been here for research collaboration, including a postdoc, and about one-quarter had been here as graduate students.

That flips around with developing countries, where nearly half have been here as graduate students and maintain their affiliation upon returning home, and about one-quarter have been here not as students but as collaborators.

This collaboration that is showing up in the research literature also is going on in general. Rachel Ivie from AIP did a survey of women physicists in 55 different countries, and although the base rates are different, there was an extremely strong base rate for people moving from one country to another to go to school or to do a research collaboration, or they are living in a third country altogether. The mobility of scientists in general is significant.

AIP conducted a survey of graduate departments about a year ago, asking them if any of the international students who were accepted into their programs and expected to arrive did not make it. What we found was that for the fall of 2002, 20 percent of the foreign students who were expected to make it did not make it for the start of the year, and many of them did not make it at all.

Extent to which APS International Members Read Physics Research in APS Journals

	%
Most	40
Half	27
Less than half	25
None	8

Importance of O.S.A relative to other Societies to which members belong

	Int'l %	U.S. %
OSA is primary	61	56
OSA is 2nd	30	33
OSA is 3rd or 4th	9	11

APS International Members and their Relationship with the U.S. Community

	Industrialized Countries %	Developing Countries %
Studied in the U.S.	26	42
Worked in the U.S.	43	26
Neither	31	32

Visa Problems and Foreign Grad Students

Studies conducted by AIP show that:

- Fall 2002, 20% of foreign students who were accepted into physics did not arrive for start of the academic year.
- Fall 2003, 13-15% of foreign students who were accepted into geoscience did not arrive for start of academic year.
- Fall 2003, 10% more foreign students entered physics than previous academic year.
- Fall of 2003, 45% more U.S. citizens entered grad physics programs than 5 years earlier.

Then, AIP conducted a survey for the geosciences in fall of 2003, and their base rates were a little bit lower. The response rate was not quite as good, but about 13 to 15 percent of the foreign students who were expected to show up did not make it for the fall of 2003.

Then, there is this weird phenomenon where the number of foreign students who actually made it for the fall of 2003 in physics was 10 percent higher than the year before. It turns out that a couple of things are going on. First, had most or all of the foreign citizens in the class of 2002 made it, we would have had the largest entry class of foreign citizens in physics ever by a distance, and then, very few of the folks who did make it for the start of 2003 were folks who originally tried to make it in 2002 and were just now getting there. So, that is a very small part of that.

Obviously, there are a lot of dynamics going on here. We do not know if people are starting their application process a little earlier or if they are having a somewhat easier time of it, but what we are seeing here is that we are still getting lots of foreign students. In fact, the number who made it in 2003 is now up to the same level as pre-9/11.

And then, in the fall of 2003, 45 percent more U.S. citizens entered that year than 5 years earlier. And the really startling number there is that that is literally twice the increase at the bachelor's level in physics. So it is not just that we are producing more degrees, which we are, but there is something else going on.

Since the foreign students are not getting in, are the departments lowering their standards? To answer this, I talked to several department chairs at some of the best departments, and they said uniformly that the number of domestic applications that they had received was the largest that they can remember in the last decade, and that the quality of those applications was so high that when they hit their cut-offs, they found that their standards were actually higher than they had been in years. So, the numbers are increasing, and there is apparently something positive going on in undergraduate physics education in this country.

One thing that is clear is that there is publishable scientific research being conducted all around the world, not just in developed countries and not just in the U.S. Scientists cross national boundaries regularly to conduct research and for their education. And the U.S. is an integral part of that global scientific enterprise. Our research journals are among the most respected in the world, and it is a place where lots of scientists come to do research and to publish their research, but it is not the only center for such activities.

Concluding Remarks

- Publishable scientific research is going around the world
- Scientists cross national boundaries to conduct research
- U.S. is integral part of the global scientific community

Audience Questions/Comments:

- Participant – Do you have any data on postdocs?

Response – No. It is really hard to find them because they are not part of the department; they are part of one person's grant. We do not even know what percent of the postdocs in academic departments are individuals who came here with a Ph.D. in hand. We are guessing that it might be around one-third, but it is a real guess. We just do not have that data point.

- Richard Ellis, Ellis Research Services – There has been this big increase in graduate physics students. Is something changing in the job market? Is there reason to believe that those people think that there is going to be more work?

Response – I am sure that is part of it. The job market at the bachelor's level was very strong in the 1990s when IT and the economy were booming. We have been in what the economists are now calling a "jobless recovery" where everything is going up except the likelihood of finding a job. When there is a downturn in the economy, we often see a slight increase in the likelihood of bachelor's going on to Ph.D.s, but that does not account for this kind of a jump.

Something very good is going on. We think that it may actually have something to do with faculty paying more attention to undergraduates in physics. There has been a real change in the last decade, and there seems to be a real effort to make undergraduates feel like they are part of the community and maybe even part of the department early on and as a result, the quality of their experience may be improving.

- Participant – Is gender equivalent across that increase, or is the growth primarily male or female?

Response – What we are seeing is that the entry class of first-year graduate students is very close to the bachelor's, and the percent of women bachelor's has gradually been going up. It is roughly around 22 percent now. And curiously, too, the male-female split for international students tends to be identical to U.S. students.