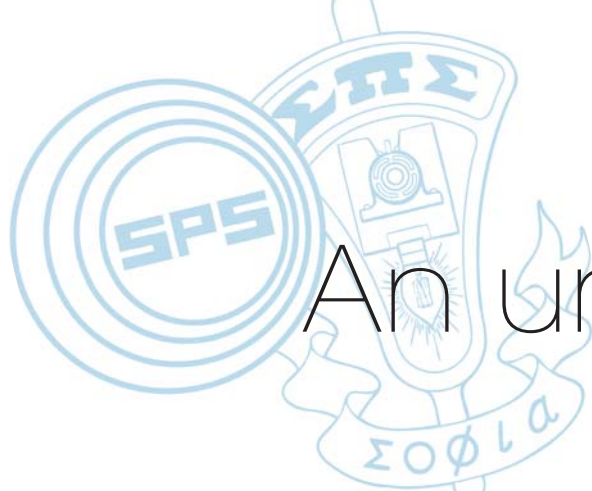




# An undergraduate alliance comes of age

Steve Feller and Toni Sauncy

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**Together, Sigma Pi Sigma and the Society of Physics Students establish a vital link between the physicists of tomorrow and those of today and yesterday.**

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Last November more than 800 people from across the US and the world gathered for a four-day physics conference in Orlando, Florida. On hand was a first-class slate of plenary speakers, including Nobel laureate John Mather, Freeman Dyson, Jocelyn Bell Burnell, Mercedes Richards, and John Johnson. Researchers presented their latest findings on topics ranging from synthetic chemotaxis to star formation in starburst galaxies and from terahertz spectroscopy of nanoparticles to the diagnosis of Alzheimer's disease. During workshops, attendees grappled with some of the most pressing issues facing physicists today: how best to connect science and technology; how to communicate physics to the public; how to improve diversity in the physics community.

Unlike typical society meetings, however, the Orlando gathering—the 2012 Quadrennial Physics Congress, or PhysCon 2012, for short—was planned, promoted, and attended mainly by undergraduate students. Hosted by the physics honor society Sigma Pi Sigma ( $\Sigma\Pi\Sigma$ ) and planned in conjunction with the Society of Physics Students (SPS), the meeting was probably the largest-ever assemblage of undergraduate physics students in a single place at a single time.

For those who may be worried about the future

of physics, PhysCon 2012 should allay their fears. As anyone who was there can attest, tomorrow's physicists are an inquisitive and infectious enthusiastic bunch. For almost 50 years, SPS and  $\Sigma\Pi\Sigma$  have worked together to help cultivate such curiosity and enthusiasm; the Quadrennial Physics Congresses are but one of many avenues by which the organizations' members engage with their peers, campus, and community.

For its part, SPS offers members a menu of educational and career-development opportunities, including scholarships, internships, and community outreach programs. Meanwhile,  $\Sigma\Pi\Sigma$ , which boasts the likes of George Gamow, Vera Rubin, Mildred Dresselhaus, and Nobel Laureates Mather and William Phillips among its alumni rolls, welcomes between 1200 and 1500 high-achieving physics students into its fold each year. Induction marks a rite of passage into the broader physics community—especially for those students from small departments.

In terms of the programs they provide, SPS and  $\Sigma\Pi\Sigma$  have grown in leaps and bounds in recent decades. In this article, we chart their transformation from fledgling clubs into global societies and take a look ahead at what tomorrow may hold.

## Back to the beginning

Founded in 1921 at Davidson College in North Carolina,  $\Sigma\Pi\Sigma$  was the first national organization for undergraduate physics students. The Greek letter name was chosen to stand for Scholarship Physics Society. As chronicled by Peggy Dixon, who served for more than a decade as the society's historian,  $\Sigma\Pi\Sigma$  started out as a small, fraternity-

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TRACY SCHWAB, AIP

like club, chartered by five students and four faculty members.<sup>1</sup>

The organization grew rapidly: Its first congress, held in 1928 at Davidson College, was attended by six chapters; by 1931,  $\Sigma\Pi\Sigma$  had expanded to 20 chapters and had held its third national congress at Purdue University. It evolved from a fraternity into an honor society, with members inducted on the basis of their academic achievement. The nascent society flourished in large part due to the hard work and vision of Marsh White, who founded  $\Sigma\Pi\Sigma$ 's third chapter on the campus of the Pennsylvania State University and was a pillar of the national leadership for decades thereafter.

In the 1950s a second organization for physics majors was formed—the student sections of the American Institute of Physics. By that time, AIP had built a thriving network of professional societies and looked to augment that network with programs for preprofessionals. According to the organization's 1952 director's report, the student sections "were established to meet a strong demand from the growing numbers of students majoring in physics who desire a form of affiliation with their prospective profession. . . . The aims must be to serve and stimulate the student, to enhance his professional pride and responsibility at the start of his career, and to recruit him as a worthy member of one of our Member Societies" (see PHYSICS TODAY, May 1952, page 6).

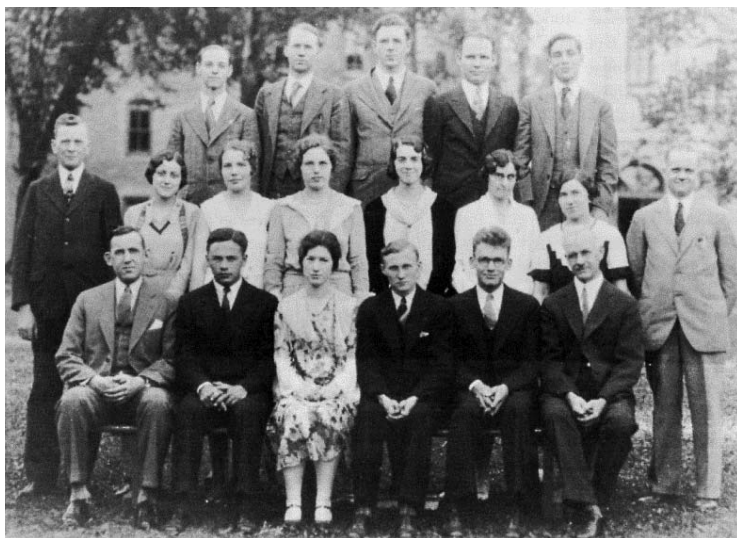
Unlike  $\Sigma\Pi\Sigma$ , membership in AIP's student sections was extended to all students of physics, without regard for major, year of study, or academic record. Among the organization's leaders were Donald Cunningham, Arnold Strassenburg, Peter

### Snapshot of SPS membership demographics (April 2013)

|                            | % of respondents |
|----------------------------|------------------|
| <b>Class</b>               |                  |
| Undergraduate              | 71.3             |
| Master's                   | 3.5              |
| PhD                        | 5.8              |
| High school                | 0.7              |
| Faculty                    | 5.0              |
| Other                      | 13.7             |
| <b>Type of institution</b> |                  |
| Two-year college           | 1.9              |
| Bachelor's only            | 43.4             |
| Master's-granting          | 8.6              |
| PhD-granting               | 35.4             |
| High school                | 0.4              |
| Other                      | 10.3             |
| <b>Gender</b>              |                  |
| Male                       | 76.3             |
| Female                     | 23.7             |
| <b>Race</b>                |                  |
| African American           | 3.6              |
| Asian                      | 8.5              |
| White                      | 77.7             |
| Other                      | 8.9              |
| <b>Ethnicity</b>           |                  |
| Hispanic                   | 10.8             |

Kahn, Leonard Olsen, and AIP director Van Zandt Williams. Members were provided with, among other things, information about graduate and research opportunities, reduced rates for AIP publications, and grants supporting chapter activities.

The AIP student sections and  $\Sigma\Pi\Sigma$  recruited from the same pool of students for campus leaders and membership. By 1960 roughly 2000 physics students from 80 different colleges and universities were members of AIP student sections. Meanwhile,  $\Sigma\Pi\Sigma$  had grown to more than 100 chapters nationwide. In the 1960s a movement to merge the two undergraduate associations began to gather steam. Formal discussions between AIP and  $\Sigma\Pi\Sigma$  began in 1965, and in 1966  $\Sigma\Pi\Sigma$  officers presented a merger proposal to their national council. The council voted in favor, and in August of that year,  $\Sigma\Pi\Sigma$  and the AIP student sections merged.



**Members of Sigma Pi Sigma's** Wheaton College chapter in Illinois, after their installation ceremony on 6 June 1931. Seated at the far left is Marsh White, an instrumental figure in the organization's transformation from a small fraternity into a national physics honor society. (Photo courtesy of Wheaton College.)

Not until December 1967, at a historic convocation at Purdue of more than 200 delegates from 90 chapters, did  $\Sigma\Pi\Sigma$  and AIP vote to create the organization now known as SPS. According to lore,  $\Sigma\Pi\Sigma$  president Worth Seagondollar chain-smoked 75 cigars during the marathon meeting as delegates spoke one by one to argue for or against the merger. Ultimately, the motion to create SPS passed with just a single vote to spare. The next year, on 22 April 1968—Marsh White's 72nd birthday, coincidentally—the new society for undergraduates was born.<sup>1</sup>

### A society of their own

Billed as “the professional society for physics students and their mentors,” SPS represents many physics students' first exposure to the important concept of membership in a professional organization. Anyone with an interest in physics can join. Although undergraduates at four-year institutions

make up the lion's share of the membership, other members are graduate students, high school students, and undergraduates at two-year colleges (see the table on page 47).

In recent years the official membership of SPS has hovered between 4000 and 5000, corresponding to roughly 20–25% of the nation's reported physics majors. But many more students participate in chapter, zone, and national activities. For every official member, three to four students in physics and allied disciplines are in one way or another involved with SPS activities and programs. Statistics from PhysCon 2012 indicate that only one-third of registrants were SPS members, and informal analysis of annual chapter reports shows that most chapters record student participation numbers far exceeding their membership counts.

The honor society  $\Sigma\Pi\Sigma$  remains a distinct organization housed within SPS. A member of the Association of College Honor Societies,  $\Sigma\Pi\Sigma$  has a historical membership of more than 85 000. The society currently has more than 550 active chapters, mostly in the US.

The governance of SPS and  $\Sigma\Pi\Sigma$  is largely student driven. The organizations are divided into 18 geographic zones, each represented on a joint national council by one faculty member (the zone councilor) and one student member (the associate zone councilor). The council is led by the elected presidents of SPS and  $\Sigma\Pi\Sigma$  and sets the organizations' programs and priorities under the guidance of an executive committee composed of a peer-elected student member, the two society presidents, an at-large member, the SPS director, the executive director of AIP, and an appointed historian. A staff based at AIP headquarters in College Park, Maryland, provides the organizations with administrative support.

### Undergraduates at work and play

From the start, the missions of SPS and  $\Sigma\Pi\Sigma$  have been to support and encourage the undergraduate community. Aside from providing members important perks—including a subscription to this magazine—SPS offers scholarships, a thriving summer internship program, support and awards for outreach initiatives, support for zone and regional meetings, and support for student travel to physics society meetings. Many of those opportunities are made possible by strong underwriting support from AIP.

Perhaps no undertaking is bigger than the quadrennial congresses hosted by  $\Sigma\Pi\Sigma$ . Until about 20 years ago,  $\Sigma\Pi\Sigma$  congresses were modest affairs. Attendance was limited to the honor society's members, and the meetings themselves were primarily a venue for conducting official business. Since a 1992 meeting in Dayton, Ohio—the first of the so-called modern era of  $\Sigma\Pi\Sigma$  congresses—the meetings have blossomed into full-blown scientific conferences, replete with technical talks, workshops, poster sessions, and tours of science facilities. For more detail, see the box on page 50.

To a large extent, students are given the reins: Development of each congress's theme, program, and marketing strategies are driven by the SPS



**Society of Physics Students (SPS)** members introduce physics to K–12 students and to the community at large through a variety of outreach programs and hands-on demonstrations. **(a)** A member of the Angelo State University SPS chapter helps a child to operate a hovercraft. **(b)** SPS National Council member Joanna Taylor participates in family outreach at the Smithsonian's National Museum of American History. (Photo courtesy of Peter Nguyen.) **(c)** Chapter members from the College of Southern Maryland prepare an experiment for the SPS-cosponsored Physics Day at the Six Flags America theme park. (Photo courtesy of Matthew Payne.) **(d)** An interactive, educational haunted lab created by SPS members at Idaho State University. (Photo courtesy of Jordan Keough.)

student leadership under the guidance of a faculty chair and with logistic help from the SPS national office staff. Turnout at the congresses has grown steadily over the past 15 years; it reached a record at the recent meeting in Orlando, where for the first time ever the invitation to attend was extended to all SPS members and affiliates. More than 1000  $\Sigma\Pi\Sigma$  and SPS members are expected to attend PhysCon 2016 in San Jose, California.

The impact of the congresses on the students who attend them is nearly impossible to quantify, but anecdotal feedback suggests the meetings are a singularly empowering experience. Students cite as a key benefit the opportunity to make connections with a large and diverse group of peers who share their interests and career goals. And few physics conferences can match the energy, vibrancy, and excitement of one in which the overwhelming majority of participants are undergraduate students.

### The greater good

The impact of SPS and  $\Sigma\Pi\Sigma$  is felt not only by students; the organizations and their members help to strengthen departments, campuses, and communi-

ties. During the 2001–02 academic year, a task force operating under the auspices of AIP, the American Association of Physics Teachers, and the American Physical Society visited 21 of the nation's top physics departments to learn the secrets of their success and find innovative ways to improve physics departments nationwide. The project, known as Strategic Programs for Innovations in Undergraduate Physics, or SPIN-UP, cited SPS chapters as playing a pivotal role in departmental community building.<sup>2</sup> For many physics departments, particularly those threatened with budget cuts or elimination of degree programs, a thriving SPS chapter can enhance student recruitment, retention, and morale; foster a sense of inclusion; and provide venues for cultivating informal mentor-mentee relationships.

Local SPS chapters often serve as a primary vehicle for engaging with the nonphysics community, both on and off campus. Through the Science Outreach Catalyst Kits and Marsh W. White Award programs, for instance, SPS provides local chapters with funding, materials, and curricula for hands-on physics demonstrations and mentoring projects with local K–12 students and the general

## The quadrennial congresses

In 1992, Sigma Pi Sigma ( $\Sigma\Pi\Sigma$ ), the physics honor society, held its first national congress since joining forces with the American Institute of Physics 25 years earlier. Around 100 students and faculty mentors were on hand for that meeting—considered the first of the modern era. From then on, congresses have been held once every four years, in conjunction with the Society of Physics Students (SPS), and have steadily grown in size and scope. Some 400 students and faculty attended the 2004 installment in Albuquerque, New Mexico. Roughly twice that many were present in Orlando, Florida, in 2012. The Orlando congress also took on an international flavor: Making the trek were six students and one faculty adviser from the SPS chapter at Southeast University in Nanjing, China. The meeting might have been bigger still, were it not for space limitations that left 50 students on a waiting list.

As attendance has grown, so, too, have the meeting programs. Indeed, the congresses have taken on the air of full-fledged professional society meetings. Over the years, plenary talks have been given by luminaries such as Nobel laureates Carl Wieman and Leon Lederman, Young-Kee Kim, Louis Lanzerotti, Neal Lane, and Jocelyn Bell Burnell—a two-time plenary speaker.<sup>5</sup> Other distinguished speakers have come from outside academia—among them, John Grunsfeld, former NASA chief scientist, and Aziza Baccouche, a physicist who now runs a media and television production company.

Workshops at the congresses provide forums for dialog on the myriad issues affecting undergraduate students. Past topics have included professional ethics, national science policy, diversity in

the physics community, and the public perception of physics. More than just talk, the discussions typically culminate with official SPS policy recommendations, which can serve as catalysts for action.<sup>6</sup> For example, a call to encourage undergraduates to become more active and informed on issues of science policy was fulfilled in 2009 with the initiation of the Mather Policy Intern Program at the American Institute of Physics. (For information on that program, see <http://www.spsnational.org/programs/internships>.)

Student presentations are an integral part of the congress experience. In 2012 nearly 200 students presented posters on undergraduate research and chapter outreach efforts. The photo shows



KEN COLE, APS

one of those students, Dontrel Reynolds of Alabama A&M University, explaining his research to Michael Duncan of the US Naval Research Laboratory. The 2008 conference marked the debut of a student art contest, in which students enter physics-inspired creations. And at every conference since 1996, the Worth Seagondollar Service Award—named after the former  $\Sigma\Pi\Sigma$  president—has been presented to a worthy SPS or  $\Sigma\Pi\Sigma$  leader. (For a list of past recipients, see

<http://www.sigmapiisigma.org/awards/worth-seagondollar>.)

Behind-the-scenes scientific tours have become a tradition at the modern  $\Sigma\Pi\Sigma$  congresses: In 2004, conference goers got special permission to visit the Trinity nuclear test site near Albuquerque, New Mexico; at the 2008 congress in Batavia, Illinois, students toured Fermilab; and at the 2012 congress in Orlando, attendees visited labs and launch facilities at NASA's Kennedy Space Center. Tours of SLAC are planned for the upcoming 2016 congress in San Jose, California.

public. In addition, SPS supports diversity in physics with the Future Faces of Physics program, aimed at promoting physics across cultures. Many SPS members also tutor and mentor younger students on campus.

Besides coordinating programs, the SPS national council plays another key role: It gives physics students a collective voice on matters of policy in academia and society.<sup>3</sup> In the past, the council has developed and passed resolutions supporting increased participation of undergraduates in meaningful research, better promotion of the range of careers available to physics graduates, and expanded efforts to recruit women, minorities, and other underrepresented groups into the physics community. The inroads made by SPS with respect to diversity were particularly evident at PhysCon 2012, where more than 30% of the attendees were women and more than 20% were from other groups that are generally underrepresented in physics. Forty students from 16 historically black colleges and universities and 2 minority-serving institutions attended the congress with support from NSF as part of the AIP Career Pathways Project. In general, SPS outpaces the broader undergraduate physics population in including underrepresented minorities (see the table). If the demographics of today's SPS are at all indicative of tomorrow's physics community, the SPS-related initiatives seem to be stirring winds of positive change.

Fruits of various SPS efforts are chronicled in the organization's two publications—the quarterly *SPS Observer* and *Radiations*, a  $\Sigma\Pi\Sigma$  magazine issued twice a year. Both disseminate news and updates on topics of relevance to the undergraduate and alumni physics communities, and much of their content is contributed by student reporters. Those publications, along with the online, peer-reviewed *Journal of Undergraduate Research in Physics*, are managed by the SPS national office staff.

## Going global

Over the past decade, under the leadership of Ed Neuenschwander, Gary White, and other directors, SPS has transformed from a “pizza and soda” club into a legitimate professional society with programs aimed at addressing the overall undergraduate experience. The SPS model has drawn interest from our colleagues around the globe who strive, just as we do, to improve and increase numbers in undergraduate physics programs. The recent addition of two SPS chapters in China and a third in Singapore, and ongoing conversations with universities in India and Kazakhstan, are evidence that the vision of a strong undergraduate professional organization is shared by physicists around the world.

This is a good time for undergraduate physics. More than 6300 physics bachelor's degrees—a record—were awarded nationwide in 2012. The most recent statistics indicate that there are currently more than 20 000 declared physics majors at the junior and senior levels throughout the US.<sup>4</sup> Together, SPS and  $\Sigma\Pi\Sigma$  offer a glimpse of the breadth and diversity of that undergraduate population.



**Jessica Doehrmann and Benjamin Heppner**, both undergraduates at Bethel University in Minnesota, were part of a team that received a 2012 Sigma Pi Sigma research award to study supersonic flows through nozzles. The awards provide calendar-year grants to support local Society of Physics Students chapter activities deemed imaginative and likely to contribute to the strengthening of the society. (Photo courtesy of Woody Dahlberg, Bethel University.)

Whether from historically robust physics programs or those just beginning their journey, in large cities and in small communities, undergraduate physics students share a common enthusiasm for science and an excitement about what tomorrow holds. As the next generation of scientists, engineers, faculty, entrepreneurs, and “hidden physicists” in various other professions, SPS and  $\Sigma\Pi\Sigma$  members are poised to shape the world in which they live. Judging from their passion and initiative, and the community they've helped to build and strengthen, the future of physics is bright, indeed.

*We thank Kendra Redmond, Gary White, and Thomas Olsen for their critical reads and important contributions to this article. We are also grateful to Tracy Schwab and Elizabeth Hook for poring over thousands of photos to select the ones used in this article.*

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6. Recommendations from the 2004 Quadrennial Physics Congress are available at <http://www.sigmapisigma.org/congress/2004/ethics.htm>; for recommendations from the 2008 congress, see *Radiations*, Spring 2009, p. 4, [http://www.sigmapisigma.org/radiations/2009/congress\\_glimpses.pdf](http://www.sigmapisigma.org/radiations/2009/congress_glimpses.pdf). ■