The World Year of Physics in 2005

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The year 2005 has been designated the World Year of Physics (WYP) to commemorate the 100th anniversary of Albert Einstein's legendary papers on quantum theory, Brownian motion, and special relativity, first published in 1905. Organizations around the globe are planning a variety of programs to raise worldwide public awareness for physics in 2005. This paper provides a brief description of the WYP, discusses the significance of 1905, presents national objectives for the U.S. physics community, and outlines a variety of activities that individuals or teams can pursue to contribute to the success of this international campaign.

The European Physical Society (EPS) first proposed the WYP as a vehicle to raise worldwide public awareness of physics. By demonstrating the role that physics has played, and continues to play in our cultural, economic, and technical heritage, the EPS hopes to increase the general public's appreciation for and interest in the field. To support this enterprise, the International Union of Pure and Applied Physics passed a resolution during its 2002 General Assembly declaring 2005 the "World Year of Physics."

The WYP's primary goal is to provide a positive physics encounter for people who would *not normally* experience physics, while also targeting secondary schools, colleges and universities, and people who frequently attend public events. The WYP promotes and encourages enriching public outreach activities that expose the general population to the wonders of physics. To add some artistic flair to these promotions, a colorful marketing logo has been designed to brand the WYP (above). The logo has many creative interpretations; it may be used to represent colored light, a focal length, the inverse-square law, light cones, refraction of light through a lens, warped space-time, a wormhole, etc. The WYP celebration will occur over a 500-day period that begins in October 2004 and culminates in February 2006.

1905: Einstein's *Year of Miracles*

Albert Einstein was born in Ulm, Germany, on March 14, 1879. In 1905, at the age of 26, he earned his Ph.D. in physics and published five legendary papers within a four-month period that shattered many cherished scientific beliefs. Each paper alone would have secured his reputation as one of the 20th century's leading thinkers. Collectively, they demonstrate one man's sense of confidence, rigor, productivity, and insight that stands without parallel in the history of science. Originally published in the German journal *Annalen der Physik*, all five papers now exist in translations.[1] Reading these papers enables one to relive perhaps the most dramatic year in the history of physics.

In March 1905, Einstein published *On a Heuristic Point of View Concerning the Production and Transformation of Light*. Up to this point in time, Maxwell's equations and the laws of thermodynamics predicted that light carried energy in waves via oscillating electric and magnetic fields, and that these waves could contain any amount of energy no matter how small. This electromagnetic wave theory had been one of the crowning achievements of 19th-century physics and it superbly described optical phenomena. In this paper

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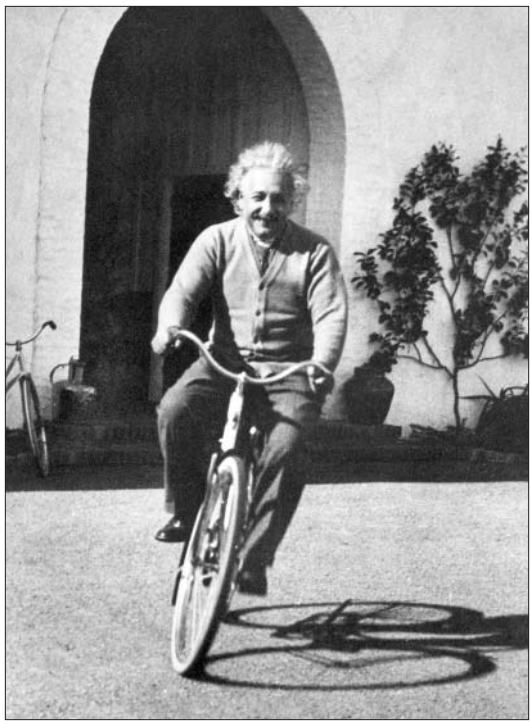
Einstein acknowledged these ideas, but then proposed a radically different thought — that light could also be regarded as a collection of particles. He hypothesized that a light particle carries an amount of energy that depends on its frequency. In 1926 Gilbert Lewis named these particles "photons." Einstein used this interpretation to explain the photoelectric effect in which certain metals emit electrons when illuminated with light above a certain frequency. This theory, and its subsequent elaboration, formed the basis for much of quantum mechanics. Einstein won the 1921 Nobel Prize in physics for the ideas presented in this paper.

After Einstein completed his Ph.D., his dissertation, *A New Determination of Molecular Dimensions*, was published (1905) and remains one of his most cited articles. In this work, Einstein describes how one can determine Avogadro's number and the sizes of ions in solution by measuring osmotic pressures and diffusion coefficients.

Einstein's next significant work, *On the Motion of Small Particles Suspended in Liquids at Rest Required by the Molecular-Kinetic Theory of Heat*, addressed the statistical aspects of molecular theory and Brownian motion. With profound insight, he blended ideas from kinetic theory and classical hydrodynamics to calculate the average trajectory of a microscopic particle buffeted by random collisions with molecules in a fluid or in a gas. Einstein derived an equation for the mean free path of such particles as a function of time. These calculations could account for Brownian motion, the apparently erratic movement of pollen in fluids, which had been noted by the British botanist Robert Brown. This paper provided convincing evidence for the physical existence of atoms, which had already received much theoretical discussion. In 1926, Jean-Baptiste Perrin won the Nobel Prize in physics for experimentally confirming Einstein's calculations.

On June 30, 1905, Einstein published *On the Electrodynamics of Moving Bodies*, one of his more famous papers that contained what was later known as the special theory of relativity. He assumed that the speed of light remained constant in all frames of reference. With the speed of light constant, Einstein uncovered the phenomenon of time dilatation. Time, and by analogy length and mass, became a function of the velocity of a frame of reference. Although Einstein was not the first to propose all the elements that went into this special theory, his unique contribution lies in having unified important parts of classical mechanics and Maxwellian electrodynamics. (In 1915 he published a paper on the general theory of relativity, presenting a new theory of gravitation that included Newton's theory as a special case.)



Albert Einstein enjoys a lighthearted moment at the home of Ben Meyer in Santa Barbara, California, on February 18, 1933.
Photo courtesy of The Archives, California Institute of Technology

In his fifth paper of 1905, *Does the Inertia of a Body Depend on Its Energy Content?,* Einstein asserted the equivalence of mass and energy. This led to the famous $E = mc^2$ formula and eventually paved the way to unleashing atomic energy.

These trailblazing papers have greatly affected the course of modern physics. While working as an obscure patent examiner, Einstein saw the world as no one had before. Although Einstein had few academic connections and very little contact with other physicists, his ideas established a new course for theoretical physics. After 1905, physics would never be the same.

The year 2005 commemorates the 100th anniversary of Einstein's *Year of Miracles.* His ideas continue to resonate beyond science, influencing modern cul-

ture from painting, to poetry, to popular music. As *Time* magazine's Person of the Century,[2] Einstein remains the genius among geniuses who discovered, merely by using his imagination, that the universe was not as it seemed. Einstein died on April 18, 1955.

AAPT-APS National Objectives and the WYP

The American Physical Society (APS) will coordinate the WYP efforts for the United States. It will direct a variety of community outreach and public information activities via a national marketing effort that maintains a current events website, promotes small-scale physics shows, and creates a variety of special activities aimed at all levels of K–16 science education. APS will also work with local groups to market the WYP by encouraging tours to physics-related sites, coordinating a speaker's program, and supplying promotional materials. Visit http://www.physics2005.org for more information about these and other ideas and to give your WYP event national publicity.

AAPT is also planning public outreach programs, for which we need member support. AAPT has more than 10,000 members across the nation from academia (high schools, two- and four-year colleges, and universities), industry, national laboratories, and science centers. This vast human resource can be used to diminish science phobias and improve physics education in our local communities, in addition to providing some local color and entertainment. With this in mind, AAPT invites its members to participate in the WYP. The spirit of the enterprise is for AAPT members to continue doing what they *already do* to make the public aware of the glories of physics, while attaching the name of AAPT and the WYP to the activities.

Public outreach need not be an indomitable task — even the simplest physics activities can have a broad impact! The general public has the sensory tools to experience physical phenomena … eyes that see, ears that hear, noses that smell, fingers that touch, and tongues that taste. What many lack in the realm of science is the understanding or insight that describes what happens. As professional educators, we have the ability and the duty to help these minds bridge the gap between "Wow, that's neat!" and "Hey, here's what's really happening behind all that neatness." Science outreach — no matter how simple, small scale, or grassroots it may be — has the potential for making a difference in our local communities.

In April 2003, AAPT President Charles Holbrow appointed Chuck Stone to chair an AAPT committee to identify activities appropriate to the WYP that the AAPT could organize and conduct. Committee members are listed in Table I. AAPT wants to help its members promote the WYP locally via small-scale educational outreach projects; the committee's role is to facilitate, guide, and encourage members in these endeavors. AAPT will help publicize whatever its members organize. The committee will direct four major outreach programs in 2005.

AAPT-WYP 4 Major Outreach Targets

• **Live Presentations.** Steve Shropshire will develop a list of outreach activities that can be presented in traditional settings (church camps, civic clubs, secondary schools, youth scout groups, etc.) and non-traditional venues (amusement parks, bookstores, city council meetings, coffee shops, gaming clubs, science fiction conventions, shopping malls, sporting events, state and regional fairs, etc.).

• **Static Displays.** Michelle Larson will encourage and work with museums and science centers to develop unmanned static displays that can be set up in art galleries, bookstores, restaurants, and shopping malls, and that excite and educate the general public about the WYP.

• **Classroom Activities.** Jessica Clark will promote classroom activities (e.g., measuring the size of the Earth using shadows from sticks) that might require AAPT local sections to work together on a joint activity.

• **Departmental Activities:** Warren Hein will encourage college physics departments to host open houses, promote AAPT sectional efforts, and oversee AAPT public service announcements.

AAPT Projects for the WYP

In addition to the four previously mentioned AAPT-WYP outreach targets, the following list describes a variety of activities that AAPT members might also want to investigate. Depending on one's ambition, a single individual could tackle some of these activities, while others require the cooperation

Table I. AAPT Committee on the World Year of Physics in 2005

Member	Institution	Email	Expertise
Matt Briggs	Los Alamos National Laboratory	*briggs@lanl.gov*	–National Lab Outreach Programs –AAPT Committee on Science Ed. for the Public
Jessica Clark	American Physical Society	*clark@aps.org*	–Public Outreach Specialist
Julie Conlon	Purdue University	*jaconlon@physics.purdue.edu*	–Physics Outreach Coordinator
Warren Hein	American Association of Physics Teachers	*whein@aapt.org*	–AAPT Associate Executive Officer –Coordinates WYP Campaign via AAPT Executive Office
Ted Hodapp	National Science Found. Div. of Undergrad. Ed.	*thodapp@nsf.gov*	–NSF Program Director –Informal Science Education
Michelle Larson	Montana Space Grant Consortium	*mlarson@physics.montana.edu*	–Deputy Director of NASA's Montana Space Grant Consortium –AAPT Committee on Astronomy Education
David Maiullo	Rutgers University	*maiullo@physics.rutgers.edu*	–Physics Support Specialist –PIRA (Physics Instructional Research Association) –Directs AAPT Lecture Demonstration Workshops
Steve Shropshire	Idaho State University	*shropshi@physics.isu.edu*	–Physics Professor –Hosted Demo Show at 2002 AAPT Summer Meeting in Boise, ID –Has "blueprint" for Mobile Physics Outreach
Chuck Stone	North Carolina A&T State University	*cstone@ncat.edu*	–Physics Professor –AAPT-WYP Committee Chair –AAPT Executive Board Member

of a physics class, a science club, an academic department, an AAPT local section, or a joint national effort.

1. **Mobile Demonstration Shows:** Employ large-sized, easy-to-see demos. These shows should use humor, be fast paced, focus on a theme or concept, and be fun and exciting.
2. **Mobile Hands-On Activities / Experiments:** These should address specific topics that support a school's curriculum. Experiments should motivate and engage learners with some sort of physical activity.
3. **Physics "Open House" Programs:** Perform live demonstrations at your home institution. Set up a series of hands-on, tabletop activities that the audience can play with. MBL activities with force, light, motion, sound, and temperature sensors provide many options.
4. **Teacher Workshops:** Use your effort where it matters, do not attempt to attract reluctant teachers, and work with your institution's School of Education if at all possible.
5. **Physics Coffee Shop / Bookstore Chats:** Schedule physics/space science/astronomy chats at local coffee shops or bookstores. Less formal than a public lecture, but still organized around a specific topic or series of topics. Merchants could advertise this much like they do poetry readings or music events around an in-store display of science books.
6. **Physics Car Wash:** A great project for SPS chapters or science clubs. Hold a car wash and perform physics demos for the customers. Most local radio and TV networks will advertise the event for free.
7. **Physics Puzzles on Public Transportation or Public Venues:** Place physics cartoons on placards that attach to public buses/subways/trolleys in your local town. Kiosks and bulletin boards also work. Each cartoon presents a physics puzzle or question, with a dialog leading to correct understanding.
8. **Physics Demo / Trick of the Week:** Establish a local listserve for secondary school science teachers. Each week, email teachers one simple demo or trick they can easily build and use in their class.
9. **Physics Question of the Week:** Disseminate one simple, insightful physics question to K–16 students across the nation each week. Tailor questions to the student audience (grades K–3, 4–6, 7–9, 10–12, and 13–16). Provide weekly answers;

tally results locally, regionally, and nationally to give the task a competitive flair.

10. **Question-Your-Favorite-Physicist Radio Talk Show:** Great for those institutions that have an on-campus radio station or intercom system. Discuss how things work and perform live demos on the air. Listeners call in and ask a teacher questions about astronomy, math, physics, science, etc.
11. **WYP T-Shirts:** Brand your outreach activity and your organization with a T-shirt that features the WYP logo and your own special art. Commercial printers will silk-screen custom graphics on cotton shirts for about $7 per shirt. These items are great motivational tools and readily identify your group.
12. **Newspaper, Radio, and TV Announcements:** Local media can provide public service announcements describing what is happening in WYP. Get town mayors to declare "WYP Day" or "WYP Week" for their area; get local politicians, members of the chamber of commerce, and town officials to highlight students, teachers, and programs in local secondary schools, colleges, museums, science centers, etc.
13. **Undergraduate Outreach Assistants — Education Majors and Preservice Science Teachers:** Preservice science teachers and undergraduate education majors can assist science education outreach programs by visiting schools, assisting with hands-on activities, leading demonstration shows, and distributing WYP memorabilia. As an extension, high school students can share their science experiences with younger audiences (middle school and elementary school students).
14. **Physics Day:** Designate one specific date in 2005 where physicists across the nation perform similar activities.
15. **"Re-Enact a Classic Experiment" Day:** Do a grand-scale demonstration or re-enact a classic, well-known experiment. Examples include determining the size of the Earth, measuring the speed of sound in air, measuring gravitational acceleration on Earth, showcasing Aristotle's and Galileo's different notions on the behavior of falling bodies, etc.
16. **Interdisciplinary Physics Theme Shows:** These shows illustrate the connections between physics and art, biology, chemistry, mathematics, music, painting, photography, sculpture, sports, etc.
17. **Co-Host Physics Program with Local Science Centers:** Physics educators work with an astronomy club, art/science museum, observatory, planetarium, public library, etc. to highlight the "physics" of selected artwork, devices, displays, and exhibits.
18. **Share Physics with Local Community Organizations:** Visit secondary school groups, church youth groups, civic groups (Big Brothers, Big Sisters, Boy Scouts, Girl Scouts, Indian Guides, YMCA, YWCA, etc.), youth sports groups (and discuss the physics of different sports such as baseball, basketball, dance, football, gymnastics, ice hockey, soccer, swimming, track & field, etc.), and adult daycare centers.
19. **Book Promotions:** Book publishers can promote popular science authors with book tours.
20. **Joint Meetings:** AAPT sections can sponsor joint meetings with other professional groups in their local area.
21. **Physics on Public Television:** Many communities have cable-access television networks that let local individuals freely broadcast educational-based programs.
22. **Miscellaneous Themes:** These include promoting public understanding of physics and physical sciences, physics in education, physics as the basis for many other disciplines, physics as the incubator for newly emerging technological fields, great challenges of physics in the 21st century, physics in developing countries, women in physics, minorities in physics, and the cultural heritage of physics from ancient Egyptian and Greek legacies to modern times.

Future Plans

Several WYP-related items are currently being developed or planned for the future:

• **U.S. Website.** For information on the WYP in the United States, go to http://www.physics2005.org. The site has a calendar of events, as well as downloadable copies of the WYP logo.

• **Global Website.** From a global perspective, the European Physical Society has launched a website that should centralize any valuable information and ongoing progress from all nations participating in the WYP. Go to http://www.wyp2005.org/ for details.

• **Congressional Efforts.** In September 2003, representatives from AAPT, AIP, and APS visited the staff of Congressmen Vernon Ehlers (R-Mich.) and Rush Holt (D-N.J.), the two physicists in Congress, to seek their support for a congressional resolution

endorsing the designation of 2005 as the World Year of Physics. The physics community hopes to see progress toward such a resolution in the next several months; to expedite this process, you may be asked to send letters of support to your own congressmen.

• WYP Booth at 2004 AAPT Winter Meeting in Miami Beach, FL. AAPT and APS members will staff a booth in the exhibition area to answer WYP questions, distribute promotional items, and spread the WYP good news.

• WYP Crackerbarrel at 2004 AAPT Summer Meeting in Sacramento, CA. Panelists will describe activities, ideas, and resources that physics teachers can use to develop community outreach programs that support the World Year of Physics in 2005. Come learn more about the WYP and find out how you can play a role in this international campaign. We will discuss the logistics of small and large-scale outreach programs, how to include your students and institution, and how to incorporate the WYP into your teaching.

• Future *TPT* Papers. To prepare the physics teaching community for the WYP, a number of manuscripts are being prepared for submission to *The Physics Teacher* in 2004.

Keep informed, get involved, and let's make 2005 a year to remember!

References

1. John Stachel, *Einstein's Miraculous Year: Five Papers That Changed the Face of Physics* (Princeton University Press, Princeton, NJ, 1998).
2. Frederic Golden, "Albert Einstein: Person of the Century," *Time* **154**, 62 (Dec. 31, 1999).

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Chuck Stone *is a visiting assistant professor of physics at North Carolina A&T State University. His research interests focus on the teaching and learning of physics and astronomy, plus improving secondary school science education by leading community outreach programs. His* Communicating Science to Kids: The Great Pumpkin Drop! *is a popular community outreach activity that gets undergraduate physics majors involved with the School of Education, the Theatre Arts program, and the Department of Journalism & Mass Communication to share the fun side of science with local secondary school students. He is a member of the AAPT Executive Board and chairs the AAPT Committee on the World Year of Physics.*

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