IRPS BULLETIN

Newsletter of the International Radiation Physics Society

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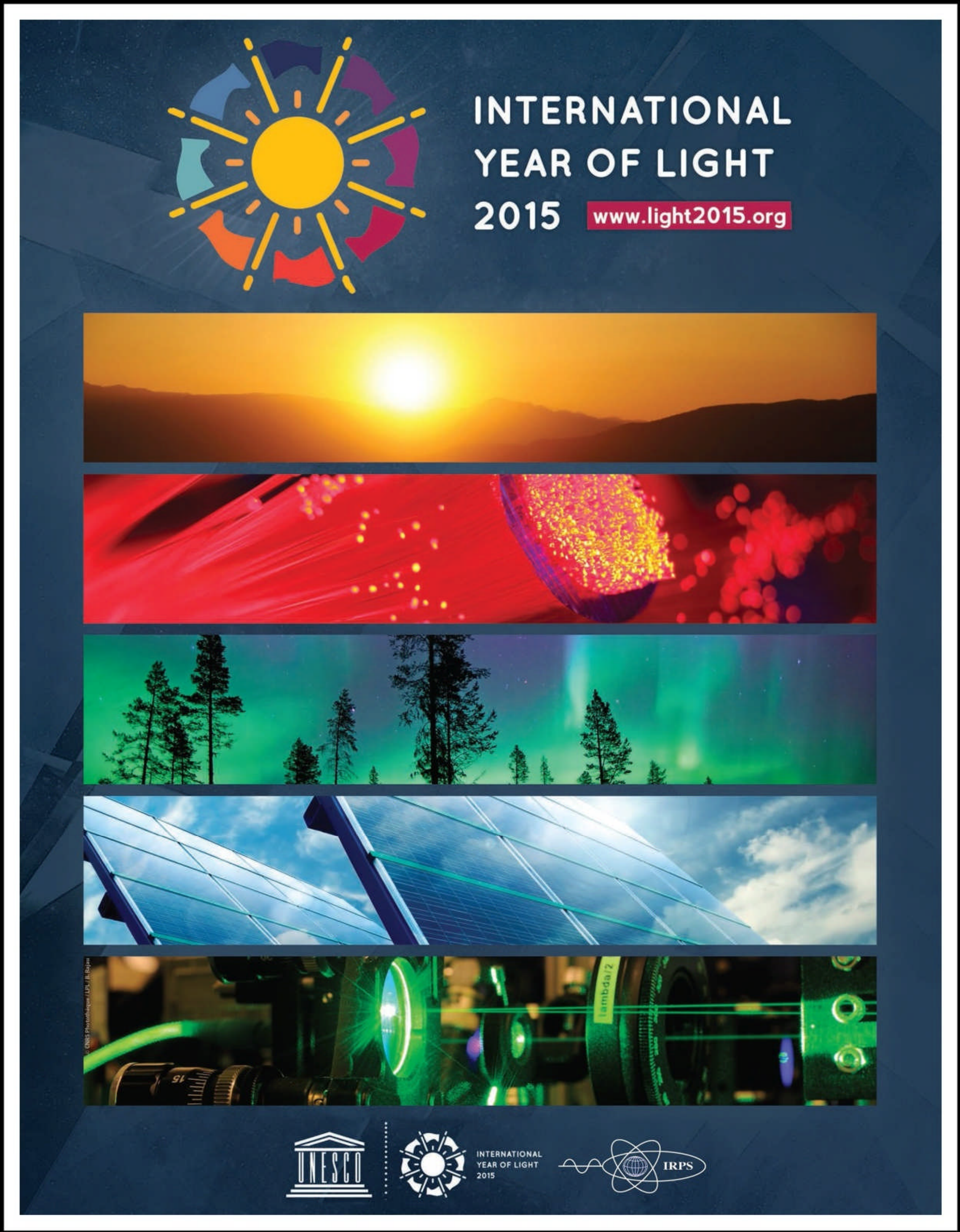

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(Our normal one will soon be back on line)

And we have a developing "sister website " : http://radiationphysics.org/

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Contents of this Journal

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Membership form for new members, and details for payments by cheque for new and renewing members are on the last 2 pages of this journal and information for payment by credit card is below

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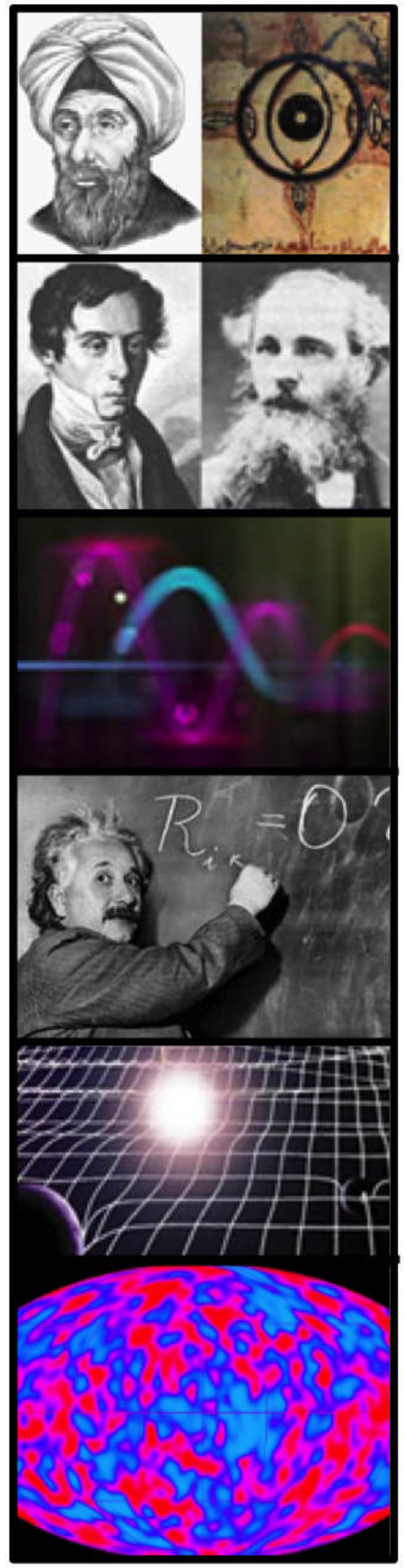
From the Editors

Dear Reader,



The Proclamation of 2015 as the International Year of Light by the United Nations seeks to highlight the importance of light and its potential applications, generating cross-disciplinary and cross-border educational and outreach projects. In a small way we hope this issue of the Bulletin of the Radiation Physics Society resonates with the many efforts of other scientific organizations around the world to promote improved public and political understanding of the central role of light in the modern world.

One notes some of the major anniversaries in 2015 related to Light:

- 1015 Ibn Al-Haytham *Book of Optics*
- 1815 Fresnel and the wave nature of light
- 1865 Maxwell and electromagnetic waves
- 1915 General relativity – light in space and time
- 1965 Cosmic microwave background, Charles Kao and optical fiber technology

Our celebration begins with a wonderful essay by Professor Dwight Neuenschwander on the importance of light in all branches of physics. We then unveil the newly released poster marking our society's triennial symposium, ISRP-13. For some, the trek to Beijing in September may be distant, but your conference organizers and society council members are working to make it a worthwhile effort and fruitful meeting. Please continue to check the conference web site as its construction is completed.

We then come to unfinished business from last year. As is customary in the first issue of a new volume of the *Bulletin*, we highlight some of the top physics news stories of the previous year. This is preceded by our election ballot form, due in early August so that the results can be announced at ISRP-13.

Rounding out this issue are additional radiation physics workshops and meetings of interest to the membership. As always, please be invited to submit items of regional and international scope to appear in the next issue.

In celebration of IYL2015,

Larry Hudson and Ron Tosh

More pictures next page …


LIGHT
INTERNATIONAL YEAR OF LIGHT
YEAR OF LIGHT
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HOW A PHOTON IS BORN
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INTERNATIONAL YEAR OF LIGHT

President's Column

Dear Colleagues

"Publish or perish" nowadays expresses the situation in academic life more or less all over the world. And if you publish, you need to publish in the journal with the highest-possible impact factor. I do not want to deal here with contentious issues such as: whether the highest number of publications is evidence of the highest scientific quality, or whether the impact factor expresses the real impact and high quality of the journal, or whether it reflects more the size of the scientific community dealing with the scientific area covered by that journal. These are of course important matters, but I want to address a different, though related, issue here.

A serious scientific journal makes a sincere effort to publish the most meritorious papers that it receives. A peer review is widely recognized as a valid part of the selection process – though any experienced editor could tell numerous tragi-comic stories about peer reviews. The journal requires at least two reviews of a submitted paper, in order to reach a decision on whether to accept or reject the paper, or to ask for it to be resubmitted in a revised form. The editor finds some specialists in the topic of the paper and asks them to write a review. Especially when the topic of the paper is very narrow, it is not easy to find reviewers with the required specialized knowledge. It is also not easy for the editor to match the topic of the paper to the scientific area of the reviewer that he addresses. However, let us consider the most frequent case, and assume that the editor has succeeded in her or his efforts, and has selected appropriate reviewers. These selected reviewers can be expected to respond in one of the eight ways listed below (if this list is not exhaustive, please send me further suggested categories of responses):

- Yes, I will do it - and the review is supplied promptly.
- Yes, I will do it - but the review takes a considerable time to arrive. This is still acceptable, if the delay is not too long.
- Yes, I will do it - but no review is ever submitted.
- No, I can't do it, but I recommend that you approach my colleague, who works on a closely related topic, or who has more time.
- I can't do it. I don't have time / I have many other papers to review / the topic is far from my field of interest / I will be travelling and therefore they cannot write the review in time, etc.
- No! (I don't like this journal, and don't ever want to collaborate with it.)
- No! (without any comment or explanation).
- No reply at all.

In my experience, this last response is the most frequent one. I have met cases when it was necessary to approach ten or more potential reviewers to obtain two reviews.

Why am I telling this sad story? It is because I would like to ask all authors who have submitted papers for publication in a reviewed journal to show some patience. The editor is probably doing his best to obtain the required number of reviews from relevant experts as soon as possible. However, if he is turned down a few times, or receives no response, there is a delay that is as frustrating for the editor as it is for the author.

On the other hand, dear colleagues, when you are addressed by the editor of a journal with a request to carry out a review, please do not decline the request without really serious reason, and if you agree to take on the task, please deliver your review promptly. You will certainly soon submit a paper of your own with your own scientific results to a good-quality reviewed journal, and you will want the same prompt service from your anonymous academic colleagues in their role as reviewers

I hope that your paper will be sent to reviewers who will submit well-judged and positive evaluations to the editor – promptly.

Ladislav Musilek

LIGHT, THE NEXUS IN PHYSICS

by Dwight E. Neuenschwander
Professor of Physics, Southern Nazarene University, Bethany, OK

In December 2013, the United Nations 68th General Assembly declared 2015 to be "The International Year of Light and Light-Based Technologies."[1] The following essay explores the importance of light to all branches of physics. Optics is the study of light, but here we imagine physics as the study of optics.

In a concept map of physics the study of light stands at all the major intersections. Insights into light illuminate the whole of physics, just as scattered light rays illuminate a whole house. This article is not a scholarly history but an illustrative overview, written with hindsight, of the central role of light in making connections.

In 1267 Roger Bacon, with whom the post-medieval "awakening began,"[2] published *Opus Majus*. In Book V, the *Optics* section of that encyclopedic work, Bacon wrote:[3]

> *"It is possible that some other science may be more useful, but no other science has so much sweetness and beauty of utility. Therefore it is the flower of the whole of philosophy and through it, and not without it, can other sciences be known."*

Seven hundred years later this motif was made explicit by Jacob Bronowski:[4]

> *"We see matter by light; we are aware of the presence of light by the interruption of matter. And that thought makes up the world of every great physicist, who finds that he cannot deepen his understanding of one without the other."*

Let us begin at the beginning.

Geometrical Optics

> *"About 10 months ago a rumor came to our ears that a spyglass had been made . . . This finally caused me to apply myself totally to investigating the principles and figuring out the means by which I might arrive at the invention of a similar instrument, which I achieved shortly afterward on the basis of the science of refraction."* –Galileo Galilei [5]

Navigation and surveying have long depended on the straightness of light rays. Through the practical experience provided by these activities, the optical laws of rectilinear propagation and reflection became known in antiquity. The first unified theory in physics came from Hero of Alexandria (c. 10–70 CE), who set forth the principle that light rays follow the path of minimum distance; rectilinear propagation and the law of reflection follow as consequences.[6]

Refraction has been known qualitatively from time immemorial. A partially immersed stick appearing to be sharply bent at the water's surface was mentioned in Plato's *Republic* (c. 360 BCE). "Burning glasses," lenses for starting fires by focusing sunlight, were part of ancient technology, as documented by artifacts such as a magnifier found in the ruins of the palace of Assyrian King Sennacherib (708–681 BCE). Refraction was made a quantitative science in the Middle Ages by Muslim scholars such as Ibn al-Haytham (c. 965–1040), known to us as Alhazen, who introduced the practice of measuring angles from the normal for reflected and refracted rays. Alhazen's contemporary Abu Sàd al-Alá ibn Sahl (c. 940–1000) expressed the law of refraction in terms of the hypotenuses of right triangles.[7] Willebrord Snellius (or Snell) rediscovered in 1621 the law of refraction, which René Descartes rediscovered again and published in its well-known sine form in 1637.

Refraction made possible the lens, which made the cell and the stars accessible to human senses. Galileo's *Starry Messenger* of 1610 and Robert Hooke's *Micrographia* of 1665 opened new worlds to investigation. They deepened the questions, and not only for scholars:

. . . He burned his house down for the fire insurance
And spent the proceeds on a telescope
To satisfy a lifelong curiosity
About our place among the infinities.
–Robert Frost, "The Star-Splitter"

Hero's principle of minimum distance does not explain refraction. That gap was remedied by Pierre de Fermat in 1657 through a broader unifying principle: Of all possible paths connecting two fixed points, the path followed by a light ray minimizes the time for light to go between the points. Fermat's principle requires light to travel at finite speed. Astronomy offered the first meaningful estimate of this speed in 1676 when Ole Rømer used as a clock the periodic emergence of Io from behind Jupiter's shadow. (The moon has an orbital period of 42.5 hours.) During the time of year when Earth recedes from the Jupiter–Io system, after each orbit of Io around Jupiter the clock is seen from Earth to run slow. Rømer interpreted the delay as the time light took to travel the additional distance between Earth and Io. Astronomy, which possesses information carried from the heavens to us by light, now gave back from the heavens information about light itself.

Lenses and Spectra

"I procured me a triangular glass-prisme, to try therewith the celebrated Phenomena of Colours . . ." –Isaac Newton

The edge of every lens forms a prism. The rainbow of colors that emerges from prisms was familiar in Aristotle's time. Received doctrine held that a prism somehow modifies the color of light. Isaac Newton had to investigate. He made a hole in his window shutter to let in a fine beam of sunlight. The prism produced the expected colors of the rainbow, but Newton noticed the significance of something else: the circular beam that entered the prism emerged as an elongated ellipse. Each color refracted at a different angle.[8]

With a second aperture Newton could select from this rainbow one color to enter a second prism. This prism did not change the color. Allowing *all* the colors to enter the second prism produced white light on its far side. A prism did not *modify* light but *separated* it. Newton wrote, "A naturalist would scarce expect to see ye science of those colours become mathematical, and yet I dare affirm that there is as much certainty in it as in any other part of Optiks."[9] This image of a prism separating white light into a spectrum and the inverse operation of synthesizing distinct colors into white light, illustrates visually the mathematics of synthesis and analysis, such as the harmonic series of Fourier's theorem.

William Herschel and his sister Caroline made some of the first catalogs of stars, discovering many binary systems and the planet Uranus. While testing a red filter for observing sunspots, William happened to place his hand at the focal point of his reflecting telescope and noticed the region to be unexpectedly warm. To study the temperature of light, in 1800 William inserted thermometers into the separate colors of the sun's spectrum. He noticed that in going from violet to red, the temperature increased. Intrigued, he placed a thermometer beyond the red, and there found the highest temperature. Herschel called this warm invisible light beyond the red "caloric rays," which we know as infrared. Herschel's results were anticipated by 63 years by Emilie du Châtelet. This remarkable woman essentially discovered the work-energy theorem, translated Newton's *Principia* into the French translation used to this day, and collaborated with Voltaire across many years. Her opus was *Eléments de la Philosophie de Newton* (1738), which went deep into the philosophical foundations of mechanics and was influential in shifting French scientists from the mechanics of Descartes to that of Newton. In 1737 du Châtelet entered an essay competition on the nature of fire. In her essay "Dissertation on the Nature and Propagation of Fire," she argued that fire is not a material substance, and different colors of light transport different quantities of heat. The way to demonstrate this, she suggested, was to line up an array of thermometers, one inserted into each of the separated colors of the spectrum, which was precisely what William Herschel did in 1800. du Châtelet was not able to perform the experiment herself for lack of thermometers.[10]

Joseph von Fraunhofer supervised glass melting and grinding processes in his Munich optical institute. He needed to measure the refractive indices for different colors in various kinds of glass. In one of his experiments, light from an oil lamp flame passed through a prism to be viewed through a telescope. Fraunhofer noted dark lines in the spectrum. Intrigued, he looked for generalizations. Repeating Newton's experiment on sunlight with his telescope-equipped prism, in 1814–15 dark lines were revealed in the solar spectrum.

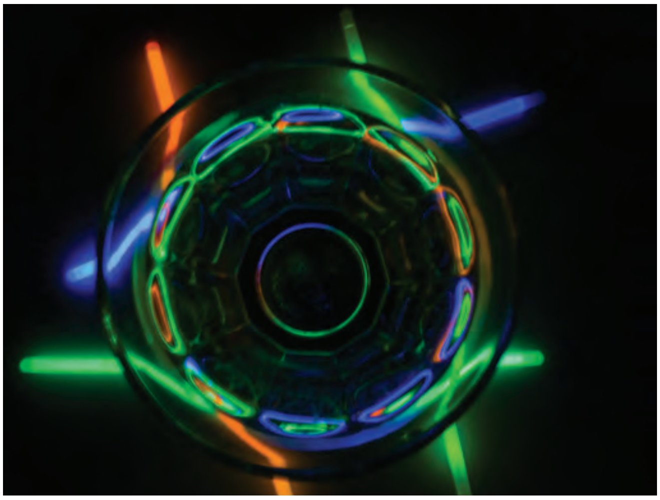
In 1857 the "daring and resourceful experimenter" Robert Bunsen invented a burner that produced a colorless flame.[11] With Bunsen's burner the spectra of chemicals placed in the flame could be cleanly separated. His collaborator Gustav Kirchhoff added a prism to complete the basic tool of modern spectroscopy, the spectroscope. Payoffs came quickly. In 1860 Bunsen and Kirchhoff discovered rubidium and cesium in a sample of Dükheim mineral water. In 1868 two astronomers, Pierre Janssen from France and Norman Lockyer from England, independently reported a yellow line in the solar spectrum that fit no known element. Interpreting it as an unknown element, Lockyer named it after *helios*, Greek for "the Sun."[12] Terrestrial helium was not confirmed until 1895 when William Ramsey isolated it as a byproduct of uranium ore. In 1907 Ernest Rutherford and Thomas Royds collected alpha particles emitted by radioactive decay, examined their spectra, and showed that the particles were helium.

Classical Mechanics

"Following in the footsteps of Hero and Fermat, he [Maupertuis] then proclaimed that this simplicity causes nature to act in such a way as to render a certain quantity, which he named the 'action,' a minimum." –Wolfgang Yourgrau and Stanley Mandelstam [13]

After Newton revolutionized optics he turned to mechanics. Generalizing inductively from specific problems solved in quantitative detail [14]—Archimedes on the lever, Galileo on projectiles, Huygens on the pendulum, and Newton himself on gravitation—he postulated in 1687 three laws of motion that turned mechanics into an axiomatic system. As the laws of geometrical optics could be derived from Fermat's least time principle, could the same be done for mechanics? Several proposals were forthcoming. These included Johann Bernoulli's 1717 principle of virtual work for statics, extended to dynamics by Jean le Rond d'Alembert in 1743.

Around 1740 Pierre Louis Moreau de Maupertuis (who tutored young Emilie du Châtelet in calculus) suggested that a particle acted on by specific forces moves in a way that minimizes the "action." This approach was successfully demonstrated for central forces by Leonhard Euler in 1744. In his *Mécanique Analytique* of 1788, Joseph Lagrange generalized Maupertuis' principle to all conservative forces and clarified "action" as the line integral of momentum. The generalization of this principle to all of mechanics (later extended to most of physics) was published in two papers by William R. Hamilton in 1834–35.[15] Hamilton's principle postulates that of all the conceivable trajectories whereby a particle might travel between two fixed points, the trajectory actually followed minimizes the time-averaged difference between the particle's kinetic and potential energies. The principles of Hamilton and Fermat arose from similar motivations, but a logical connection between them would have to await general relativity.


Used by permission from AAPT, 2014 High School Physics Photo Contest, "Glowing Refraction," by Claire Inna Isabelle Saloff-Coste, Ithaca High School.

Ontology

"From the multitude of experiences it [science] selects a few simple forms, and constructs from them, by thought, an objective world of things." –Max Born [16]

"You know something and then the quality stimulus hits . . . , but to define it all you've got to work with what you know. So your definition is made up of what you know. It's an analogue to what you already know." –Robert Pirsig [17]

A debate about the ultimate reality of light began in the time of Plato and the Sophists. By the time of Newton and Huygens, those arguing the question "What is light?" faced a binary choice: What is light—wave *or* particle? Robert Hooke's *Micrographia* describes how colors of thin films depended on a film's thickness, suggesting a standing wave condition. Christaan Huygens argued that the tremendous speed of light would be feasible only if light was a disturbance *through* a medium, not the bulk motion *of* a medium. He gave the wave hypothesis predictive power by postulating that each point on a wave front behaves as the source of another wave. If that were so, then light should radiate into regions that would otherwise remain in geometric shadow. Hooke and Francesco Grimaldi had noticed diffraction in the fine structure of shadows cast by a needle.

Initially ambivalent ("I make no hypotheses"), Newton eventually argued that light was a beam of particles. While acknowledging that *something* periodic occurs with waves (and discovering an interference pattern called "Newton's rings"), he interpreted the periodicity as something that matter does *to* light. To Newton, the diffraction reports did not require light to be a wave. Gravity acts between separated massive bodies, so matter could bestow its periodic influence on light from a distance.

Refraction offered one way to decide the question. When light passes from air into water the ray bends toward the normal. If light consists of waves, the speed of light in water would be less than its speed in air. If light consists of particles the reverse would happen.

In 1800 Thomas Young demonstrated that the interference of light passed through a double aperture. Such a pattern could be interpreted only as the superposition of waves. Augustin Fresnel worked out a comprehensive theory of diffraction based on the assumption that light consists of waves, and his predictions were vindicated, famously so with the notorious "Poisson's spot," a bright spot, due to wave diffraction, in the shadow behind an illuminated disk. In 1850 Léon Foucault measured the speed of light in water and found it to be less than the speed of light in air. The riddle "What is light?" seemed answered.[18]

Lingering questions remained, as they always do with important questions that have multiple layers. First, supposing light to be a wave, what is waving? Second, acoustical waves require a medium; what serves as the medium for light, the "aether"? Third, light had been found to be polarized by bifringent crystals. Reconciling polarization and the rapid speed of light with our ability to breeze freely through the aether offered a perplexing situation.

Electromagnetism

"Maxwell shewed light to be an electromagnetic phenomenon, so that the whole science of Optics became a branch of Electromagnetism. . . ." –James Jeans [19]

Hints at a connection between electricity and magnetism came when Hans Christian Ørsted showed that moving electric charge makes magnetism and when Michael Faraday showed that changing magnetism makes electricity. A unified theory of electromagnetism was written by James Maxwell in 1862. Action at a distance, which served well for static interactions, was replaced with the dynamic concept of the field, a function of space and time.

The interactions of matter proceed through fields. On one hand, local fields tell a particle of matter how to move. Newton's second law with the Lorentz force, for instance, predicts the motion of a charged particle in response to electromagnetic fields. On the other hand, matter determines the fields around it. Maxwell's equations relate the electric and magnetic fields to their charged particle sources and relate the fields to each other. When a charged particle accelerates, Maxwell's equations say the fields it produces must change. A changing electric field produces a magnetic field that also changes, and the changing magnetic field produces a changing electric field. Together the changing fields make a self-propagating wave moving at the speed of light.

In response to the "What is waving?" question, light must thus be a wave in the electromagnetic field! The equations describing this wave have no restriction on the frequency, suggesting the existence of a continuous electromagnetic spectrum of harmonics whose frequencies range from zero to infinity. The equations also say that the propagating fields are transverse to the direction of wave travel, implying polarization and explaining the effects of bifringent crystals.

In 1886–89 Heinrich Hertz affirmed Maxwell by broadcasting and detecting radio waves in the laboratory. While doing so the alert Hertz noticed a spurious glitch in his apparatus. Radiation of low intensity but sufficiently high frequency immediately stimulates an electric current in certain materials; at low frequencies the incoming light produces no current even at high intensity. Dubbed the photoelectric effect, this anomaly in the interaction of light with matter did not fit Maxwell's theory. For two decades it remained a mystery.

Maxwell had answered important questions about light, but others remained. The equations say that electromagnetic waves need no medium, that they travel in empty space at the speed of light, *c*, but the equations are silent on the frame of reference. In 1895 16-year-old Albert Einstein wondered what he would observe if he rode on a beam of light. Intuition said that Einstein's light-wave surfer should observe a stationary crest of the electromagnetic wave. But Maxwell's equations insist that electromagnetic waves travel at speed *c* even from the surfer's perspective! This paradox, like all paradoxes, suggested that the question should be restated.

Einstein held the question in his mind for 10 years. Then the 26-year-old Einstein wrote "On the Electrodynamics of Moving Bodies," noting that "Maxwell's electrodynamics—as usually understood at the present—when applied to moving bodies, leads to asymmetries that do not seem to be inherent in the phenomena."[20]

The relative motion between a magnet and a coil of conducting wire illustrates the issue. Whatever the reference frame, the relative motion results in a force on the charge carriers, driving an electric current in the coil. An observer aboard the coil sees a changing magnetic flux as the magnet sweeps by. Faraday's law says an electric field **E** gets induced in the coil, producing the force $q\mathbf{E}$ on the charges. An observer aboard the magnet sees a different picture. The coil sweeps by with velocity **v**, carrying the charged particles through the magnetic field **B**. Each charge q feels the force $q\mathbf{v}\times\mathbf{B}$. Thus do distinct mechanisms describe the same result, an asymmetry in the *explanation* not inherent in the *phenomena*. Einstein wondered what principle would unify the two explanations.

The thought experiment about light surfing suggested a clue in light itself. If you ride on the beam of light that bounces off a clock at 10:00 am, then you stay with the information that says the time is 10 o'clock.[21] For the light-wave surfer, time stands still. Newtonian relativity of inertial frames postulates the separate invariance of length and time intervals; as a consequence, the speed of light must be relative. Einstein replaced those assumptions with the postulate of the invariance of the speed of light between inertial frames, which requires space and time intervals to be relative. Mechanics had to adapt to light, instead of the light adapting to mechanics.

Special relativity, which linked light to space and time, also linked light to mass and energy. Energy and momentum became the time and space components of a vector in four-dimensional space-time. Its geometry was not Euclidean but hyperbolic. The square of the energy–momentum four-vector was given by a difference, not a sum, with the particle's mass as the vector's magnitude. For a free particle, $E^2 - (pc)^2 = (mc^2)^2$.

Thermodynamics and Quantum Physics

"By 1906 or 1908 Planck had come to see that his compromise over cavity radiation had loosed something brand new and menacing into the world of physics." –J.L. Heilbron [22]

The thermodynamics of light motivated the extension of Newtonian mechanics to quantum mechanics. Macroscopic thermodynamics serves as a boundary condition on microscopic statistical mechanics. After many triumphs with engines and phase changes and the kinetic theory of gases, statistical thermodynamics confronted the question of finding the energy density of light as a function of frequency. Light and matter in thermal equilibrium was produced in the laboratory by a metal box held at temperature *T*. The atoms in the box walls are made of oscillating charged particles and radiate light. According to Newtonian mechanics, the energy of a harmonic oscillator is proportional to the frequency squared. The sum over all microscopic states, a procedure required by statistical mechanics, thus predicts an energy density that diverges as frequency cubed, the "ultraviolet catastrophe." Although the experimental spectrum of light in thermal equilibrium with matter goes as the frequency cubed at low frequencies, as the frequency increases the distribution mapped by data reaches a peak and then slides toward zero at the highest frequencies.

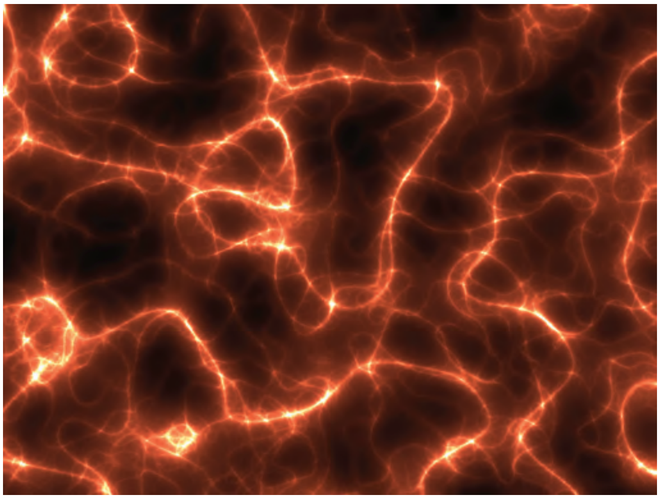


Photo courtesy of www.thepublicdomain.net.

Max Planck realized that the predicted distribution function could be made to peak and trail off at high frequencies if the energy of an oscillator of frequency f was linear in f and exhibited only a harmonic series of discrete overtones, so that $E_n = nhf$, where $n = 0,1,2,3, \ldots$ with h a constant to be fit to data. The distribution function that resulted had the right shape, whatever the value of Planck's constant h. It fit the data precisely if h had the astonishingly small value 6.6×10^{-34} J$\cdot$s. Planck had solved this important problem, but at the price of making an *ad hoc* hypothesis about energy quantization, a drastic move which at the time pointed to nothing else.

Five years after Planck's hypothesis Einstein revisited the thermodynamics of light. He calculated the entropy of radiation and compared the result to the entropy of a box filled with ideal gas molecules. Then came the heretical punch line. The entropy of the radiation matches the entropy of the molecules, said Einstein, if a light wave of frequency f corresponds to a swarm of particles, each carrying energy $E = hf$. According to Einstein, light itself is quantized. He showed how this corpuscle interpretation of light solved outstanding mysteries in the interaction of matter and radiation. Most famously, the photoelectric effect made sense as a collision between a light corpuscle and an electron if Einstein's h has the same value as Planck's h. Planck's constant h pointed to something deep.[23] The name of the light corpuscle, the photon, came years later, in 1926.[24]

With the concept of the photon in mind, one can look again to special relativity, which requires any particle moving at the speed of light to carry zero mass. With zero mass, the energy–momentum relation for a photon simplifies to $E = pc$. Together with $E = hf$ and $c = \lambda f$, it follows that a light wave of wavelength λ corresponds to a swarm of photons, each carrying momentum $p = h/\lambda$. This idea, rigorous for massless particles, was boldly postulated by Louis de Broglie in 1924 to hold for massive particles too. Thus did the thermodynamics of light—along with spectroscopy's stained-glass window into the atom—lead the way into quantum mechanics.

General Relativity

"Another important consequence of the theory, which can be tested experimentally, has to do with the path of rays of light . . . We can therefore draw the conclusion from this, that a ray of light passing near a large mass is deflected . . . The existence of this deflection, which amounts to 1.7 . . . was confirmed, with remarkable accuracy, by the English Solar Eclipse Expedition in 1919. . . ." –Albert Einstein [25]

Between 1905 and 1915 Einstein extended special relativity to arbitrarily accelerated frames. Thanks to the principle of the equivalence of gravitational and inertial mass, general relativity serves as a theory of gravitation. Early tests of general relativity checked its predictions for the behavior of light, including the deflection of a light ray grazing the sun, gravitational redshift, and radar echo delay.

David Hilbert realized that Einstein's gravitational field equations could be derived in analogy to Fermat's principle: Of all the possible trajectories that a particle might follow between two events in space-time, the trajectory actually followed maximizes the particle's proper time for the trip. In the limiting case of a particle moving slowly in a weak gravitational field, this "Fermat's principle for gravity" reduces to Hamilton's principle of classical mechanics.

Newtonian cosmology had originally envisioned a static, everlasting, infinite universe. However, the Newtonian universe was unstable and paradoxical—how could a universe filled to infinity with stars show a dark sky at night (Olbers' paradox)? In 1917, with his new tool expressing gravitation as the curvature of space-time, Einstein solved the cosmological problem at infinity by abolishing infinity. He postulated the three-dimensional universe to be the surface of a static sphere embedded in four-dimensional Euclidean space. Alexander Friedmann and Georges Lemaître asked why the universe must be static. Their equations predicted a universe in which space could contract or stretch to show a velocity–distance relation. At the cosmic scale the relative speed of two points would be proportional to their separation.

Measuring astronomical distances requires the light of standard candles. Henrietta Swan Leavitt provided crucial candles in 1912 when she discovered a relationship between the periods and luminosities of Cepheid variable stars. Edwin Hubble used Cepheids in 1924 to probe distances to spiral nebulae, which turned out to be millions of light-years away. The universe suddenly became very big. By applying the Cepheid distance indicators and Doppler shifts to the spectra of galaxies, in 1929 he offered the first evidence for the cosmic velocity–distance relation. The journey toward big-bang cosmology was underway.

In a universe that begins in the big-bang scenario, after the primordial gas of relativistic particles cools sufficiently for atoms to form, an afterglow of photons must remain. The wavelengths of those photons are continuously stretched by the cosmic expansion. In 1948 the existence in our universe of this background radiation was predicted by Ralph Alpher and Robert Hermann. Their first estimate placed its temperature today near 5 K. Alpher and Hermann tried throughout the 1950s to convince radio astronomers to look for the afterglow.[26] In 1964 it was accidently found by Arno Penzias and Robert Wilson. Their measurements gave a temperature of 2.7 K.[27] Ever since, it has offered a window into the genesis of the universe.

Today light has become the most incisive of tools in cosmology. Precision measurements of the cosmic afterglow of the big bang heralded the era of precision cosmology; the harmonics in the afterglow's power spectrum offer a kind of electrocardiogram for the early universe. The irony of our present state of fertile ignorance is that the greatest mysteries at present are not about the existence of light, but its absence: dark matter and dark energy. Could dark energy be our aether?

Quantum Electrodynamics and Beyond

"The diagrams we make of quarks exchanging gluons are very similar to the pictures we draw for electrons exchanging photons. So similar, in fact, that you might say that the physicists have no imagination—that they just copied the theory of quantum electrodynamics for the strong interactions! And you're right: that's what we did, but with a little twist." –Richard Feynman [28]

In the mid-1920s, quantum mechanics developed into the form now taught to physics majors. But it took two more decades to reconcile quantum mechanics with electrodynamics. An electron is not an ideal point charge. The "total" electron includes its ideal "bare" charge plus the interactions of the electron with its own electromagnetic field. An electron emits and reabsorbs photons, and some of those photons briefly turn into electron–positron pairs that combine back into a photon before returning to the original electron. The energy budget for producing these virtual particles comes from the energy fuzziness inherent in the Heisenberg uncertainty principle. Thus what we see as "the electron" in the laboratory includes a cloud of virtual photons and electron–positron pairs. This is a serious problem because these intermediate processes contribute infinity to the quantum state!

The remedy is "renormalization." A theory is said to be renormalizable when all divergent pieces cancel out each other in perturbation theory, leaving as a residue the observed charge and mass. According to our present understanding, renormalizability presents a necessary condition for any sensible theory of fundamental interactions.

Quantum electrodynamics—the interaction of light with electrically charged matter—was the first renormalizable theory of elementary particle interactions. It serves as the template for the other theories of elementary particle physics.[29] At its foundation stands a principle of least action, adapted to quantum field theory, that traces its inspiration back through the analogous principles of Hamilton and Fermat.[30]

***

From quarks to cosmology, light has been a tool, a model, and an inspiration to all of physics. Light has also been a metaphorical symbol of hope and wisdom in all cultures. The Hindu four-day festival of lights, Diwali, celebrates the triumph of knowledge over ignorance, hope over darkness. In the Book of Genesis, the "poem of the dawn" in the Judeo-Christian mythos, God speaks the universe into existence by uttering "Let there be light." In Buddhism one seeks enlightenment, the lights of wisdom and compassion. Let 2015, the Year of Light, be a celebration of knowledge and wisdom overcoming poverty and ignorance.[31] Physics and its technological applications have essential roles in achieving these ends. May we use them wisely and in the service of all that lives. May the secular world of physics help us find "our place among the infinities" in a festival of light.

Acknowledgments

I thank Devin Powell, Kendra Redmond, and Daniel Golombek for suggestions that resulted in an improved manuscript.

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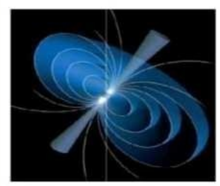
13th International Symposium on Radiation Physics

The Beijing Convention Center
September 7-13, Beijing, China



The 13th International Symposium on Radiation Physics (ISRP-13), which will be held in **September 7-13, 2015, at the Beijing Convention Center, Beijing, China**.

The ISRP-13 will feature the current trends in the broad area of radiation physics and will bring together foremost scientists and researchers from around the world for this event. This conference will include two categories of invited talks. The first one is expected to be a review of a specific area, covering the historical development, the current situation and future perspectives within both experimental and theoretical aspects. The second will deal with the hot topics and projects in the Radiation Physics Area.


For up to date information, visit http://isrp13.ustc.edu.cn or contact the Conference Coordinator list below.

Important Dates

Abstract submission: **Jul.1, 2015**
Notification of accepted oral and poster presentations: **Aug 1, 2015**
Early Bird Registration : **July 7, 2015**

Conference Location

The Beijing Convention Center,
No.8 Beichendong Road,
Chaoyang District, Beijing, China

Conference Chair:

Prof. Ziyu Wu

Co-chair: Prof. Guoqing Xiao

Conference Coordinator

Dr. W.S. Chu,
Email: isrp13@ustc.edu.cn or chuws@ustc.edu.cn

中国科学技术大学
University of Science and Technology of China

中国科学院高能物理研究所
Institute of High Energy Physics Chinese Academy of Sciences

In Memory of Professor Ziyu Wu

Ziyu Wu,
Professor,
August 1956 - March 23, 2015

It is with sadness that I report on the passing of Professor Ziyu Wu, a good friend and colleague, of terminal cancer at the age of 58. He was a Vice-President (North-East Asia) of our Society, and was the Chair of the coming International Symposium on Radiation Physics (ISRP-13) in Beijing.

Accordingly, the Symposium will be dedicated to the memory of Dr. Wu.

It was excellent to have ZiYu and ZhiYun Pan and their large group of students and staff visit Australia and Melbourne for ISRP-11 in 2009, and to see his earlier connections and strong research with Italy and Elettra bloom into a strong and vigorous Chinese community of excellent research and indeed advanced synchrotron facilities.

He graduated from the Department of Physics, University of Science and Technology of China (USTC) in 1982 and got his MS degree in 1985 and Ph.D degree in 1988. He did research as postdoc at the Italian Academy for Advanced Study during 1988 – 1989. After 1990, he worked respectively at Laboratori Nazionali di Frascati of INFN (Italy), Stanford University (USA), Center for Scientific Research (France), Bayreuth Geophysics Institute (Germany) and the French Atomic Energy Commission as researcher, guest researcher or part-time researcher.

He was a great scientist, a great politician and a great ambassador for China and Chinese research. He was until recently director and chief scientist of the National Synchrotron Radiation Laboratory of the USTC. He was a winner of the CAS Hundred Talents Program and of the National Natural Science Funds for Distinguished Young and National Brought-in Experts by the Ministry of Personnel. He was a member of the Executive Committee of the International Society of X-ray Absorption Spectroscopy—IXAS, a vice president of the International Radiation Physics Society—IRPS, member of the International advisory committee of Vacuum Ultraviolet and X-Ray Physics-VUVX and Science Advisor of the American Xradia company.

His research was mainly devoted to developing new theories and methods for synchrotron radiation applications, in particular to characterize the electronic state and the atomic structure of metallo-proteins, nano-(composite) materials, energy related materials, transition metal compounds and amorphous systems. He also developed new high-resolution phase contrast CT imaging methods and was committed to promoting the development and innovation of synchrotron radiation applications and cutting-edge scientific research. Such activity creates new research areas and has already made significant creative achievements in related fields, improving the overall research level of the associated disciplines and pushing at the same time high-level crossover studies. He was responsible for and coordinated several national major projects including strategic projects of the National Natural Science Foundation, the National Major Equipment Development Project of the Ministry of Finance, the CAS Knowledge Innovation Project, the 985 Project of the Ministry of Education, and projects of the National Natural Science Funds for Distinguished Young Scientists. He was invited to present reports to many international conferences and meetings. He published over 200 publications in international journals such as Nature, Science, PNAS, JACS, Phys. Rev. Lett., Chem. Commun., Chem. Mater., Carbon and PRB., with total citations of more

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than 2000. He is the holder of four Chinese patents and 2 USA patents with 1 additional patent in China and 1 in Europe pending. He chaired the 1st, 2nd and 3rd International Conference on Synchrotron Radiation Imaging, and was appointed as chairman of the 15th International Synchrotron radiation XAFS Conference held in Beijing in 2012; he was also chairman of the 38th International Conference on Vacuum Ultraviolet and X-ray Physics Synchrotron Radiation in Hefei in 2013, and chairman of the 11th International Conference on X-ray Microscopy in Shanghai in 2012.

We are sorry for his loss and our prayers and best wishes are for his family and the Chinese community.

Christopher Chantler, for the IRPS Council

http://www.aps.org/publications/apsnews/201501/stories.cfm

Top Ten Physics News Stories in 2014

Every year, APS News looks back to see which physics news stories grabbed the attention of the public. This list is not necessarily a compilation of the most important advances or discoveries of the year, but rather the ones that seemed to garner the most headlines and column-inches. In (roughly) chronological order, the top ten physics stories of 2014 were:

Fusion Milestone
Physicists at Lawrence Livermore National Laboratory announced in **February** that they reached an important milestone: At the National Ignition Facility, 192 simultaneous laser pulses blasted tiny hydrogen pellets, and the resulting fusion reactions emitted slightly more energy than was initially absorbed — a key first step in inertial confinement fusion. However, there is still a long way to go before the machine produces a net gain in energy, since the pellets absorbed only a small fraction of the incoming laser energy.

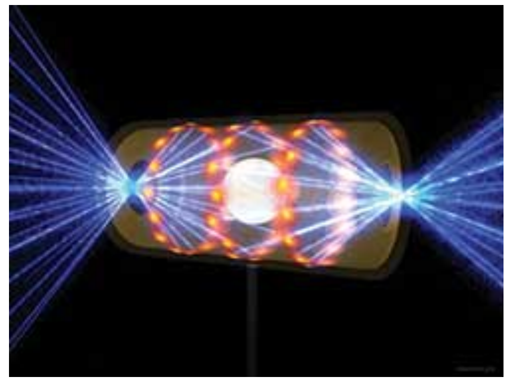

Photo: LLNL

Fusion first step

BICEP2
In **March** the scientific team behind the BICEP2 telescope at the South Pole made the sensational announcement that they had seen the first evidence of "B-mode" polarization in the cosmic microwave background (CMB) radiation. At the time it was held up as "the smoking gun" for evidence of gravitational waves left over from a period of rapid inflation in the early universe. However, soon after the announcement, doubts about the data started to emerge, and it was unclear if the team could definitively rule out the effect of cosmic dust. In the resulting scientific paper, published in **June**, the team acknowledged that dust may have affected the observations, but nevertheless they still felt the gravitational wave signal was real. In **September** a new report from the ESA's Planck satellite reinforced concerns about the initial results, but the two teams are continuing to work together to resolve the discrepancies. Also in **December**, independent of the BICEP2 research, Planck's team announced that they had finished processing the data from the satellite's four-year run and had created the most detailed map of the CMB.

Photo: Steffen Richter/Harvard

BICEP2 searches for inflation

Intergalactic Neutrinos
In 2013, the IceCube neutrino detector at the South Pole observed additional highly energetic neutrinos, which provided further evidence of neutrinos from outside our galaxy. A new event announced in **April**, dubbed "Big Bird," unseated the reigning champs "Bert" and "Ernie." At more than two petaelectronvolts, it's twice as energetic as the previous record-holders, but because it's not anything like an order of magnitude greater, investigators think that they might be close to seeing the upper limit of cosmic neutrino energies.

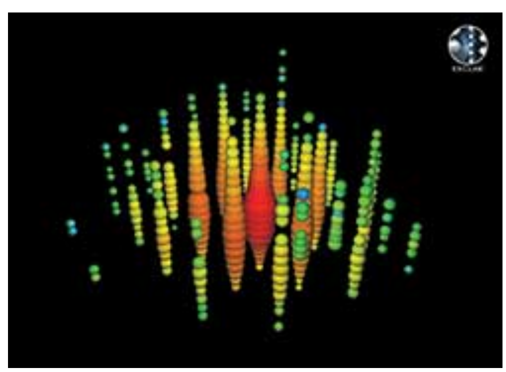

Photo: IceCube Collaboration

IceCube's big find

Physics in Movies

2014 was a blockbuster year for science on film and TV. Premiering in **March**, Neil deGrasse Tyson's highly anticipated follow-up to Carl Sagan's TV series *Cosmos* captivated audiences and took them on a journey into the universe. Also in **March**, the documentary *Particle Fever* was released across the country, offering an intimate look at the lives of CERN's researchers hunting for the Higgs Boson. The life of Stephen Hawking got the Hollywood treatment in the critically acclaimed film The Theory of Everything, as did mathematician Alan Turning in The Imitation Game. After years of development, the film Interstellar hit the big screen. Inspired by physicist Kip Thorne's theories of gravitation and relativity, it wowed audiences with its impressive visuals of black holes and time dilation.

Element 117

Ununseptium, the placeholder name for element 117, was spotted for an instant in Germany in **May**. At the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, scientists bombarded a berkelium target with accelerated calcium atoms to create the short-lived artificial element. This follows up on an experiment in Russia in 2010 that first created the element, confirming its existence and likely paving the way for its official inclusion on the periodic table of the elements. In addition, one of the isotopes of lawrencium discovered in the process had a half-life of nearly eleven hours, giving physicists hope that experiments might be bringing them close to the hypothesized shores of the "Island of Stability" for super-heavy elements.

Galactic Black Hole

In 2012, astronomers discovered a mysterious massive object falling towards the giant black hole at the center of the Milky Way galaxy. They predicted that its observed elliptical orbit would bring it closest to the black hole around **mid-summer** and were primed to watch the predicted fireworks of the object being ripped apart. Instead, it was more of a fizzle. Originally thought to be a giant gas cloud, the object might actually harbor a large star in its center, which would have held the cloud together in the face of the enormous gravitational tidal forces. Based on its trajectory, there's a chance that in a few decades the hypothetical star will pass through the dust and gas surrounding the black hole, and maybe then scientists will witness the show they had hoped for.

Ebola's Potential Spread

As the Ebola virus ravaged West Africa, researchers worried about its potential spread started mapping its transmission. Physicist Alessandro Vespignani of Northeastern University used computer models to simulate the movement of people throughout the world and the ways the disease might spread. His dire conclusion in **August** was that if nothing was done, tens of thousands of people could be infected within months. Fortunately, a lot is being done to combat the outbreak, which according to the Centers for Disease Control so far has resulted in just over 6000 deaths.

Nobel Prizes

Without winning the Nobel prize in their own field, physicists did well in **October** anyway. The physics prize went to two engineers and a materials scientist, one from the United States and two from Japan, for their work developing the blue light emitting diode. After the quick invention of the red and green LED, an efficient blue device took nearly twenty years to produce. The following day, physicists from the United States and Germany won the chemistry prize for the development of super-resolved fluorescence microscopy, which pushed the limits of optical microscopy down to the nanoscale.

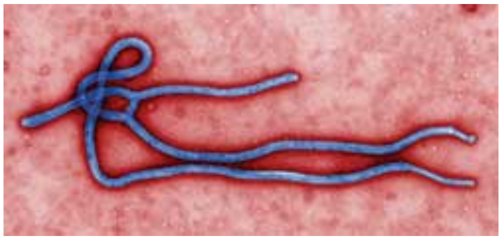

Photo: CDC

Ebola virus

Photo: NSF

Nobel prizes for blue LEDs

Space Exploration

This fall, interplanetary exploration was a central focus of the world's space agencies. In **October**, India made headlines by successfully placing a small satellite into Martian orbit, only the fourth space agency to do so and more cheaply than any other Mars mission to date. On November 12, the European Space Agency's Rosetta space probe dropped the its tiny Philae lander onto the surface of the comet 67P/Churyumov-Gerasimenko, but its operational life was cut short after the lander bounced off its planned landing zone into a shady crater. Without functioning solar panels, the reserve battery discharged, but not before the lander carried out 80 to 90 percent of its scientific mission. This included a startling discovery announced in December that the isotopic content of the comet's water molecules didn't match that on Earth, rekindling questions about where our planet's water originated. Also in December, NASA successfully launched a prototype of Orion, its new spacecraft designed to take astronauts into Earth orbit and beyond.

Tabletop Accelerator

In **December**, scientists at Lawrence Berkeley National Lab announced a new world record for a compact particle accelerator. The team used a tabletop-sized laser-plasma accelerator to energize electrons up to 4.25 GeV. Though not nearly as powerful as the massive LHC, the tiny BELLA accelerator can do in about one meter what would take CERN 1,000 meters. Physicists hope that this emerging compact accelerator technology will pave the way to new generations of particle colliders.

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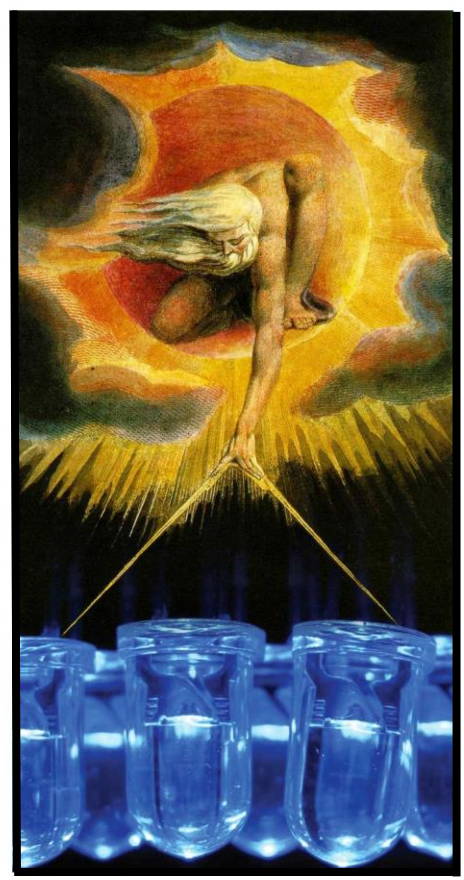

Conferences - 2015

11 – 14 April, 2015 **ICRPA-1**

The First International Conference on Radiation Physics and Its Applications

Alexandria, Egypt

The Radiation Physics Group, Physics Department, Faculty of Science, Alexandria University, Alexandria, Egypt in cooperation with the National Network of Radiation Physics of Egyptian Atomic Energy Authority and IRPA-Egypt cordially invites you to attend The First International Conference on Radiation Physics and Its Applications.

The conference offers a valuable opportunity for specialists in radiation physics, protection and medical physics to meet others and discuss all aspects of the use of ionizing and non-ionizing radiations in order to help the community to accompany the important advances in the use of radiation physics and its applications currently in a phase of rapid growth and change.

Deadline for submission of Abstracts : 31 March, 2016
One week after submission : notification of the abstract acceptance.
The peer reviewed, accepted papers, will be published in a special issue of J.Taibh.Univ.Sci., Elsevier Publisher. (www.elsevier.com/JTUSCI/)

Contacts : Prof. Mahmoud Ibrahim Abbas , Conference Co-ordinator
Phone : 002 01227431429 *Email :* mahmoud.abbas@alexu.edu.eg

Prof. Mohamed Ahmed Gomaa , Atomic Energy Authority
Phone : 002 01001457161 *Email :* radmedphys@yahoo.com

27 – 29 May, 2015 **NUCLEAR 2015**

8th International Conference on Sustainable Development through Nuclear Research and Education

Institute for Nuclear Research, Pitesti, Romania

Nuclear 2015 intends to bring together a large representation of nuclear research and industry, academia and energy policy makers from all over the world, to address the major concerns and challenges in nuclear energy in the context framed by national and international priorities.

Nuclear 2015 is a three-day meeting consisting of plenary sessions, topical sessions, poster presentations and a technical visit of ICN facilities (TRIGA Research Reactor, Hot Cells and Material Testing Laboratories).

The conference will award the best three papers presented by young researchers.
The most original and valuable papers will be published in
Journal of Nuclear Research and Development - www.jnrd-nuclear.ro.

The NUCLEAR 2015 Organizing Committee looks forward to your participation and appreciates your valuable scientific contribution in order to enhance our effort to keep the NUCLEAR Conference on the world agenda as a significant scientific event for the sustainable development through nuclear research and education.

Important Deadline

April 30, 2015 - Full papers submission
For more information regarding this Conference, please contact :*daniela.diaconu@nuclear.ro*
Registration, abstract and full paper should be submitted at : *conference@nuclear.ro*
Registration Form is available on : *http://www.nuclear.ro*

11th INTERNATIONAL CONFERENCE OF NUCLEAR SCIENCES AND APPLICATIONS

and

SECOND IRPA-EGYPT RADIATION PROTECTION WORKSHOP

20 – 24 February, 2016

Hurghada, Red Sea, Egypt

The Egyptian Society of Nuclear Sciences and Applications (ESNSA) organizes an international conference every four years that deals with current research activities in the field of nuclear sciences and applications. The conference aims at providing a forum for exchanging knowledge in the interdisciplinary fields of nuclear sciences and their applications.

The Egyptian Atomic Energy Authority cooperates with ESNSA in the execution of the present conference.

IRPA-Egypt of ESNSA is a member of IRPA International as Associate Society.

First IRPA-Egypt workshop was organized in 2007. The Second IRPA workshop will be held within the activity of the conference. Radiation protection, nuclear safety, regulatory experts are invited to participate in the second IRPA-Egypt workshop.

Further information on the following pages

Second Announcement

11th INTERNATIONAL CONFERENCE OF NUCLEAR SCIENCES AND APPLICATIONS

And
Second IRPA-EGYPT Radiation Protection Workshop

The Egyptian Society of Nuclear Sciences and Applications (ESNSA)
Member of the International Nuclear Societies Council (INSC)

The Egyptian Atomic Energy Authority (EAEA)
February(20-24), 2016
Hurghada,Red Sea, Egypt,
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ORGANIZED By

REGISTRATION FORM

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Name of Participant:

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Oral presentation ☐ **Poster Presentation** ☐

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- Nuclear Basic Sciences
- Radiation Basic Sciences & Technology
- Power & Research ReactorApplications
- Isotopes production and Accelerator Applications
- Nuclear Analytical Techniques
- Material Sciences & Technology
- Nano Technology&Nuclear Materials
- Non Destructive Testing
- Radiation and Nuclear Technology in Industry
- Radiation Sciences in Medicine , Biology and Agriculture
- Environmental Research, NORM, etc.
- Archeological Applications
- Heavy and Super Heavy Elements
- Non ionizing radiation & Applications

Workshop Topics

Radiation Protection &dosimetry
Shielding of medical, industrial,nuclear facilities and nuclear and radiation emergencies
Nuclear and Radiation inspection &Control
NuclearSecurity and Radiation Regulations
Education and Training

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PUBLICATION

Papers will berefereed and published in a special issue of the "Arab Journal of Nuclear Sciences and Applications".

*Abstracts of scientific contributions to be submitted before the first of May2015.

* The complete manuscript to be submitted before the end ofOctober2015, written according to the periodical instructions ;http://www.esnsa-eg.com

INVITATION

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The scientific activities of the conference will include keynote presentations by international and national recognized scientists to highlight recent progress in nuclear sciences, as well as contributed papers dealing with the on-going research. Issues of public concern, human health, the environment, developmental programs will be addressed, and the promotion of peaceful applications of nuclear sciences using nuclear techniques. The conference sessions will also include panel discussions, technical presentations on certain nuclear applicationsin Archeology as well as Rad. Prot. Workshop.

REGISTRATION FEES

Registration fees cover full accommodation(double room)* during Conf. period, Conf. documents and transportation(Cairo-Hurghada-Cairo).

700 Euro For NonResident Participants.

1750 L.E For Egyptian ESNSA Members.

1800 L.E For Non- ESNSA Members.

*Extra charges for single room accommodation.

Registration Fees are payable to:

"Conference of Nuclear Sciences and Applications. Account No: 12200100029021 Bank Misr, Garden City Branch".

CORRESPONDENCE

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Hurghada, Red Sea, Egypt,
Sonesta Pharaoh Beach Resort 5*

2nd International Conference on Dosimetry and its Applications (ICDA-2)

3 – 8 July, 2016

University of Surrey, Guildford, United Kingdom

Web site : http://www.surrey.ac.uk/physics/index.htm

Scope

Together with various institutions all over the world, the International Radiation Physics Society (IRPS) co-organises International Symposia on Radiation Physics (the ISRP series) and Topical Meetings on Industrial Radiation and Radioisotope Measurement Applications (the IRRMA series), both as triennial events. The aim is to bring together scientists and engineers from around the world who share an interest in measurement and applications of ionising radiation. Covering the one year gap between these two scientific events, the IRPS also sponsors a triennial series of conferences devoted to current trends and potential future issues in ionising radiation dosimetry (the ICDA series). The scientific sessions of ICDA-2 will include invited lectures by leading experts in the field, contributed oral papers and poster presentations of contributed papers. Participants to ICDA-2 will have an opportunity to share ideas on all theoretical and experimental aspects of dosimetry, and on its applications in radiation protection, radioactivity within the environment and workplace, medical applications of ionizing radiation and other fields of human activity, including fundamental nuclear structure and decay physics research.

Topics

A. Basic Concepts and Principles in Dosimetry
B. Personnel Dosimetry
C. Accident and High-Dose Dosimetry
D. Environmental Radioactivity Measurement and Monitoring
E. Dosimetry & Measurement in Medicine and Biology
F. Dosimetry & Measurement in the Nuclear Industry and at Accelerators
G. Standardization and Intercomparison in Dosimetry
H. Monte Carlo Calculations in Dosimetry and Radiation Measurement
I. Novel Developments in Nuclear and Radiation Spectrometry
J. Nuclear Data and Evaluation

Further information :

Please visit the Venue and Accommodation page
(http://www.surrey.ac.uk/physics/news/events/icda-2/venue/index.htm)
for more information about the Conference location, or visit the registration and submission page
(http://www.surrey.ac.uk/physics/news/events/icda-2/registration/index.htm)
for details of how to submit an abstract and register for the conferenc

Calendar - 2015

11 – 14 April **ICRPA-1**

The First International Conference on Radiation Physics and Its Applications

Alexandria, Egypt

Further information on page 19 of this Bulletin

Contacts : **Prof. Mahmoud Ibrahim Abbas , Conference Co-ordinator**
Phone : **002 01227431429** ***Email :*** **mahmoud.abbas@alexu.edu.eg**

Prof. Mohamed Ahmed Gomaa , Atomic Energy Authority
Phone : **002 01001457161** ***Email :*** **radmedphys@yahoo.com**

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27 – 29 May **NUCLEAR 2015**

8th International Conference on Sustainable Development through Nuclear Research and Education

Institute for Nuclear Research, Pitesti, Romania

Full information on page 19 of this Bulletin

Contact : daniela.diaconu@nuclear.ro

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14 – 20 June **CRETE -15**

The 2015 International Conference on Applications of Nuclear Techniques

Crete, Greece

Full information on page 33 of the December, 2014 Bulletin

Contact : ***Email : info@crete15.org*** ***Website : www.crete15.org***

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7 – 13 September **ISRP-13**

13th International Symposium on Radiation Physics

Beijing, P.R. China

Information on page 13 of this Bulletin

and Ballot Paper on page 14

Contact : Conference Chairman, Professor W.S. Chu

Email : **isrp13@ustc.edu.cn** ***or*** **chuws@ustc.edu.cn**

.../ 2016 Calendar

Calendar - 2016

20 – 24 February, 2016

11th International Conference of Nuclear Sciences and Applications and Second IRPA-Egypt Radiation Protection Workshop

Hurghada, Red Sea, Egypt

Full information on pages 20-22 of this Bulletin

Conference Contact : Prof Abdel-Fattah I. Helal ***Email : aihelal@yahoo.com***

Workshop Contact : Prof. M.A.M. Gomaa ***Email : radmedphys@yahoo.com***

Website : **http;://www.esnsa-eg.com**

3 – 8 July, 2016

ICDA-2

2nd International Conference on Dosimetry and its Applications

University of Surrey, Guildford, UK.

Further information on page 23 of this Bulletin

Website : **http://www.surrey.ac.uk/physics/index.htm**

INTERNATIONAL RADIATION PHYSICS SOCIETY

The primary objective of the International Radiation Physics Society (IRPS) is to promote the global exchange and integration of scientific information pertaining to the interdisciplinary subject of radiation physics, including the promotion of (i) theoretical and **experimental research in radiation physics,** (ii) investigation of physical aspects of interactions of radiations with living systems, (iii) education in radiation physics, and (iv) utilization of radiations for peaceful purposes.

The Constitution of the IRPS defines Radiation Physics as "the branch of science which deals with the physical aspects of interactions of radiations (both electromagnetic and particulate) with matter." It thus differs in emphasis both from atomic and nuclear physics and from radiation biology and medicine, instead focusing on the radiations.

The International Radiation Physics Society (IRPS) was founded in 1985 in Ferrara, Italy at the 3rd International Symposium on Radiation Physics (ISRP-3, 1985), following Symposia in Calcutta, India (ISRP-1, 1974) and in Penang, Malaysia (ISRP-2, 1982). Further Symposia have been held in Sao Paulo, Brazil (ISRP-4, 1988), Dubrovnik, Croatia (ISRP-5, 1991) Rabat, Morocco (1SRP-6, 1994), Jaipur, India (ISRP-7 1997), Prague, Czech Republic (ISRP-8, 2000), Cape Town, South Africa (ISRP-9, 2003), Coimbra, Portugal(ISRP-10, 2006), Australia (ISRP-11, 2009) and ISRP-12 in Rio de Janiero, Brazil in 2012. The IRPS also sponsors regional Radiation Physics Symposia.

The **IRPS Bulletin** is published quarterly and sent to all IRPS members.

The IRPS Secretariat is : Prof. Jorge E Fernandez (IRPS Secretary),
Universita di Bologna, Laboratorio di Ingegneria Nucleare di Montecuccolino
I-40136 Bologna, Italy
Phone : +39 051 2087 718 *Fax:* +39 051 2087 747
email: jorge.fernandez@unibo.it

The IRPS welcomes your participation in this "global radiation physics family."

INTERNATIONAL RADIATION PHYSICS SOCIETY

Membership Registration Form

1. Name : ____
(First) (Initial) (Last)

2. Date and Place of Birth : ______________________________________

3. Business Address : ______________________________________

____
(Post Code) (Country)

Telephone:________________ Email: ____________________ Fax: ____________

4. Current Title or Academic Rank (Please also indicate if Miss, Mrs., or Ms.): ______________

5. Field(s) of interest in Radiation Physics (Please attach a list of your publications, if any, in the field:

____

____

6. Please list any national or international organization(s) involved in one or more branches of Radiation Physics, of which you are a member, also your status (e.g., student member, member, fellow, emeritus):

____

../Continued

7. The IRPS has no entrance fee requirement, only triennial (3-year) membership dues. In view of the IRPS unusually low-cost dues, the one-year dues option has been eliminated (by Council action October 1996), commencing January 1, 1997. Also, dues periods will henceforth be by calendar years, to allow annual dues notices. For new members joining prior to July 1 in a given year, their memberships will be considered to be effective January 1 of that year, otherwise January 1 of the following year. For current members, their dues anniversary dates have been similarly shifted to January 1.

Membership dues (stated in US dollars - circle equivalent-amount sent):

Full Voting Member: 3 years	**Student Member: 3 years**
Developed country $75.00	Developed country $25.00
Developing country $30.00	Developing country $10.00

Acceptable modes of IRPS membership dues payment, to start or to continue IRPS membership, are listed below. Please check payment-mode used, enter amount (in currency-type used), and follow instructions in item 8 below. (For currency conversion, please consult newspaper financial pages, at the time of payment). All cheques should be made payable to :

International Radiation Physics Society.

(For payments via credit card - http://www.irps.net/registration.html)

[ ] *(in U.S. dollars, drawn on a U.S. bank)*: Send to Dr W.L. Dunn, Dept. Mechanical and Nuclear Engineering, Kansas State University, 3002 Rathbone Hall, Manhattan, KS, 66506-5205. U.S.A.
Amount paid (in U.S. dollars) ____________________

[ ] *(in U.K. pounds):* Send to Prof. Malcolm J. Cooper, Physics Dept., University of Warwick, Coventry, CV4 7AL, U.K.. Bank transfer details:
Account number: 30330701. Bank and Branch code: Barclays, code 20-23-55.
Eurochecks in U.K. pounds, sent to Prof. Cooper, also acceptable.
Amount paid (in U.K. pounds) ____________________

8. Send this Membership Registration Form ***AND*** a copy of your bank transfer receipt (or copy of your cheque) to the Membership Co-ordinator:

Dr Elaine Ryan
Department of Radiation Sciences
University of Sydney
75 East Street, (P.O. Box 170)
Lidcombe, N.S.W. 1825, Australia
email: elaine.ryan@sydney.edu.au

9. ______________________________ ______________________

Signature *Date*