OutPost on the Endless Frontier©

EPRI e-News on Recent Key Developments in Energy Science and Technology
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The Gathering of the Clan

Every year, about that time when winter starts to thaw into spring, a curious human homing phenomenon occurs, akin to the swallows arrival at San Capistrano and the monarch mariposas darkening the skies of Michoacan. These humans are a special lot, very social but in a peculiar way, gathering together in tightly knit knots of intense conversation, oblivious to the immediate environment, all carrying guidebooks whose size and weight rival the Manhattan phone book, and whose pecuniary benefices (i.e., tips) bestowed on the local inhabitants of their temporary abode are invariably minimal. They are Physicists.

At these periodic "gatherings of the clan," physicists throughout the nation – and much of the world as well – assemble together to dazzle each other with the brilliance of one's discoveries made and theories deduced therefrom since the previous gathering four seasons ago. This intellectual ritual, known as the March General Meeting of the American Physical Society, moves about the country from year to year, spanning such exotic civic locales all the way from New York City to Indianapolis (I don't remember it ever being in Boston, though, at least not during my career!). The "March Meeting" is indeed an exciting event for us, the talks and symposia often the first general disclosure of new physics found and the harbinger of Nobel Prizes to come.[1]

Our 1999 convention, held at the Georgia World Congress Center in Atlanta, was an especially auspicious occasion, last year being the 100th anniversary of the founding of the American Physical Society. The meeting was extended to seven days in length to allow for special Nobel Colloquia (over 40 past winners participated), several gala events (well, "gala" at least by the usual social standards that prevail in the profession), and a broad range of accentuated outreach programs to groups as diverse as the current Federal body politic to high school science students.[2] These ranged all the way from a sometimes raucous panel discussion which included all the past presidential science advisors from Clinton to Johnson, to demonstrations of the physics of such diverse objects as the french horn and baseball bats.

I can't say this year's meeting revealed any new discoveries in energy-related physics that would have direct technical consequences for our endeavors. Nope, we're not much closer to too-cheap-to-meter fusion-derived electricity…that's still (fill in the blanks) years in the future.[3] However, there were several ancillary developments that could impact energy policy and, quite honestly, also some really neat new knowledge about our

surroundings was revealed that I think you would enjoy hearing about. Let's just call this issue of OutPost a "technical vitality" exercise.

The Big Bang – Mother of All Energy in the Universe

One of the first symposia at the meeting dealt with open problems in astrophysics, most notably in three areas:

Beyond Silicon – Moore's Law Finally Runs Into the Wall of Physics

SubSection Body

Electrifying Life – The Conductivity of DNA

SubSection Body

Surface Scars – Early Cancer Detection via Spectroscopy

SubSection Body

Southpaw Waves – The Strange World of Left-Handed Light

All you folks recall how to derive Maxwell's wave equation for the propagation of electromagnetic radiation in a vacuum (yeah, right). Some things called the "permittivity and permeability of free space" which relate "displacement currents" and "magnetic induction"(D and B) to the time dependence of the basic electric and magnetic driving fields (E and H), enter in product form whose reciprocal defines the square of the wave velocity, in this case the velocity of light, 186,000 miles/sec or about 3×10^8 m/s,[zz] constant and fixed in all reference frames according to Michelson and Einstein and that's that. However, "that's" not necessarily true in matter, where the electronic reaction to imposed electric and magnetic fields has to be taken into account.[xxx] In such cases, the velocity of light can be smaller (never greater…OK, OK, Cerenkov radiation is a special case, a consequence of relativity, not a violation of it) and vary with wavelength. That's why we can see rainbows and oil slicks and other natural phenomena like the reason diamonds are a female human's best friend.[yyy] What you probably don't remember is that under certain special situations one can obtain "negative permittivity" in a given wavelength range. A simple example is provided by a household screen upon which millimeter-scale microwave radiation impinges (ever wonder why that "window" on your kitchen microwave looks like a screen of small holes?). Under these conditions and the appropriate wavelength, the dielectric constant (permittivity) of the "effective medium" goes negative, the velocity of light becomes imaginary and the electromagnetic wave is attenuated exponentially. End of story.

Not exactly. Could one devise an "effective medium" whereby the magnetic permeability went negative? Until recently, this possibility was thought unlikely. Anyway, even if you could do it, the result would be the same as for negative permittivity

– the electromagnetic wave…light, microwaves or whatever…would simply disappear exponentially fast. Big deal.

But what if you could arrange to have both the permittivity and permeability go negative in the same given wavelength band?

Nuclear Power -- Back to the Future

A March Meeting tradition is the annual presentation of awards and prizes to honor those who have made outstanding contributions to the advancement of physics – sort of our modest equivalent to Holywood's Academy Awards. One of the "Oscars" given is the George E. Pake Award, endowed by the Xerox Corporation and named in honor of the first director of its world-famous Palo Alto Research Center.[xx] The Pake Award, bestowed in the spirit of "lifetime achievement," is given "to that physicist who best combined a career in research with industrial management and leadership." Since its inception in 1983, the Pake has gone to the leaders of the world's major industrial research institutions, e.g., Philips, BellCore, and, of course, several times to IBM and Bell Laboratories.

The 2000 winner was EPRI's Chauncey Starr, whose citation read, " get this off the web ." A more fitting recipient this last year of the 20th century would be difficult to find, wouldn't you agree? All APS prize winners are required to deliver an "acceptance speech," a plenary lecture on the subject of their award. The title of Chauncey's was "A Physicist's Journey in the World of Nuclear Power.[yy]" He began with his apprenticeship under E. O.Lawrence (there's a great photo of Chauncey at the 1939 meeting of the APS standing in the midst of Fermi, Teller, and other notables of that era), followed by his years at Oak Ridge and Atomics International. The theme throughout was the challenge presented by any large first-of-kind technology-driven project, e.g., nuclear power, and how surprisingly well physicists manage them. Emphasis was placed on the absolute necessity for openness and education of the public and the press as necessary for its success, a lesson sadly forgotten by the nuclear power industry as it matured. Chauncey concluded with a gentle prediction that nuclear power will eventually return to fill a major portion of the world's energy needs in the 21st century, even in the United States. Every physicist I know, even those committed to renewable and fusion-derived alternative energy production, admit privately that nuclear fission power makes compelling sense if and when public perception and weapons proliferation issues are resolved. But that's a subject for a future OutPost.

One invariably returns from "March Meeting Week" both mentally and physically exhausted, as well as with the deep frustration that it is impossible to satisfy one's natural bent as a physicist to get personally involved in all the "neat stuff" you just learned about. At least in the meantime I can get some satisfaction from passing the news on to you – however wait 'til next year – I guarantee it be even more interesting!

[1]An outstanding example was the 1987 meeting in New York where the world at large first heard of the discovery of high temperature superconductivity, earning the Nobel Prize for Bednorz and Mueller a short six months later. Your correspondent was fortunate to have one of the central roles at that event, whose excitement I tried to capture in a 10th anniversary retrospective, "Woodstock of Physics Revisited," published in the 13 March 1997 issue of Nature (I have an Adobe PDF reprint available – e-mail me if you'd like a copy). Incidentally, the only March Meeting I've not participated in since graduate school was due to an interference created by the birth of my last child (poor strategic planning, there). There are some personal relationship conflicts not even a physicist can avoid!

[2]For an overview of the APS Centennial Events, visit *www.aps.org/centennial*. The details of the scientific program are at *www.aps.org/meet/CENT99/BAPS*. I HIGHLY recommend stopping by *www.timeline.aps.org* to view *A Century of Physics*, a timeline panorama of physics history which coincided, not accidentally, with the emergence of the American Physical Society. The panorama will be distributed as a wallchart to all secondary school science departments in the United States.

[3]*vide* OutPost 7, "Return to Death Valley Days," archived at *www.epriweb.com/srd/outpost/outpost7.html* and pdf-downloadable.

[xx]"PARC" is EPRI's next door neighbor on Hillview Avenue. PARC is perhaps best known for inventing the "graphical user interface" as a feature of its STAR computer project, which ultimately bore fruit as Steve Wozniak's Apple Macintosh and is now found in all major workstation operating systems from Microsoft Windows 2000 to the X-Windows application supported on Unix and its derivatives.

[yy]A copy of Chauncey's talk can be found on EPRIWeb at ????