

AKPA Newsletter

재미 한인 물리학자 협회

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The current and past AKPA newsletters are found in the AKPA website: <http://www.akpa.org/>.

1. An Evening in March in Baltimore

[This is a preliminary alert. Full details will be announced in the March issue. This alert is to enable interested parties to reserve the evening of March the 15th for an exciting event in the Inner Harbor area of Baltimore.]

Each year at the March meeting of the American Physical Society's condensed matter physics, some seventy to eighty Korean physicists, materials scientists, engineers, chemists, and students attending the APS meeting would set aside one evening, usually the evening of Wednesday, and get together to share dinner and fellowship, escaping the grind of APS sessions all day for several days.

Such informal, friendly, and unstructured functions have been going on for over three decades by now, thanks largely due to selfless hard work of a handful of condensed matter physics group of Korean physicists. This year, 2006, continues, of course, this lofty tradition.

This year the March meeting will be held at the Convention Center in the Inner Harbor area of the city of Baltimore and the dinner get-together will be held at a restaurant within a walking distance from the Center. According to the preliminary schedule, the event will run from 6:00 pm to 9:00 pm. The get-together will also include two special programs, one old and the other brand new, for the first time this year.

A brief program, no more than 15 minutes, will be devoted to the presentation of the most prestigious award of AKPA, the Outstanding Young Researcher Award (OYRA). The presentation of OYRA has always taken place during such a get-together and it provides a meaningful exposure of the young selected awardees to a large gathering of Korean physicists.

A second program (this is a new undertaking this year) is an Invited Speaker's Talk. The organizers of the program wanted someone from outside of the field of physics. This year the invited speaker is Dr. Roy U.T. Kim, Professor of International Political Economy at Drexel University and a Senior Fellow of the Foreign Policy Research Institute in Philadelphia. Professor Kim will give an after-dinner talk under the title "Natural gas from Russian Far East for the benefit of North and South Korea's economic integration."

Professor Kim has visited North Korea as a member of the US Congressional delegation headed by Congressman Curt Weldon (R-PA). Professor Kim has contributed an article titled “US Intelligence Flaws on North Korea” to the Korean-American Forum in the website of the Society of Korean-American Scholars, www.skas.org, KAF, article 2006-#1.

At the conclusion of the dinner get-together, since many of the attendees are also members of AKPA, there will be a brief and short discussion of AKPA affairs. This short get-together after 9:00 pm will be attended by those affiliated with AKPA, AKPA members, the officers of AKPA, ex-Presidents and ex-officers, and anyone interested in the affairs of AKPA. Other March meeting dinner attendees are certainly excused from this function, but, of course, are welcome and are invited (maybe even slightly encouraged) to attend, if only to see what is this all about (You may be pleasantly surprised). In any case, the meeting will be rather short and brief.

As stated earlier, full details will be posted in the March issue of the AKPA Newsletter. This preliminary alert is to encourage readers to mark the date on their calendars so they can plan to attend the function for an enchanting evening of fellowship.

2. Korea's Science Hall of Fame: Benjamin Lee Inducted

Last month, the Ministry of Science and Technology announced the induction of three Korean scientists to the Science Hall of Fame of Korea. The three are: Dr. Lee Benjamin Whiso (1935-1977), a Korean-American elementary particle theorist, Dr. Jang Ki-ryeo (1920-2003), Korea's foremost liver cancer expert, and ancient sage Seo Ho-su (1736-1799), an astronomer from the late Joseon Dynasty.

Here we republish three items, a photo of Benjamin Lee, an obituary written by Steven Weinberg and Chris Quigg that appeared in PHYSICS TODAY in 1977, and an article by Moo-Young Han presented at the Centennial Conference of the Korean Immigration, 2003 that is published in the Korean-American Forum section of the SKAS homepage at www.skas.org.



이 휘 소 (李輝昭)
Benjamin W. Lee
1935-1977

Obituary by Steven Weinberg and Chris Quigg

Chris Quigg, Fermi National Accelerator Laboratory

Steven Weinberg, Harvard University

Published in *Physics Today* **30**, 76 (September 1977)

Benjamin W. Lee

Benjamin W. Lee, head of the theoretical physics department at the Fermi National Accelerator Laboratory and professor of physics at the University of Chicago, was tragically killed in an automobile accident near Kewanee, Illinois on 16 June. He was traveling to the summer meeting of the Fermilab Program Advisory Committee in Aspen, Colorado. The other members of his family who were accompanying him were not seriously injured. Lee was widely regarded as one of the world's leading physicists working on the theory of elementary particles.

Born in Seoul, Korea in 1935, Lee came to the United States as a student, receiving his BS degree from Miami University of Ohio in 1956. His graduate work was at the University of Pittsburgh, where he received the MS degree in 1958, and at the University of Pennsylvania, where he worked under the direction of Abraham Klein, receiving the PhD degree in 1960. He became a naturalized US citizen in 1968. After several years at Pennsylvania and at the Institute for Advanced Study in Princeton, N.J.; in 1966 Lee accepted a professorship at the Institute for Theoretical Physics at the State University of New York, Stony Brook, which is directed by C. N. Yang. He served there until his move to Fermilab in 1973.

Lee had one of the broadest ranges of interests and research of any physicist of his generation, but he returned again and again to the study of symmetry principles and the weak interactions. He was one of the first of the physicists working on SU(6) and related symmetries in the mid-1960s to propose that these symmetries would find their natural expression through the algebra of currents. He then played a leading role in the development and applications of current algebra and phenomenological Lagrangians, culminating in the publication in 1972 of his monograph on *Chiral Dynamics*. Lee turned in the early 1970s to the fundamental problem of the renormalization of theories with spontaneously broken symmetry, such as the σ model, and developed ideas and techniques that were to serve him well in his later work on gauge theories.

Lee's involvement with gauge theories dated back to 1964. He was concerned about the fact that superconductors appear to provide a counterexample to the general theorem, which requires that spontaneous symmetry breaking is always accompanied with massless spin-zero bosons. With Klein, he wrote an article suggesting that the same might occur in relativistic theories. It was soon realized that this is indeed the case, provided the broken symmetry is a gauge symmetry, as it is in a superconductor. Lee

shown by functional methods that these theories are renormalizable, Lee developed a proof of this result (for Abelian gauge theories) by operator methods. For theorists who were unfamiliar with the functional formalism, it was Lee's proof that really settled the matter. In the following year, Lee and Jean Zinn-Justin completed the demonstration that renormalization does not spoil the cancellation of unphysical singularities in these theories.

Lee also made a major contribution to the application of this formalism to unified theories of the weak and electromagnetic interactions. His talk at the "Rochester" conference at Fermilab in 1972 and his review article with Ernest Abers have been instrumental in introducing physicists to this subject. Spurred by the discovery of neutral currents in 1973, Lee along with Mary K. Gaillard and Jonathan L. Rosner undertook a systematic survey of the experimental signatures of charmed mesons and baryons. Their report was circulated shortly before the discovery in November 1974 of the J/ψ particle, and immediately became the bible that guided subsequent experimental work. Even before the discovery of the J/ψ , Lee and Gaillard had used gauge-theory calculations of the $K_L - K_S$ mass difference and the $K_L \rightarrow \gamma\gamma$ decay rate to argue that the c-quark mass would have to be about 1.5 GeV or less, a prediction that appears to have been strikingly confirmed by the observed mass of the J/ψ . Lee and his Fermilab colleagues were among those who most actively elaborated and sharpened the theoretical understanding of the new hadrons.

Lee's decision to move permanently to Fermilab was a declaration of his faith in the laboratory and of his recognition of unity of theory and experiment. His brilliance, dedication, and deep understanding — not only of physics but of human nature — added immeasurably to the style and standards of a young laboratory. He attracted other outstanding people to the laboratory, and made of it a world center of theory as well as of experiment. He was a wise and trusted counselor to many experimentalists.

At the time of his death, Lee was in the midst of a period of enormous creativity. In the last six months of life he had explored the problems of CP violation, of lepton-number nonconservation, and of the high-energy limit of weak interactions in gauge theories, and had formulated a theory based on the enlarged gauge group $SU(3) \times U(1)$. He was just beginning a program of research on cosmology and was delighted with this opportunity to move into yet another field.

Lee felt a strong sense of gratitude to older physicists who had helped to advance his career, and he in turn took every possible opportunity to help the young physicists of the next generation to make their way in research. To him, the advance of physics was a common enterprise, in which the contributions of all deserved respect and encouragement. He will be keenly missed by the large number of physicists who learned so much from his work, and most poignantly, by those of us who had the privilege to know him and work with him.

Benjamin Whiso Lee: Korea's Oppenheimer?

Moo-Young Han, Duke University

Editor-in-Chief, Society of Korean-American Scholars; Editor-in-Chief, AKPA

Paper presented at the Centennial Celebration of Korean Immigration to the United States Conference

THE KOREAN AMERICANS: PAST, PRESENT, AND FUTURE

August 16-18, 2002, Fairview Park Marriott Hotel, Falls Church, Virginia 22042

Benjamin Whiso Lee (1935-1977) was a brilliant theoretical physicist of our time, unquestionably the highest-achieving Korean-American physicist in the history of the Korean-Americans. His life was tragically cut short by a traffic accident in the summer of 1977; at the time he was only 42 years old, but already a rising star in the international community of elementary particle physics.

Often, Ben Lee is compared to J. Robert Oppenheimer, the legendary theoretical physicist who served for a long time as the Director of the Institute of Advanced Study in Princeton, but remembered widely by the public as the Director of the Manhattan Project of World War II that developed the first atomic bomb.

After his untimely death, some imaginative authors in Korea published fictions in which attempts have been made to connect Ben Lee, his accidental death, and Park Chung-Hee to an alleged plot by the South Korean government to develop nuclear weapons. This has helped to cast some dark clouds of intrigue, rumors and wild speculation upon the legacy of Ben Lee.

Ben Lee and I entered the Seoul National University in 1952 when the SNU campus was temporarily relocated in Pusan; Ben entered the chemical engineering and I the electrical engineering departments of the then College of Engineering. By 1953 Ben came to the US to pursue his study; I came in 1954. Our careers ran pretty much on parallel tracks, pursuing theoretical elementary particle physics. The last time I met up with Ben was in 1976, at an international conference at Stanford; he just returned from a visit to Korea to advise Korea of the importance of established strong basic sciences. A year later, he died in a traffic accident on an interstate highway.

A Brief Timeline of Benjamin Whiso Lee

Born in Seoul, Korea on January 1, 1935

Entered Seoul National University, Chemical Engineering in 1952

M.S. in 1958, University of Pittsburgh

Ph.D. in 1960, University of Pennsylvania (at the age of 25)

1961-62: Institute of Advanced Study, Princeton

1961-63: Assistant Professor, U of Penn.

1963-65: Associate Professor, U of Penn

1965-66: Professor, U of Penn

1966-76: Professor, Inst of Theoretical Physics, SUNY at Stony Brook.

1973- till death: Head, Theoretical Physics Department, Fermi National Accelerator Lab

Fellow, American Academy of Arts and Sciences

Died on June 16, 1977 at the age of 42.

Question: Ben Lee, Korea's Oppenheimer?

Answer: It depends on which Oppenheimer.

J. Robert Oppenheimer (1904-67)

U.S. theoretical physicist and science administrator, noted as director of the Los Alamos laboratory during the Manhattan Project that developed the atomic bomb (1943- 45) and as director of the Institute for Advanced Study, Princeton.

[1] Oppenheimer, the brilliant theoretical physicist and teacher/mentor, can be characterized as

(1) Brilliant, (2) Person from whom everyone sought answers to their questions, (3) Profound teacher/mentor. (4) However, Oppenheimer lacks any truly important milestone contribution of historical proportion; whereas Oppenheimer was already a living legend during the period in which quantum physics was founded, his contributions do not compare with the likes of Einstein, Bohr, Heisenberg, Schrodinger, Dirac, and Pauli.

Benjamin Lee's career had an uncanny parallel to that of Oppenheimer: Brilliant and a Person from whom many theoretical and experimental physicists sought counsel. As the Head of the Theoretical Physics Department at the Fermi National Accelerator Lab, he was at the epicenter of theoretical and experimental elementary particle physics in the 60s and 70s, the golden years of particle physics. He contributed much, but again as with Oppenheimer, he lacked a lasting monumental work of historical proportion. Perhaps, that was yet to come had he lived. In this sense, one can answer in the affirmative: **Yes, Benjamin Lee could have been Korea's Oppenheimer the brilliant theoretical physicist and teacher/mentor.**

[2] Oppenheimer, the director of the Manhattan Project, the development of the atomic bomb.

There are widely held speculations in Korea that Ben Lee was somehow associated with the attempt by South Korea, under the strongman rule of Park Chung-Hee, to develop Korea's own atomic weapon program. This insinuation was spread by works of fiction in Korea that portrayed him as such, based on wild imaginations of some authors.

I am a theoretical elementary particle physicist whose timeline closely parallels that of Ben Lee. In fact, I met up with him on many occasions. Last time we met was in the campus of Stanford University at an international physics conference in 1976, a year before his death. He just came back from Korea in connection with establishing an AID program to improve basic sciences in Korea.

If one looks at the career line, during the 16 years after getting Ph.D. and until his death, Ben Lee spent 1 year at the Institute of Advanced Study, 5 years at the University of Pennsylvania (during which time he was on many occasions at the IAS on leave from Penn), 7 years at the Institute of Theoretical Physics at SUNY at Stony Brook (with C N Yang), and 3 years as the Director of the Theoretical Physics Department at FNAL. The 60s and 70s were the busiest golden years of particle physics during which the so-called Standard Model would come to be established. Ben was up to his ears in theoretical elementary particle physics.

At no time during his career, Ben was ever associated with any of the national weapons lab such as Los Alamos, Livermore or Sandia. Now, we all know the physical principle of nuclear fission, but that does not make any of us, nuclear and particle physicists, experts in nuclear weaponry. We all know how an internal combustion works: a mixture of gasoline and air, when ignited by sparks, can be a source of energy, but that is a far cry from us being experts in automobile engine design!

No, Ben Lee had not been associated with any of the nuclear weaponry project. **In this sense, the answer to the question, “Korea’s Oppenheimer?” is most certainly no.**

3. OYRA Recipients (5)

The recipient of the 1998 OYRA was Dr. Piljin Yi who was at the time of the award a researcher at Cornell University. He is now a professor of physics at the Korea Advanced Institute of Studies. He received his Ph. D. from Caltech in 1994. Dr. Yi’s research specializes in gravity, low energy effective string theory, and nonperturbative aspects of superstring theory and Yang-Mills theory. Much of his work involves solitonic objects, such as magnetic monopoles and D-branes, and the low energy dynamics thereof. With help of supersymmetry, he and his collaborators invented and made use of many new aspects of such solitonic system. All of these developments are crucial ingredients in recent progress in string theory and Yang-Mills theory. Dr. Yi’s website is at http://newton.kias.re.kr/~piljin/public_html.



4. Schroedinger’s Cat Revisited

Quantum Trickery: Testing Einstein's Strangest Theory

By DENNIS OVERBYE, *The New York Times*, December 27, 2005

Einstein said there would be days like this.

This fall scientists announced that they had put a half dozen beryllium atoms into a “cat state.” No, they were not sprawled along a sunny windowsill. To a physicist, a “cat state” is the condition of being two diametrically opposed conditions at once, like black and white, up and down, or dead and alive.

These atoms were each spinning clockwise and counterclockwise at the same time. Moreover, like miniature Rockettes they were all doing whatever it was they were doing together, in perfect synchrony. Should one of them realize, like the cartoon character who runs off a cliff and doesn’t fall until he looks down, that it is in a metaphysically untenable situation and decide to spin only one way, the rest would instantly fall in line, whether they were across a test tube or across the galaxy.

The idea that measuring the properties of one particle could instantaneously change the properties of another one (or a whole bunch) far away is strange to say the least – almost as strange as the notion of particles spinning in two directions at once. The team that pulled off the beryllium feat, led by Dietrich Leibfried at the National Institute of Standards and Technology, in Boulder, Colo., hailed it as another step toward computers that would use quantum magic to perform calculations.

But it also served as another demonstration of how weird the world really is according to the rules, known as quantum mechanics.

The joke is on Albert Einstein, who, back in 1935, dreamed up this trick of synchronized atoms – “spooky action at a distance,” as he called it – as an example of the absurdity of quantum mechanics. “No reasonable definition of reality could be expected to permit this,” he, Boris Podolsky and Nathan Rosen wrote in a paper in 1935. Today that paper, written when Einstein was a relatively ancient 56 years old, is the most cited of Einstein’s papers. But far from demolishing quantum theory, that paper wound up as the cornerstone for the new field of quantum information.

Nary a week goes by that does not bring news of another feat of quantum trickery once only dreamed of in thought experiments: particles (or at least all their properties) being teleported across the room in a microscopic version of Star Trek beaming; electrical “cat” currents that circle a loop in opposite directions at the same time; more and more particles farther and farther apart bound together in Einstein’s spooky embrace now known as “entanglement.” At the University of California, Santa Barbara, researchers are planning an experiment in which a small mirror will be in two places at once.

Niels Bohr, the Danish philosopher king of quantum theory, dismissed any attempts to lift the quantum veil as meaningless, saying that science was about the results of experiments, not ultimate reality. But now that quantum weirdness is not confined to thought experiments, physicists have begun arguing again about what this weirdness means, whether the theory needs changing, and whether in fact there is any problem.

This fall two Nobel laureates, Anthony Leggett of the University of Illinois and Norman Ramsay of Harvard argued in front of several hundred scientists at a conference in Berkeley about whether, in effect, physicists were justified in trying to change quantum theory, the most successful theory in the history of science. Dr. Leggett said yes; Dr. Ramsay said no.

It has been, as Max Tegmark, a cosmologist at the Massachusetts Institute of Technology, noted, “a 75-year war.” It is typical in reporting on this subject to bounce from one expert to another, each one shaking his or her head about how the other one just doesn’t get it. “It’s a kind of funny situation,” N. David Mermin of Cornell, who has called Einstein’s spooky action “the closest thing we have to magic,” said, referring to the recent results. “These are extremely difficult experiments that confirm elementary features of quantum mechanics.” It would be more spectacular news, he said, if they had come out wrong.

Anton Zeilinger of the University of Vienna said that he thought, “The world is not as real as we think.” “My personal opinion is that the world is even weirder than what quantum physics tells us,” he added.

The discussion is bringing renewed attention to Einstein’s role as a founder and critic of quantum

theory, an “underground history,” that has largely been overlooked amid the celebrations of relativity in the past Einstein year, according to David Z. Albert, a professor of philosophy and physics at Columbia. Regarding the 1935 paper, Dr. Albert said, “We know something about Einstein’s genius we didn’t know before.”

The Silly Theory

From the day 100 years ago that he breathed life into quantum theory by deducing that light behaved like a particle as well as like a wave, Einstein never stopped warning that it was dangerous to the age-old dream of an orderly universe. If light was a particle, how did it know which way to go when it was issued from an atom? “The more success the quantum theory has, the sillier it seems,” Einstein once wrote to friend. The full extent of its silliness came in the 1920’s when quantum theory became quantum mechanics.

In this new view of the world, as encapsulated in a famous equation by the Austrian Erwin Schrödinger, objects are represented by waves that extend throughout space, containing all the possible outcomes of an observation – here, there, up or down, dead or alive. The amplitude of this wave is a measure of the probability that the object will actually be found to be in one state or another, a suggestion that led Einstein to grumble famously that God doesn’t throw dice.

Worst of all from Einstein’s point of view was the uncertainty principle, enunciated by Werner Heisenberg in 1927. Certain types of knowledge, of a particle’s position and velocity, for example, are incompatible: the more precisely you measure one property, the blurrier and more uncertain the other becomes. In the 1935 paper, Einstein and his colleagues, usually referred to as E.P.R., argued that the uncertainty principle could not be the final word about nature. There must be a deeper theory that looked behind the quantum veil.

Imagine that a pair of electrons are shot out from the disintegration of some other particle, like fragments from an explosion. By law certain properties of these two fragments should be correlated. If one goes left, the other goes right; if one spins clockwise, the other spins counterclockwise. That means, Einstein said, that by measuring the velocity of, say, the left hand electron, we would know the velocity of the right hand electron without ever touching it. Conversely, by measuring the position of the left electron, we would know the position of the right hand one.

Since neither of these operations would have involved touching or disturbing the right hand electron in any way, Einstein, Podolsky and Rosen argued that the right hand electron must have had those properties of both velocity and position all along. That left only two possibilities, they concluded. Either quantum mechanics was “incomplete,” or measuring the left hand particle somehow disturbed the right hand one. But the latter alternative violated common sense. Such an influence, or disturbance, would have to travel faster than the speed of light. “My physical instincts bristle at that suggestion,” Einstein later wrote.

Bohr responded with a six-page essay in *Physical Review* that contained but one simple equation, Heisenberg’s uncertainty relation. In essence, he said, it all depends on what you mean by “reality.”

Enjoy the Magic

Most physicists agreed with Bohr, and they went off to use quantum mechanics to build atomic bombs and reinvent the world. The consensus was that Einstein was a stubborn old man who “didn’t get” quantum physics. All this began to change in 1964 when John S. Bell, a particle physicist at the European Center for Nuclear Research near Geneva, who had his own doubts about quantum theory, took up the 1935 E.P.R. argument. Somewhat to his dismay, Bell, who died in 1990, wound up proving that no deeper theory could reproduce the predictions of quantum mechanics. Bell went on to outline a simple set of experiments that could settle the argument and decide who was right, Einstein or Bohr.

When the experiments were finally performed in 1982, by Alain Aspect and his colleagues at the University of Orsay in France, they agreed with quantum mechanics and not reality as Einstein had always presumed it should be. Apparently a particle in one place could be affected by what you do somewhere else. “That’s really weird,” Dr. Albert said, calling it “a profoundly deep violation of an intuition that we’ve been walking with since caveman days.”

Physicists and philosophers are still fighting about what this means. Many of those who care to think about these issues (and many prefer not to), concluded that Einstein’s presumption of locality – the idea that physically separated objects are really separate – is wrong.

Dr. Albert said, “The experiments show locality is false, end of story.” But for others, it is the notion of realism, that things exist independent of being perceived, that must be scuttled. In fact, physicists don’t even seem to agree on the definitions of things like “locality” and “realism.” “I would say we have to be careful saying what’s real,” Dr. Mermin said. “Properties cannot be said to be there until they are revealed by an actual experiment.”

What everybody does seem to agree on is that the use of this effect is limited. You can’t use it to send a message, for example. Leonard Susskind, a Stanford theoretical physicist, who called these entanglement experiments “beautiful and surprising,” said the term “spooky action at a distance,” was misleading because it implied the instantaneous sending of signals. “No competent physicist thinks that entanglement allows this kind of nonlocality.”

Indeed the effects of spooky action, or “entanglement,” as Schrödinger called it, only show up in retrospect when the two participants in a Bell-type experiment compare notes. Beforehand, neither has seen any violation of business as usual; each sees the results of his measurements of, say, whether a spinning particle is pointing up or down, as random. In short, as Brian Greene, the Columbia theorist wrote in “The Fabric of the Cosmos,” Einstein’s special relativity, which sets the speed of light as the cosmic speed limit, “survives by the skin of its teeth.”

In an essay in 1985, Dr. Mermin said that “if there is spooky action at a distance, then, like other spooks, it is absolutely useless except for its effect, benign or otherwise, on our state of mind.” He added, “The E.P.R. experiment is as close to magic as any physical phenomenon I know of, and magic should be enjoyed.” In a recent interview, he said he still stood by the latter part of that statement. But while spooky

action remained useless for sending a direct message, it had turned out to have potential uses, he admitted, in cryptography and quantum computing.

Nine Ways of Killing a Cat

Another debate, closely related to the issues of entanglement and reality, concerns what happens at the magic moment when a particle is measured or observed.

Before a measurement is made, so the traditional story goes, the electron exists in a superposition of all possible answers, which can combine, adding and interfering with one another. Then, upon measurement, the wave function “collapses” to one particular value. Schrödinger himself thought this was so absurd that he dreamed up a counterexample. What is true for electrons, he said, should be true as well for cats.

In his famous thought experiment, a cat is locked in a box where the decay of a radioactive particle will cause the release of poison that will kill it. If the particle has a 50-50 chance of decaying, then according to quantum mechanics the cat is both alive and dead before we look in the box, something the cat itself, not to mention cat lovers, might take issue with.

But cats are always dead or alive, as Dr. Leggett of Illinois said in his Berkeley talk. “The problem with quantum mechanics,” he said in an interview, “is how it explains definite outcomes to experiments.” If quantum mechanics is only about information and a way of predicting the results of measurements, these questions don’t matter, most quantum physicists say. “But,” Dr. Leggett said, “if you take the view that the formalism is reflecting something out there in real world, it matters immensely.” As a result, theorists have come up with a menu of alternative interpretations and explanations. According to one popular notion, known as decoherence, quantum waves are very fragile and collapse from bumping into the environment. Another theory, by the late David Bohm, restores determinism by postulating a “pilot wave” that acts behind the scenes to guide particles.

In yet another theory, called “many worlds,” the universe continually branches so that every possibility is realized: the Red Sox win and lose and it rains; Schrödinger’s cat lives, dies, has kittens and scratches her master when he tries to put her into the box.

Recently, as Dr. Leggett pointed out, some physicists have tinkered with Schrödinger’s equation, the source of much of the misery, itself. A modification proposed by the Italian physicists Giancarlo Ghirardi and Tullio Weber, both of the University of Trieste, and Alberto Rimini of the University of Pavia, makes the wave function unstable so that it will collapse in a time depending on how big a system it represents.

In his standoff with Dr. Ramsay of Harvard last fall, Dr. Leggett suggested that his colleagues should consider the merits of the latter theory. “Why should we think of an electron as being in two states at once but not a cat, when the theory is ostensibly the same in both cases?” Dr. Leggett asked. Dr. Ramsay said that Dr. Leggett had missed the point. How the wave function mutates is not what you calculate. “What you calculate is the prediction of a measurement,” he said. “If it’s a cat, I can guarantee you will get that it’s alive or dead,” Dr. Ramsay said.

David Gross, a recent Nobel winner and director of the Kavli Institute for Theoretical Physics in Santa Barbara, leapt into the free-for-all, saying that 80 years had not been enough time for the new concepts to sink in. “We’re just too young. We should wait until 2200 when quantum mechanics is taught in kindergarten.”

The Joy of Randomness

One of the most extreme points of view belongs to Dr. Zeilinger of Vienna, a bearded, avuncular physicist whose laboratory regularly hosts every sort of quantum weirdness. In an essay recently in *Nature*, Dr. Zeilinger sought to find meaning in the very randomness that plagued Einstein. “The discovery that individual events are irreducibly random is probably one of the most significant findings of the 20th century,” Dr. Zeilinger wrote. Dr. Zeilinger suggested that reality and information are, in a deep sense, indistinguishable, a concept that Dr. Wheeler, the Princeton physicist, called “it from bit.”

In information, the basic unit is the bit, but one bit, he says, is not enough to specify both the spin and the trajectory of a particle. So one quality remains unknown, irreducibly random. As a result of the finiteness of information, he explained, the universe is fundamentally unpredictable. “I suggest that this randomness of the individual event is the strongest indication we have of a reality ‘out there’ existing independently of us,” Dr. Zeilinger wrote in *Nature*. He added, “Maybe Einstein would have liked this idea after all.”

5. Dues and Contributions

As of January 31, 2006, dues and contributions received: \$10,170.

You can now pay your due or send your contribution *electronically*. Please go to www.akpa.org, register as a member, and follow the instruction for electronic payment. Or if you prefer, you can still mail your check to our Treasurer, Professor Eun-Suk Seo at the Institute for Physical Science and Technology, University of Maryland, College Park, MD 20742.

The annual membership fee for regular members is \$25. If you are a student, do not worry about the fee because we are in the process of eliminating the \$5 fee for the associate membership.

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