The relevant papers are those numbered 3 and 5 in the convenient collection, Ettore Majorana Scientific Papers: On the occasion of the cente-
in understanding the spectra treated by Majorana, and extensions of his theory to other areas of physics. We find several puzzles concerning the treatment of
spectroscopy of many-electron atoms, Ettore Majorana in 1931 solved several outstanding problems by developing the theory of autoionization [1]. Later
Maryland, WILLIAM C. MARTIN, National Institute of Standards and Technology — In some of the first applications of modern quantum mechanics to the
di Fisica E. Fermi, Universita di Pisa, CHARLES W. CLARK, Joint Quantum Institute, National Institute of Standards and Technology and University of
the conference was no longer held. In this talk I will delineate the successes and limitations of the Washington Conference on Theoretical Physics.

In the relativistic velocity $u = p/m_0 = \beta = \beta_0$. With the error corrected, it became clear that while velocity is constrained to a negative-curvature 3-space, space-time is a flat 4-space. The changes between [1], [2] and [3] will be discussed in the light of M’s evolving understanding, his different intended audiences, and the possibility that he chose to defer the noneuclidean aspects of velocity and of space-time for later treatment.

Based on a biographical memoir to be published by the National Academy of Sciences.

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**Session B5 FHP FPS AAPT: Secrecy and Physics**

**10:45AM B5.00001 Secrecy and Physics**

PETER GALISON, Harvard University — Secrecy in matters of national defense goes back far past antiquity. But our modern form of national secrecy owes a huge amount to the large scale, systematic, and technical system of scientific secrecy that began in the Radar and Manhattan Projects of World War II and came to its current form in the Cold War. Here I would like to capture some of this trajectory and to present some of the paradoxes and deep conundrums that our secrecy system offers us in the Post-Cold War world.

**11:21AM B5.00002 Secrecy and Physicists: Intersections of Science and National Security**

STEVEN AFTERGOOD, Federation of American Scientists — Physicists have been proponents as well as critics of government secrecy affecting their work. Enrico Fermi once wrote (in Physics Today) that “Contrary to what is most common belief about secrecy, secrecy was not started by generals, was not started by security officers, but was started by physicists.” Yet Edward Teller, Frederick Seitz and others argued that secrecy in science and technology could profitably be reduced by 90% or more.Secrecy in physics is of course most pronounced in research related to nuclear weapons development. Though this is a longstanding concern it is still not a settled one. Disputes over nuclear weapons-related secrecy continue to resonate today as researchers and authors challenge the boundaries of official disclosure regarding the nuclear weapons enterprise. This paper will survey the current landscape of secrecy in science, and will discuss recent controversies involving publication of nuclear weapons physics, the infrastructure of nuclear research, and the prospects for secrecy reform.

**11:57AM B5.00003 How Much Secrecy?**

WILLIAM HAPPER, Princeton University — Some secrecy is needed to optimize the wellbeing of societies. This has been recognized since antiquity. It is also clear that too much secrecy is counterproductive. The right balance depends on how pluses and minuses of secrecy are weighed against other important values

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Sunday, February 14, 2010 10:45AM - 12:33PM

**Session H10 FHP: History of Physics Contributed Papers**

**10:45AM H10.00001 Did Minkowski Change his Mind about Noneuclidean Symmetry in Special Relativity?**

FELIX T. SMITH, SRI International — Minkowski (M.) observed in 1907 that the symmetry of relativistic velocity space is the same as that of noneuclidean geometry. He withheld this text from publication, but Sommerfeld published it 6 years after he died, Ann. Phys. (4) 47, 927 (1915), [1]. Six weeks later in a long, careful article, Gött. Nach. (1908) 53, [2], M. made only a much weaker statement about the noneuclidean parallel. In [3], Phys. Zeitschr. 10, 104 (1909), he avoided the issue entirely. M’s reasons for the changes have never been known. I now show that a key equation in [1] had an error in sign, undetected by Sommerfeld or other commentators, which M. evidently soon saw. This error had led to omitting the factor $\beta = (1 - v^2/c^2)^{-1/2}$ in the relativistic velocity $u = p/m_0 = \beta v = \beta \dot{x}$. With the error corrected, it became clear that while velocity is constrained to a negative-curvature 3-space, space-time is a flat 4-space. The changes between [1], [2] and [3] will be discussed in the light of M’s evolving understanding, his different intended audiences, and the possibility that he chose to defer the noneuclidean aspects of velocity and of space-time for later treatment.

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**10:57AM H10.00002 Ettore Majorana and the birth of autoionization**

ENNIO ARIMONDO, Dipartimento di Fisica E. Fermi, Universita di Pisa, CHARLES W. CLARK, Joint Quantum Institute, National Institute of Standards and Technology and University of

**11:09AM H10.00003 Llewellyn Hilleth Thomas: An appraisal of an under-appreciated polymath**

JOHN DAVID JACKSON, University of California and Lawrence Berkeley National Laboratory — Llewellyn Hilleth Thomas was born in 1903 and died in 1992 at the age of 88. His name is known by most for only two things, Thomas precession and the Thomas-Fermi atom. The many other facets of his career - astrophysics, atomic and molecular physics, nonlinear problems, accelerator physics, magnetohydrodynamics, computer design principles and software and hardware - are largely unknown or forgotten. I review his whole career - his early schooling, his time at Cambridge, then Copenhagen in 1925-26, and back to Cambridge, his move to the US as an assistant professor at Ohio State University in 1929, his wartime years at the Ballistic Research Laboratory, Aberdeen Proving Grounds, then in 1946 his new career as a unique resource at IBM’s Watson Scientific Computing Laboratory and Columbia University until his first retirement in 1968, and his twilight years at North Carolina State University. Although the Thomas precession and the Thomas-Fermi atom may be the jewels in his crown, his many other accomplishments add to our appreciation of this consummate applied mathematician and physicist.

1Based on a biographical memoir to be published by the National Academy of Sciences.

**11:21AM H10.00004 The Washington Conference on Theoretical Physics: Bringing the Spirit of Copenhagen to Foggy Bottom**

PAUL HALPERN, University of the Sciences in Philadelphia — When George Gamow was offered a position at George Washington University in 1934, one of the conditions he set for acceptance was the establishment of an annual physics conference at that university, co-sponsored by the Carnegie Institution. Foggy Bottom, the Washington neighborhood where GWU is located, was not particularly known for physics. Gamow, however, wished to bring the “spirit of Copenhagen” to that locale and attract an international group of theorists. The Washington Conference on Theoretical Physics first convened in 1935 and assembled annually until 1947, except for a three year break during the war. Ironically, just like the Institute for Theoretical Physics in Copenhagen itself, the conference was galvanized the most by Bohr’s actual presence. In its fifth, and best known meeting, held in 1939, Bohr stunned the audience when he announced the successful completion of nuclear fission. After the tenth meeting in 1947, Gamow’s focus had been turning from nuclear physics to cosmology, he had begun to work more closely with graduate students and local collaborators and, in light of diminished interest, the conference was no longer held. In this talk I will delineate the successes and limitations of the Washington Conference on Theoretical Physics.
11:33AM H10.00005 Bullion to B-fields: The Silver Program of the Manhattan Project, CAMERON REED, Alma College — Between October 1942 and September 1944, over 14,000 tons of silver bullion bars withdrawn from the U. S. Treasury were melted and cast into magnet coils and busbar pieces for the “calutron” electromagnetic isotope-separators constructed at Oak Ridge. Based on Manhattan Engineer District documents, this paper will review the history of this “Silver Program,” including discussions of the contractors, production methods, and quantities of material involved.

11:45AM H10.00006 What I have learned in reading and writing history of physics, HARRY LUSTIG, City College of New York, emeritus — After a fifteen year end-of-career excursion into reading and writing in the history of physics, I will give a personal talk about what I have learned, both the good and the bad. Historians do have a problem, to give an account of history (to quote Leopold von Ranke) “how it actually has been.” Sometimes we don’t and can’t know what actually happened in which case it is admissible and tempting to speculate. It is not all right to assert that such and such must have happened. The worst offense, in my opinion, is for authors to tailor their work so as to “prove” a pre-conceived thesis. Names will be named.

11:57AM H10.00007 Twist ‘til we tear the house down: How Clifford solved the universe in 1870, JAMES BEICHLER, Semi-Retired — It is commonly believed that the first hyperspace theories in physics were developed in the early twentieth century — Kaluzza’s five-dimensional extension of relativity is the best known, but this is untrue. It is also commonly believed that W.K. Clifford ‘speculated’ on a higher space in 1870, had no followers and never published his theory (if he even had one). Nothing could be further from the historical truth. As early as 1869, Clifford, his followers and students began to develop a physical theory of matter based on a three-dimensional space curved in four dimensions. Clifford began to publish his theory, but modern researchers have failed to recognize his theoretical work because they look for something like Einstein’s theory even though Clifford developed an electromagnetic theory. Clifford may not have directly influenced Einstein’s relativity, but he made plausible arguments for the reality of space curvature, rendering the rapid acceptance of Einstein’s concept of curved space-time more plausible. Clifford’s work is either largely ignored by historians, scientists and other scholars or considered irrelevant because the early work on hyperspaces has been associated with ether theories that were abandoned, utilized quaternion algebras that were replaced by vectors and tensors, and was unfortunately associated with spiritualism.

12:09PM H10.00008 A Historical View of Kirchhoff’s Black Body Universal Distribution Function \( (\lambda_{\lambda}) \), CLARENCE A. GALL, Postgrado de Ingenieria, Universidad del Zulia, Maracaibo, Venezuela — Stefan (1879) established experimentally that Kirchhoff’s total emitted intensity \( K = \int_0^\infty K_{\lambda} d\lambda = \sigma T^4 \). Boltzmann (1884) derived this result from classical thermodynamic principles. V A Michelson (1887) first defined \( K_{\lambda} = c_1 \lambda^{6-\lambda T} e \left( \frac{\lambda^5}{\lambda^5} \right) \). Weber suggested \( K_{\lambda} = c_1 \lambda^{6-\lambda T} \left( \frac{\lambda^5}{\lambda^5} \right) \). Experimentally, Wien’s displacement law required \( \lambda_{\lambda} T = b \). Paschen (1896) thus proposed \( K_{\lambda} = c_1 \lambda^{6-\lambda T} e \left( \frac{\lambda^5}{\lambda^5} \right) \) with \( 5 < \gamma < 6 \). Compatibility with Stefan-Boltzmann’s Law led to the value \( \gamma = 5 \) in Wien’s solution. Planck’s solution \( \left( K_{\lambda} = c_1 \lambda^{-\gamma} \left( e^{\frac{\lambda^5}{\lambda^5}} - 1 \right) \right) \) is also noteworthy. From Michelson’s first attempt, \( \lambda T \) placed in the denominator of the exponential part of the function. This did not change until Gall’s derivation of the function \( \left( K_{\lambda} = c_1 \lambda^{-\gamma} \left( e^{\frac{\lambda^5}{\lambda^5}} - 1 \right) \right) \) (http://meetings.aps.org/link/BAPS.2007.MAR.X21.4), based on emission as a decay process (sites.google.com/site/purefieldphysics), placed \( \lambda T \) in the numerator. If temperature is defined as reciprocal wavelength then \( T^6 \lambda \equiv \lambda^{-5} \). It is mathematically evident that the new location of \( \lambda T \) is what finally allowed for the exact solution of Kirchhoff’s Function with the original empirical constants \((\sigma, b)\).

12:21PM H10.00009 History of the 3 Theories of Light, JEFFREY BOYD — Plato, Euclid, & Ptolemy said that we see a flower, something is emitted from our eyes that travels out to apprehend the flower. The alternative was called the intromission theory: something from the flower comes into our eye, which is how we see. The latter was an unpopular minority view defended by Aristotle, Lucretius and Galen. It wasn’t widely accepted until 1021 (Ibn al-Haytham’s Book of Optics). Einstein & DeBroglie assumed the intromission theory (wave-particle duality). That was fruitful but led to quantum weirdness, Schrödinger’s cat, & a sense that only mathematical formulas are “real.” In 2007 PhysicsWeb said, “Quantum physics says we see a flower, something is emitted from our eyes that travels out to apprehend the flower. The alternative was called the intromission theory: something from the flower comes into our eye, which is how we see. The latter was an unpopular minority view defended by Aristotle, Lucretius and Galen. It wasn’t widely accepted until 1021 (Ibn al-Haytham’s Book of Optics). Einstein & DeBroglie assumed the intromission theory (wave-particle duality). That was fruitful but led to quantum weirdness, Schrödinger’s cat, & a sense that only mathematical formulas are “real.” In 2007 PhysicsWeb said, “Quantum physics says we see a flower, something is emitted from our eyes that travels out to apprehend the flower. The alternative was called the intromission theory: something from the flower comes into our eye, which is how we see. The latter was an unpopular minority view defended by Aristotle, Lucretius and Galen. It wasn’t widely accepted until 1021 (Ibn al-Haytham’s Book of Optics). Einstein & DeBroglie assumed the intromission theory (wave-particle duality). That was fruitful but led to quantum weirdness, Schrödinger’s cat, & a sense that only mathematical formulas are “real.” In 2007 PhysicsWeb said, “Quantum physics says we see a flower, something is emitted from our eyes that travels out to apprehend the flower. The alternative was called the intromission theory: something from the flower comes into our eye, which is how we see. The latter was an unpopular minority view defended by Aristotle, Lucretius and Galen. It wasn’t widely accepted until 1021 (Ibn al-Haytham’s Book of Optics). Einstein & DeBroglie assumed the intromission theory (wave-particle duality). That was fruitful but led to quantum weirdness, Schrödinger’s cat, & a sense that only mathematical formulas are “real.” In 2007 PhysicsWeb said, “Quantum physics says we see a flower, something is emitted from our eyes that travels out to apprehend the flower. The alternative was called the intromission theory: something from the flower comes into our eye, which is how we see. The latter was an unpopular minority view defended by Aristotle, Lucretius and Galen. It wasn’t widely accepted until 1021 (Ibn al-Haytham’s Book of Optics). Einstein & DeBroglie assumed the intromission theory (wave-particle duality). That was fruitful but led to quantum weirdness, Schrödinger’s cat, & a sense that only mathematical formulas are “real.” In 2007 PhysicsWeb said, “Quantum physics says
1:30PM Q5.00001 250 Years of Physics at the College of William and Mary: 1760-2010, HANS VON BAEBYER, College of William & Mary — The recorded history of physics at William and Mary begins when Thomas Jefferson, the College’s most distinguished alumnus, meets his mentor, Dr. William Small of Scotland, who opens his eyes to the wonders of natural philosophy. After the vicissitudes of the Revolution and the Civil War, physics enjoys a revival in the twentieth century, culminating in the creation of a Ph.D. program in the 1960s and the building of the William Small Physical Laboratory in Williamsburg. In the 1980s the modern era is launched by the establishment of the US Department of Energy’s Jefferson Lab for nuclear physics research. Today both Small Hall and Jefferson Lab are in the process of renovation. The legacies of Small and Jefferson for physics at William and Mary are secure!

2:06PM Q5.00002 80 Years of Physics at Fisk University, WARREN COLLINS, Fisk University — Elmer S. Imes established the physics department at Fisk University in 1929. Imes’ interest in infrared spectroscopy set the direction of the department’s early research, which resulted in the beginning of the graduate program and the establishment of the Fisk Molecular Spectroscopy Research Laboratory in the late 1940’s, and the founding of the Fisk Infrared Institute in 1953. This research also led to important connections with Oak Ridge National Laboratory and nearby Vanderbilt University. In the 1970’s, the department’s major research emphasis began to shift away from traditional molecular spectroscopy toward infrared and Raman spectroscopy of solid state materials. The establishment of a NASA funded University Research Center in 1992, with continued support from NSF and other agencies, has resulted in a significant expansion in research, training and outreach activities. We review the department’s history of educating and training African American students or other underrepresented groups who go on and earn advanced degrees, from the beginning of the physics major to the recently established Masters-to-PhD Bridge program.

2:42PM Q5.00003 Research and Education in Physics and Astronomy at Haverford College, JERRY GOLLUB, Haverford College — This talk focuses on special features of research and education in physics and astronomy at Haverford. These include: (a) The involvement of students in research for many decades, both locally and at national facilities. At least 60 students have been co-authors of scientific papers in the last 30 years, of which many contain significant new science. (b) A noteworthy Astronomy program that has produced a surprising number of active astronomers, many of whom have been recognized by national awards. (c) A physics senior seminar that helps students to make the transition from an undergraduate education to the world of graduate education or work. (d) A network of interdisciplinary interactions and concentrations that enables the physics program to appeal to students with broad interests, e.g. in biology, computer science, education, or engineering. (e) A tradition of outreach courses to students not majoring in science. (f) Curricular coordination with neighboring Bryn Mawr College. (g) Notable laboratory courses that prepare students for research and independent learning.

Tuesday, February 16, 2010 10:45AM - 12:33PM –
Session X4 FHP GPMFC: The Laser: Historical Perspectives and Impact on Precision Measurements
Thurgood Marshall North

10:45AM X4.00001 First light: from the ruby laser to nonlinear optics, J.A. GIORDMAINE, NEC Laboratories America — Laser action was first demonstrated by Maiman in a flashlamp-pumped ruby crystal in May of 1960. This talk, based in part on personal recollections, recounts some of the research highlights during the two years that followed - a period of exponential growth in the field of quantum electronics, driven by the newly available, unprecedented coherence, power, and monochromaticity of laser light. Active areas from the beginning were new lasers in HeNe and other gas systems, in host crystals with increasingly effective dopants, and in glass. Modes in open resonators became understood, as did the surprising granularity of laser light. An important step was the Q-switch, enabling megawatt lasers and providing a new tool for the study of dielectrics at high optical fields. The field of nonlinear optics opened up with experimental discoveries including optical second harmonic generation, two-photon absorption, phase matching and stimulated Raman scattering. A key to subsequent progress was a comprehensive quantum mechanical theory that provided a general description of nonlinear optical processes. The end of the two-year period covered here coincided with two advances which were to shape the future role of lasers in technology and science: the first semiconductor lasers; and a theoretical description of states of light having truly quantum properties, properties not evident in laser light up to that time.

11:21AM X4.00002 Freedom from band-gap slavery: from diode lasers to quantum cascade lasers, FEDERICO CAPASSO, School of Engineering and Applied Sciences, Harvard University — Semiconductor heterostructure lasers, for which Alferov and Kroemer received part of the Nobel Prize in Physics in 2000, are the workhorse of technologies such as optical communications, optical recording, supercomputer scanners, laser printers and fax machines. They exhibit high performance in the visible and near infrared and rely for their operation on electrons and holes emitting photons across the semiconductor bandgap. This mechanism turns into a curse at longer wavelengths (mid-infrared) because as the bandgap, shrinks laser operation becomes much more sensitive to temperature, material defects and processing. Quantum Cascade Laser (QCL), invented in 1994, rely on a radically different process for light emission. QCLs are unipolar devices in which electrons undergo transitions between quantum well energy levels and are recycled through many stages emitting a cascade of photons. Thus by suitable tailoring of the layers’ thickness, using the same heterostructure material, they can lase across the molecular fingerprint region from 3 to 25 microns and beyond into the far-infrared and submillimiter wave spectrum. High power cw room temperature QCLs and QCLs with large continuous single mode tuning range have found many applications (infrared countermeasures, spectroscopy, trace gas analysis and atmospheric chemistry) and are commercially available.

11:57AM X4.00003 Developing Stabilized Lasers, Measuring their Frequencies, demoting the Metre, inventing the Comb, and further consequences, JOHN L. HALL, JILA/University of Colorado — Michelson’s 1907 proposal to define the SI Metre in terms of an optical wavelength was realized only in 1960, based on a 94thKrypton discharge lamp. The same year saw the cw HeNe laser arrive and a future redifinition based on laser technology assured. Separation in the late 60’s of the laser’s gain and spectral-reference-gas functions led to unprecedented levels of laser frequency stability and reproducibility. In addition to HNe:CH system at 3392 nm and HeNe:I system at 633 nm, systems at 514 nm and 10600 nm were studied. Absolute frequency measurement became the holy grail and some NBS team experiences will be shared. We measured both frequency and wavelength in 1972, and so obtained a speed of light value, improved 100-fold in accuracy. During the next decade, the NBS value of c was confirmed by other national labs, and frequency metrology was extended to the 473 THz (633 nm) Iodine-based wavelength standard. This frequency to ~10 digit accuracy was obtained in 1983, thus setting the stage for redefining the SI Metre. By consensus choice the value 299 792 458 m/s was adopted for the speed of light, effectively reducing the Metre to a derived SI quantity. Knowledge of the frequency of the particular laser being utilized was controlled by International intercomparisons, but the need for a fast and accurate means to make these laser frequency measurements was obvious. Creative proposals by H¨ ansch and by Chebotayev were to use ultra-fast repetitive pulses to create an “Optical Comb,” but it was years before any technical basis existed to implement their Fourier dreams. Finally, in 1999 the last needed capability was demonstrated – continuum production at 100 MHz rates and non-destructive power levels. By May 2000 phase-locked combs were operational in both Garching and Boulder, substantially accelerated by their collaborative interactions. Within 18 months all the known proposed “optical frequency standards” had been accurately measured via Comb techniques.