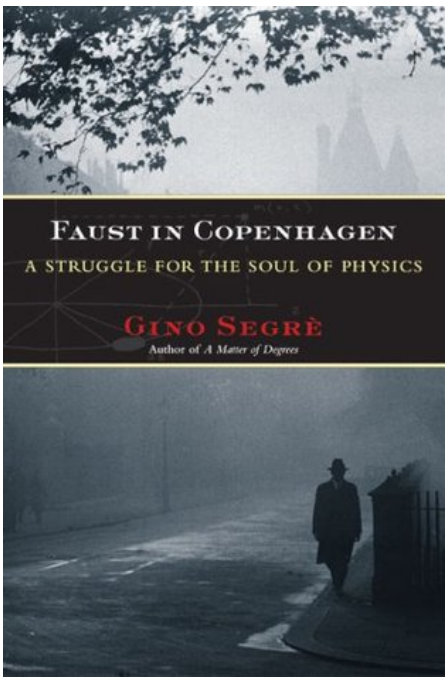

Faust in Copenhagen: A Struggle for the Soul of Physics

Gino Segrè

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A fascinating look at the landmark 1932 gathering of the biggest names in physics

Known by physicists as the “miracle year,” 1932 saw the discovery of the neutron and the first artificially induced nuclear transmutation. However, while physicists celebrated these momentous discoveries—which presaged the era of big science and nuclear bombs—Europe was moving inexorably toward totalitarianism and war. In April of that year, about forty of the world’s leading physicists—including Werner Heisenberg, Lise Meitner, and Paul Dirac—came to Niels Bohr’s Copenhagen Institute for their annual informal meeting about the frontiers of physics.

Physicist Gino Segrè brings to life this historic gathering, which ended with a humorous skit based on Goethe’s *Faust*—a skit that eerily foreshadowed events that would soon unfold. Little did the scientists know the Faustian bargains they would face in the near future. Capturing the interplay between the great scientists as well as the discoveries they discussed and debated, Segrè evokes the moment when physics—and the world—was about to lose its innocence.

Faust in Copenhagen: A Struggle for the Soul of Physics Details

Date	:	Published June 14th 2007 by Viking Adult
ISBN	:	9780670038589
Author	:	Gino Segrè
Format	:	Hardcover 384 pages
Genre	:	Science, History, Physics, Nonfiction, Biography, History Of Science

From Reader Review Faust in Copenhagen: A Struggle for the Soul of Physics for online ebook

Joel Corney says

I enjoyed getting to know the characters involved in this very revolutionary period in physics. it seems that in theoretical physics, the general rule is that you've got to make your revolutionary discovery by age 25 or not at all (though it is comforting to know that there are exceptions, such as Schrödinger, who made his big discovery at the grand old age of 39),

I have a renewed appreciation for Bohr. Of course his orbital model of the atom is about the first thing you learn about in quantum, along with some mumbo jumbo about complementarity. But perhaps his biggest contribution was not the papers he published but his role in mentoring, encouraging, advocating for and showing hospitality to younger generations of physicists. Not to mention his heroic efforts in securing the safe escape from Nazi occupied Europe of not only many Jewish scientists but also the vast majority of Danish Jews.

Anna says

greek librarians: το βιβλ?ο υπ?ρχει στα ελληνικ? απ? τον Τραυλ?
http://www.biblionet.gr/book/142973/S...

Το βιβλ?ο ε?ναι η ιστορ?α της ατομικ?ς β?μβας. Απ? ?σα ξεκ?νησαν στο Ινστιτο?το Carlsberg στην Κοπεγχ?γη (η συνεισφορ? της μπ?ρας στην πυρηνικ? φυσικ?), ?που ο Νιλς Μπορ, ε?χε μαζ?ψει τη δεκαετ?α του '30 ?λη την αφρ?κρεμα της σ?γχρονης φυσικ?ς. Εκε?, οι νεαρο? ερευνο?σαν τα μυστικ? του πυρ?να, ?βγαζαν εργασ?ες (?λοι κατ?ληξαν νομπελ?στες) και περνο?σαν ?μορφα.

?μως, ξεκιν?ει κ?τι που λ?γεται 2ος Παγκ?σμιος Π?λεμος. Ο επιστ?μονας ?χει ?να κοινωνικ? πρ?σωπο, μια πατρ?δα, μια ζω?, μια οικογ?νεια... Οι περισσ?τεροι απ? τους νεαρο?ς επιστ?μονες ε?ναι εβρα?κ?ς καταγωγ?ς, οι ?λλοι Γερμανο? πολ?τες... Τι κ?νεις τ?τε; Επ?σης, αυτ? που ερευν?ς μπορε? να χρησιμοποιηθε? και για πολεμικο?ς σκοπο?ς... Τι κ?νεις τ?τε;

Οι Γερμανο? ξεκιν?νε πυρηνικ? πρ?γραμμα. Ο Μπορ και ο Α?νστ?ιν πηγα?νουν στον Κ?σιγκερ και τον Τρο?μαν να π?ρουν χρηματοδ?τηση για να ξεκιν?σουν κι αυτο? ?ρευνες για τα πυρηνικ? ?πλα. Οι πολιτικο? τους απορρ?πτουν. Αυτο? επιμ?νουν. Εξ?λλου, αν φτι?ξουν οι Γερμανο? τη β?μβα, θα τους σκοτ?σουν. ΤΙ ΚΑΝΕΙΣ ΤΟΤΕ;
Τελικ? πα?ρνουν τα λεφτ?, αλλ? μαθα?νουν ?τι οι Γερμανο? κολλ?νε. Εντ?ξει, δεν θα σκοτ?σουμε και φ?λους... ?μως οι πολιτικο? πε?στηκαν. Το πρ?γραμμα Manhatan ξεκιν?. Συμμετ?χουν ?λοι, γιατ? ο φ?βος των Γερμαν?ν ε?ναι π?ντα στο π?σω μ?ρος του μυαλο? τους. Τα υπ?λοιπα γνωστ?...

Γραμμ?νο απ? το Gino Segre, γιο του νομπελ?στα φυσικο? Emilio Segre, ο οπο?ος τα ?ζησε ?λα αυτ? απ? κοντ?. Εξαιρετικ?, αναδεικν?ει τη σ?γκρουση αν?μεσα στον επιστ?μονα και τον ?νθρωπο και τις "αν?μαλες" καταστ?σεις που κ?νουν τους παλιο?ς φ?λους εχθρο?ς.

Austin says

A well-crafted tour through the beginnings of quantum mechanics and nuclear physics, quite accessible and comprehensible, even for those without a scientific bent. The narrative has a deft touch, the over-arching parallel between Goethe's Faust and the lives of the various physics *wunderkind*s is well chosen and well-emphasized (until a strange moment at the finale - see below).

I do have a negative critique or two: the first (and more minor) would be that the narrative jumps around among time periods rather too much, which can lead to confusion. (*Wait, Bohr was where? When? Then how did Heisenberg meet with...* etc.). A more streamlined chapter arrangement might have helped, or the inclusion of a comprehensive timeline.

The second point is a larger problem: the near-elision of Heisenberg's decision during the War to head the German attempt to develop an atomic weapon. After building the Faust example and metaphor throughout the book, the strange lack of emphasis on the Faustian-ness of Heisenberg's choice is stark and surprising. Heisenberg's path is briefly remarked upon in the epilogue, but a more thorough examination of the topic would be welcome (especially given what the author previously provided as a sketch of Heisenberg's character). To omit a discussion of Heisenberg's "devil's bargain" from a book literally named for Dr. Faustus seems unconscionable.

Barring those decisions, however, the book is a satisfying chronicle, well-composed and deftly delivered, and I'd recommend it to anyone looking to grapple with the world's move into the nuclear age.

Ed Terrell says

It was the Age of Innocence. It was 1932, before Hitlers rise to power and the exodus of scientists to places like Princeton's Institute for Advanced Study. The top physicists from around the world met yearly, first in Solvay then later in Coppenhagen. From these meetings what was to emerge was nothing short of the reordering of modern scientific thought on how the world was put together. Bohr, Pauli and Heisenberg essentially created Quantum Mechanics out of nothing and in its place came the exclusion principle and matrix calculations, quantum numbers and eigenvalues. They took away electron orbits and gave us electron states.

"Faust" written by Goethe, perhaps the last true universal genius, provides the setting for a play. Our scientists find themselves acting out a story based on themselves and this great work. Little were they to know that in the outcome of what they were searching were the seeds of a Faustian bargain for the fate of humankind. But the story gets ahead of itself. "Faust" was only a diversion, some time off of the heavy intellectual lifting, some time for a few laughs with friends.

Serge intermingles the story of the development of quantum mechanics with the play. The real characters become Mephistopheles and Faust. This book is as much about people as it is about things. It is about the resistance of Einstein to the new ideas, the wave mechanics of Schroedinger and Pauli's lack of respect for mathematics as "crutches for weak men". It is about late night conversations on anti-matter, positrons and neutrinos, and pair production. Are these particles or are these waves? Perhaps they are both but then again, perhaps they are neither and in fact are something beyond words, beyond our languaging, but existing in transcendental algebra where things like electron spin, wave functions, and quantum tunneling can be better

understood.

Great read!

Greg says

Written by a physicist for an educated but popular audience, Gino Segre accomplishes a great feet by discussing the conferences, personalities, intellects, arguments, and development in Copenhagen of modern quantum mechanical theory. “Quantum mechanics, on the other hand, emerged in 1925-26 only after a long buildup. Its details evolved over time, and its meaning continued to be debated for years. Unlike relativity, it was the work of many who struggled together, often arguing with one another as they hammered out the theory’s conclusions. Its final version, the so-called Copenhagen interpretation, was contested even by some of the creators of the revolution. The questioning has not ceased.” In this way, the development of this theory resembles most of the innovations since, resulting from collaboration from a diverse set of people to achieve a remarkable result. Segre writes “in the ongoing struggle to make sense of our lives, we sometimes have moments when pieces from a distant past realign themselves and a previously unnoticed pattern emerges. Nothing has changed except perhaps the angle from which we look at those events, but the new vista suggests another meaning or even a connection of which we were previously unaware.” In this way, physics is philosophy, and vice versa.

The stories of the people and their personalities are truly fascinating. It is truly remarkable how the contributions of Lise Meitner have not been fully appreciated, as well as the degree to which her commitment was tested by the prohibition of women in her field. “Beginning in Berlin was even harder for Meitner than for Hahn, because Fischer’s Chemical Institute was off-limits to women. After negotiations, a compromise was reached whereby Meitner could use a basement carpenter’s room that had a separate entrance to the street, but she was not allowed to go upstairs into the institute, even to Hahn’s laboratory. If she had to use a bathroom, she needed to walk to a nearby restaurant. When the Rutherfords spent a few days in Berlin on their way back to Manchester after the 1908 Nobel Prize ceremonies, the men talked in Hahn’s laboratory while Meitner went shopping with Mary Rutherford. Meitner was also unpaid, which meant continuing to live in a furnished room on an allowance from her parents. But with the exciting work propelling her forward, she extended her stay in Berlin well beyond what either she or her parents had originally envisioned.” I want to learn more about John von Neumann, who was a true universal genius as one of the century’s great mathematicians, developed economic game theory, and developed the first digital computer, in addition to his contributions to quantum theory.

Segre devotes much attention to Einstein, Bohr, and Pauli, as would be expected. Einstein’s protestations are well documented throughout this history. “When Einstein talked of the Old One, he wasn’t invoking a traditional divinity. His god was the god of Spinoza, the god of order in the universe. The notion that the observer necessarily affects the results of experiments was unacceptable to him. And yet he could not convince those who thought otherwise that his view was correct.”

There is a wonderful exchange on Einstein’s protests to the Solvay conference proposals. Einstein had turned his focus away from quantum mechanics and instead was pursuing a unification of gravitation and electromagnetism. Pauli wished Einstein’s efforts a speedy death because he thought they were doomed to failure. In the conference, he proposed a thought experiment as a challenge to the Copenhagen interpretation that involved a box of particles and a clock, with a shutter that would open and let one particle out at a time

and then the box would be weighed. In the uncertainty principle, it would be impossible to exactly measure the particle’s energy. Bohr, however, after an evening’s thought, showed that Einstein had neglected to take into account the slight movement in the earth’s gravitational field, and therefore proved that there was indeed a small uncertainty in the determination of mass an energy. Einstein ultimately conceded that he lost this battle, but not the war. The Bohr, Heisenberg, and Pauli argument won out against the lingering doubts of some physicists in 1927.

This is a highly readable history of physics, and as well collaboration between men and women of towering intellect.

Aloysius says

Acostumbramos a pensar en los físicos como parte de una maquina productora de datos y formulas. En la educación institucionalizada memorizamos formulas con sus nombres, como si solo fueran eso. Y mas aun, para las personas si educación científica, los físicos, científicos en general, son entes fríos y calculadores.
Gino Segré nos muestra una faceta mas real de los grandes fisicos que forjaron la física nuclear y cuántica, mostrandonos un poco de su trabajo y mucho de sus vidas, sus motivaciones, dudas conflictos, evidenciando que eran personas profundamente humanas, guiadas por la razón pero motivadas por el corazón.
Con el marco de la representación de Fausto, en tono de parodia, durante la reunión de Copenhague, nos relata el amanecer del siglo XX a través de la innovación científica hasta los preludios de la segunda guerra mundial.
Es altamente recomendada para entender un poco como se revoluciono la física y por sobre todo, entender a aquellos que la forjaron, no como entes eminentemente intelectuales, sino también como personas sumamente apasionadas.

Peter says

Faust in Copenhagen vertelt min of meer het standaardverhaal over het begin van de kwantummechanica. Een aantal zaken zijn (iets) anders. Ten eerste is de schrijver een natuurkundige (dit is niet anders) en komt een beetje uit een familie met natuurkundigen. Een oom van de schrijver is ook natuurkundige en heeft de roemruchte bijeenkomsten in Kopenhagen meegemaakt, iets later dan de bijeenkomst die het onderwerp van dit boek is, de bijeenkomst in het jaar 1932, het normale jaar, voordat de politieke situatie in Europa verandert.

De schrijver betrekt zijn familiegeschiedenis (Duits/Italiaans/Joods) in het verhaal. Op zich is dat misschien niet erg geslaagd, maar zijn Italiaanse roots leveren een iets ander focus op. Zo komt Fermi meer in beeld (de schrijver heeft met zijn vrouw net een biografie over hem geschreven.) Fermi berekende de kracht van de eerste atoombom ontploffing door wat papiersnippers in de lucht te gooien en de afstand te meten die deze aflegden onder invloed van de drukgolf. Elegant, diep en misschien niet waar.
Een ander punt waarin dit boek verschilt van andere verhalen is dat het tijdsperspectief iets is opgeschoven, iets meer recentere ontwikkelingen en personen komen aan bod. In 1932 werd het neutron ontdekt, de drager van de kettingreacties in atoombommen en kerncentrales. Heisenberg was een established figuur, evenals Pauli.

Het verhaal wordt opgehangen aan een toneelopvoering die ter afsluiting van de conferentie werd gegeven. Het werd een satirische bewerking van Goethes Faust (1932 was het honderdste sterfjaar van G.) De bedoeling was om de voornaamste figuren uit Faust te laten staan voor bekende natuurkundigen uit die tijd. Gretchen, geliefde van Faust, was het neutrino. De Heer was Bohr. De rol van Einstein was problematisch. Hij was zonder twijfel de grootste natuurkundige van de twintigste eeuw, misschien wel de grootste sinds Newton. Maar hij had zich afgekeerd van de kwantummechanica en ging zijn eigen weg die niet erg vruchtbaar was. Hij werd de (vlooien)koning. De tragische held Faust werd Ehrenfest (die altijd aan zijn eigen capaciteiten twijfelde). Niemand kon weten hoe tragisch zijn einde zou zijn (september 1933) vlak na de Kopenhagen conferentie van het jaar daarop.

Het boek is goed geschreven en vertelt de problemen die speelden rond 1930 op een niet-technische manier. Het boekt geeft vooral een goed beeld van de sfeer van Kopenhagen waar 'iedereen' kwam en in een sfeer van informaliteit en vrijheid van denken met elkaar omging.

Amy says

The Matrix

Werner Heisenberg, whose development of matrix mechanics yielded the uncertainty principle, said that one challenge of quantum theory is that it does not have an adequate language beyond mathematics to describe it. Heisenberg comes close to proposing that poetry is that language in *Physics and Philosophy* when, after making this statement, he immediately references Goethe’s *Faust* to describe his understanding of the structure of language. Mephistopheles says that while formal education instructs that logic braces the mind “in Spanish boots so tightly laced,” and that even spontaneous acts require a sequential process (“one, two, three!”):

In truth the subtle web of thought
Is like the weaver’s fabric wrought:
One treadle moves a thousand lines,
Swift dart the shuttles to and fro,
Unseen the threads together flow,
A thousand knots one stroke combines.

Heisenberg, while arguing that science must be as attentive to imagination as to logic, also seems to be suggesting that novel sciences must be described by novel languages. Creative endeavors like poetry have the ability to not only describe novel theories and expressions of physical reality, but also to invent them through its shorthand, “one treadle” moving “a thousand lines,” where a “thousand knots one stroke combines.” As I learned in kevin mcpherson eckhoff’s *rhapsodomancy*, the alphabets of the future are wormholes. Since the primary concern in theoretical physics today is reconciling quantum mechanics with relativity through proposals such as string theory, poetry can be thought of as an experiment in physics and physics as a field test for poetry.

Physics is the study of physical reality, which, to my mind, includes spacetime, language, poems, people, consciousness, and agency. In literary terms, string theory could be considered to be a critical theory; it not only describes physical elements, including elementary elements, within spacetime, it attempts to describe spacetime itself. Following in the tradition of Western atomic science from Thales to Democritus, physicists consider the multiverse’s subatomic, vibrating membranes of energy—the open and closed strings of string

theory—to be elementary constituents of matter.

What is the significance of these open and closed strings in relation to clinamen occurring in not just artistic contexts but in physical reality, as demonstrated by how probability functions in subatomic phenomena of mechanical systems? Poetry, which could be considered a mutation on physical and conceptual reality, replicates through the ricochet of pattern (periodicity, symmetry, order) and swerve (deviation from pattern, chance) toward novelty, or what might be thought of as the poem itself. Along with the expanding and accelerating multiverse, our understanding and experience of physical reality expands and accelerates at varying scales (subatomic, eye level, astronomical). We create and use technology like our microscopes and telescopes to interact more deeply with these scales, and as such technological advances proliferate so do our capacities to perceive, perform, and create through other mediums. Poetry that is attentive to its multiversal form as a novel technology also operates within and beyond these varying scales through the known and unknown dimensions of physical reality.

Dr. Lisa Randall, the particle physicist I saw lecturing on CERN just before the Large Hadron Collider went operational, called herself a model builder. Apologizing for the lack of realism, and asking us to use our imaginations, she presented crude graphs of open and closed strings—in other words, she presented two-dimensional portrayals of eleven-dimensional concepts—to illustrate the hypothesis that our universe is a low-gravity universe while other dimensions in the multiverse, called "branes," are high-gravity universes. Considering the homophonic relevance of the word "brane," and taking into account Heisenberg's notion that an eleven-dimensional science might require an eleven-dimensional language like poetry, I have decided that I, too, am a model builder. Like Christian Bök's Xenotext—a poem encoded into a radio-resistant bacterium that will write poems—I write poems that write me.

Heisenberg's uncertainty principle proposes that at the subatomic scale of physical reality, the future position and momentum of a particle cannot be predicted because it is impossible to accurately describe the particle's present state without ambiguity. Applied to scales at eye level, the notion that the future cannot be predicted with any certainty because it is impossible to describe the present without ambiguity reinforces the idea that time operates outside of conventional notions of linearity. Within the context of a poem, where ambiguity can operate on multiple levels—in meaning, sight, and sound—time as a linear or nonlinear experience can occur or not occur in a recognizable pattern.

According to physicist Gino Segrè's *Faust in Copenhagen*, while the mathematics used by Heisenberg's matrix mechanics was not new, the theory itself was original for developing what Max Born called "symbolic multiplication," which resulted in illustrating that the commutative law of arithmetic (*AB*, equals *BA*, i.e. 4X3 is the same as 3X4) is not valid in subatomic systems. Heisenberg's symbolic multiplication proposed that in quantum mechanics a particle's position multiplied by its momentum is not equal to a particle's momentum multiplied by its position. In other words, a particle's position multiplied by its momentum (*AB*) minus a particle's momentum multiplied by its position (*BA*) was not zero, as it would be if the product of position and momentum commuted. Instead, in matrix mechanics, a particle's position multiplied by its momentum minus a particle's momentum multiplied by its position was proportional to Planck's constant, a physical constant of subatomic quanta that is nonzero. Since Planck's constant is always nonzero, uncertainty is at play in measuring observable subatomic phenomenon of the present. By invalidating causality as well as attempts at measuring non-observable subatomic phenomenon, Heisenberg's matrix mechanics illustrated that the future position and momentum of subatomic particles cannot be calculated because the "determining elements" of the present cannot be known with certainty. This is one way that quantum mechanics conceives of time—and logic—in a novel way. In quantum poetics, such breakthroughs in physics can be applied to physical reality at all of its scales, visible and invisible, including cultural and creative scales, and, more specifically, to language and what I might call *its* matrix mechanics,

poetry.

Heisenberg's quantum mechanics conceived of space in a novel way, too, offering a new model for how electrons moved within atoms. In contrast to notions that electrons in atoms moved in orbits like planets, matrix mechanics describes the motion of electrons as jumps or leaps from one quantum state to another, reminiscent of clinamen, and evoking the possibility that clinamen could be a physical force like electromagnetism or gravity that exists not only in creative systems but also in physical reality.

How can a poem's future or present/near-future "meaning" be known with any certainty if its present cannot be described without ambiguity? Conventional notions of meaning are dependent on linear notions of time, as meaning in its conventional iterations is something arrived at, in time, after "comprehension." Most reading relies on linear notions of time as well, since grammars often follow a progression that occurs before comprehension or examined experience is reached. However, poetry can usurp conventional interactions with reading with the reader experiencing language outside linear notions of time, which might include time slowing, speeding up, or inducing a sense of no time, or a sense of all times at once, where the simultaneity of times can occur between differing or distinct time scales. Perhaps, most importantly, poems can also work in tandem (toward unity and/or disjunction) with space in a way that is attentive to the spacetime of the page, that field that transcends the border of the object or conceptual medium such as the page or screen. In poetry, like in quantum mechanics, the future cannot be forecasted with certainty, and any measurement of its physical reality, including its meaning, might only be described in terms of probability.

Of course, applying discoveries and theories in the natural sciences to sociological, phenomenological, or artistic interpretations of reality can be problematic because correlations sometimes assume a causal relationship between what are conventionally thought of as different modes of inquiry. At the same time, the academic and practical divisions between the natural and human sciences seems to be part of a systemic artifice perpetuated by cultural institutions that serve to protect distinct disciplines from interdisciplinary, and therefore competing, authorities.

To my mind, whatever human consciousness is, it must be partly comprised of electrons—the subatomic material of physical reality—and breakthroughs in describing subatomic or even astronomical phenomenon are also breakthroughs in describing reality at eye level, which is just one, though perhaps our most obvious, encounter with existence. Those attentive to the interactions of clinamatic spacetime of language on human consciousness might notice how fresh iterations of language affect existence within and outside of eye level, which includes language itself and what it means or doesn't mean to creatively communicate or replicate through mediated or non-mediated sounds and scripts. The cultural and creative dimensions of physical reality are not as distinct from theoretical or experiment-based physics as discipline-specific discourse would have us believe, but seem to be instead linked through ongoing proposals of Alfred Jarry's imaginary solutions. This exchange between disciplines is not physics or metaphysics; it's Jarry's 'pataphysics, and it invites significant communications between disciplines, or what might be thought of as translations.

A great example of successful translation within a discipline is the time in which *Faust in Copenhagen* focuses, where open, respectful, and rigorous discourse among the practitioners of physics was practiced. The community that Heisenberg, Niels Bohr, Wolfgang Pauli, and others created and maintained in those years before World War II revolved around institutional and personal mentorships, thinking together and debating in both formal and informal settings, and finding ways to disagree and persuade while furthering conversation. I was especially interested in how peaceful the intellectual conflict regarding quantum mechanics between Bohr and Albert Einstein played out. Around the same time that Heisenberg was developing his matrix mechanics, Bohr rejected the existence of Einstein's "quanta of light," the photon. Einstein rejected Bohr's notion that strict causality only holds for the mean value of a particle taken over

many measurements, and he also rejected Bohr's idea that particles don't conserve energy. Einstein never really came around to quantum mechanics as interpreted by Heisenberg and Bohr, and continuing debates about relativity and quantum mechanics are at the center of theoretical physics today. Bohr and Einstein seemed to both feel deeply about the accuracy of their positions but also seemed to understand the value of inquiry enough to debate without manipulation, aggression, defensiveness, or personal attack.

There seems to be an understanding or belief among poets that the best translators of poems from one language to another are practicing poets, since those who write poetry can often represent challenging or even traditionally un-translatable forms, concepts, sounds, and rhythms using principles and approaches from poetry that a poet would understand in a way that someone who doesn't write poetry might not. Translation is also a political discourse with its inherent interest in expanding communication and experience between cultures. It also seems to be a conceptual discourse in its iterations where translations occur between distinct creative genres. In other forms, translation is a discourse of imaginary solutions that occurs between disciplines like physics and poetry, computer science and visual art, philosophy and ecology. The ordinary risk of translation in any of these contexts might be that the translation fails at adequately communicating or representing what's being translated. However, thinking of translation in terms of stark success and failure doesn't take into account questions about authenticity and whether or not translation is even possible if translation operates at gradations rather than demarcated evaluations of success and failure. Perhaps due to the inescapable result of mistranslation, the act of translation is thus always a creative act, evoking more questions than it can resolve. This is one result of communicating across languages, disciplines, genres, and forms in the multiverse. Imaginary solutions multiply.

Therefore, *indefinitely*:

POETRY IS THE TANGENTIAL POINT BETWEEN BRAIN AND BRANE.

'Pataphysics is *the* physics of poetry….

Robert says

Gino Segre's book, "Faust in Copenhagen: A Struggle for the Soul of Physics" (2007), is a delightful narrative on the early development of quantum mechanics. Niels Bohr is the central character in Segre's refreshing story set in and around the Danish capital in those fruitful interwar years - the 1920s and 1930s. His supporting characters include Wolfgang Pauli and the five others who joined Bohr in that seminal Copenhagen meeting in April 1932 - Paul Dirac, Werner Heisenberg, Lise Meitner, Max Delbruck, and Paul Ehrenfest.

Throughout the book, Segre weaves in pertinent quotes taken from the works of Goethe, primarily from his famous work, Faust. In fact, a famous skit put on by the young physicists of 1932 in honor of Bohr and Pauli leans heavily on the main characters in Goethe's Faust. Segre also skillfully works in the personal changes his characters undergo as they do their work and deal with the external changes swirling all about them.

The year 1932 is considered one of the most significant years in physics because of the **discovery of the neutron** by James Chadwick; proof of Wolfgang Pauli's daring proposal that **a neutrino existed**; and Carl

Anderson’s detective work to validate Paul. Dirac’s hypothesis that **an anti-electron or positron existed**.

This meant that the anomalies found in atomic statistics, especially the well-studied element, nitrogen, was corrected for by neutrons; missing energy that violated the conservation of energy tenet in the nuclear beta decay of matter was explained by neutrinos; and the nuclear reactions in stars was better understood as light was produced by electron-positron annihilations as mass is converted to energy and conversely, pair-production is seen as energetic photons collide to produce electrons and positrons, effectively converting energy to mass. These three discoveries led to specialized areas of physics such as nuclear physics, with Chadwick’s uncovering of the neutron, atomic physics, condensed matter physics, and astrophysics to name a few.

The year 1932 also marked the 100th anniversary of the death of Johann Wolfgang von Goethe, regarded widely as the last true universal genius. This point was not lost on the older physicists of the 1930s, who realized there was too much knowledge to allow one to become a genius across the entire discipline of physics. The evolution of the new physics was one discipline that reinvigorated scientific life in the twentieth century that led to technical innovations that improved the quality of life. some of which I outlined in my book: *A World Perspective through 21st Century Eyes*:
http://bookstore.trafford.com/Product...

Segre’s narrative covering one of the most dynamic periods of the 20th century, the years between 1918 and 1933, frequently integrates the great changes seen in thought, art, politics, social mores, and science. Prior to the rise of Hitler and his Nazi party in Germany, it was “an era of great optimism and wild experimenting.” Goethe, 100 years earlier, would have been pleased with such a representation of “true eminence of mind and spirit.” These changes affect Segre’s characters as the story unfolds for the struggle to uncover the soul of physics. The tug-of-war between Bohr and Einstein for proof that chance and chaos rule over an absolute universal order is mirrored in the struggle of the physicists living in a world imposing rules on how to conduct themselves in society. Faustian bargains were made by all participants in science as they collectively struggled to deliver the theory and experimental proof for quantum mechanics.

I recommend this book for historians of physics and the technically-inclined general public who is interested in physics. The reader will thoroughly enjoy the interactions of those who regularly met in Copenhagen under the guiding hand of Niels Bohr in a quest to legitimize the emerging field of quantum mechanics. Segre looks at the attendees of the regular Solvay conferences and how their participation and subsequent work led to the fragmentation of the discipline of physics into an array of specialties that remain with us well into the 21st century.

Holly says

One of the most intimate-seeming physics histories I've ever read (Segrè's uncle was Emilio Segrè). Also helped me understand Einstein's relationships with the major figures. The meandering and serpentine structure would have made it very difficult to index (I imagine), but did make rewarding reading.

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dejah_thoris says

I think this would be a four-star book for someone not previously exposed to relativity and quantum mechanics because this history focuses on the relationships between scientists and their personal relationship to physics. Explanations of the various discoveries are light, without equations, and easy to follow, almost too simplified if you've read the details in other books. The story of Faust and the Copenhagen version presented in 1932 is woven throughout the text with the original illustrations from the printed version included as well. I really enjoyed learning about the personalities of each famous physicist and who was close with whom but dividing it by discovery or scientist roughly chronologically made the text of the Faust adaptation difficult to follow. Quotes were presented out of order based on who or what they described and I felt like I never got a good sense of the overall play, despite knowing Goethe's original fairly well. Segre tries to explain the original in the beginning and refers to the differences between the two throughout, but not reading the opening of the adaptation until nearly the end of the book frustrated me. I was hoping there would be a complete translated version as an appendix, so I could read it through once, but there is not.

Scott says

This book does a very good job of relating a fairly important topic - the interpretation of quantum mechanics - and setting it within the contexts of historical events and the characters of the physics community of the 1920's and early 1930's. Gino Segre is a theoretical physicist by profession, and the nephew of another great theorist, and his ability to understand and communicate the nature of complementarity and the Bohr-Heisenberg interpretation reflect this pedigree.

However, the unique narrative falls short of being great. Niels Bohr invited a group of talented physicists to Copenhagen each year to discuss the problems of the moment. Big science had yet to develop, and it was possible to gather all the most influential thinkers in developing this new science, plus their selected graduate students, into a small lecture room at Bohr's Institute. An annual part of the meeting was a skit put together by the younger invitees that spoofed their elders. In 1932, the greatest skit of all was performed, a satirical reinterpretation of Goethe's Faust with Bohr cast as the Lord God, Wolfgang Pauli as Mephistopheles, and Paul Ehrenfest as the troubled Faust.

Perhaps this was great because of how well the scientists' personalities corresponded to the characters of Goethe's drama. However, for Segre the drama also represents symbolically the "Faustian bargain" physicists would soon face in unlocking the secrets and dark power of nuclear energy, as well as the last gasp of exuberance and unity before the darkness of war descended again over Europe.

Segre weaves the story of the birth of the Copenhagen Interpretation together with the personal narratives of the key theorists (and one notable experimentalist, Lise Meitner). The climax of the narrative is the agreement between Bohr and Heisenberg on the interpretation, and unfortunately the story does not end there. The Real World is chronologically messy, and does not fit the requirements of literature. The story of the discovery of the neutron and the messy developments of the 1930's-1940's and beyond in nuclear physics intrude on Segre's storytelling, because Chadwick's discovery of the neutron was a major point of discussion at the 1932 meeting, and occurred before the Faust skit used as his plot vehicle. This means that the reader must necessarily encounter another raft of new physics (antimatter, neutrinos, and weak forces - oh my!). For an account intended for the general audience, it would be better to explain the quantum mechanics without looking into nuclear physics and the future.

This is a very good and readable account, and would be enjoyable for those who are not familiar with the science involved.

mali says

I really couldn’t figure out what this book is about, and I suspect that’s because it’s not really about anything. The organization is just so bad there’s no story there, or to be generous, you have to struggle to find it. Ultimately very boring as a result.

Steve says

This amazing book follows the history of the development of Quantum Mechanics. Every year Niels Bohr would invite physicists and their students to attend a conference at his institute in Copenhagen. Older guys like Bohr, Einstein, Planck, etc., and youngsters like Heisenberg, Pauli, Ehrenfest, Born, etc., would all attend and discuss ideas. Imagine being there and just listening to Bohr and Einstein argue for a couple of days, each trying to convince the other (and failing). Basically, every 20th century physicist you ever heard of was working together with these guys at some time. At one point they're all looking at atoms like a mini solar system, using something called Matrix Algebra to try to figure out how it's all working, and Schrodinger, out of the blue, releases a paper describing how it all works with waves. I can't say I can explain quantum mechanics to anyone, but I did learn a lot more about it from this excellent book. The author, Gino Segre, is a physics professor at the University of Pennsylvania, and his uncle Antonio Segre won the Nobel prize for physics.

Jim Coughenour says

Another chapter in the fascinating relationship between Bohr, Heisenberg et al. Segré centers his account on the legendary gathering of physicists at Bohr's Institute in 1932, the year before Hitler's rise to power would scatter their company across the globe.

The social history is mildly entertaining, and the development of quantum theory and its associated controversies is presented so that even a dilettante like me can follow it, but the "Faustian" drama at its core is minimal. The implicit morality tale feels a bit forced. And for me, every key turn of the story evokes Richard Rhode's magnum opus *The Making of the Atom Bomb* as well as Michael Frayn's play *Copenhagen.*

Which of course is unfair to Segré... but I suspect I'm not the only one who reads him in the shadow of those greater works.
