

Michael Berry

Great physicists recalled and respected

The Genius of Science: A Portrait Gallery of Twentieth-Century Physicists

Abraham Pais

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I approached this latest collection of Abraham Pais's reminiscences with the unworthy suspicion that it might consist of scraps from the many notes the author must have made for his previous biographical and historical works. The opposite is true: these are well crafted, varied, charming and fascinating essays. The 17 physicists and mathematicians from the last century are ordered alphabetically, rather than chronologically or by the importance of their discoveries: how invidious that would be. They are selected on the basis that Pais knew them as friends or colleagues. (Most are dead.)

All physicists will enjoy the anecdotes with which these essays are peppered – and indeed some are rather spicy. Many are venerable, but bear repeating, like Neils Bohr's dictum to "never express yourself more clearly than you think" and Wolfgang Pauli's cutting response to a fledgling physicist: "So young, and already so unknown." Also included is the comment from Paul Ehrenfest who, exasperated by Pauli's sarcasm, declared, "Herr Pauli, I like your article better than I like you", only to receive the calm response, "That's funny, with me it is just the opposite".

How this contrasts with the legendary politeness of Eugene Wigner, who, when frustrated by an inept garage mechanic, invited him to "Go to hell, please". We learn about Bohr's lifelong routine "to do the work himself but let others do the writing" (these days Yakir Aharonov does the same), and Isidor Rabi's rebellion against his Jewish upbringing by replacing his bar mitzvah speech by a lecture on "How electric light works".

At a time when our universities are scrambling to anticipate every scrap of profit they can squeeze out of science, and administrators (most of whom have never made a penny in any honestly competitive marketplace) strive to impose the "enterprise culture", it is salutary to read the wise words of those scientists whose discoveries laid the foundations of our knowledge economy.

Thus, we note the following from John von Neumann: "A large part of mathematics which became useful developed with absolutely no desire to be useful... This is true for all science. Successes were largely due to... refusing things which profit, relying solely on... intellectual elegance. It was by following this rule that one actually got



Portraits – clockwise: Einstein, Kramers, Wigner, von Neumann, Serber, Rabi, Pauli, Bohr, Born and Dirac

ahead in the long run, much better than any strictly utilitarian course would have permitted... The principle of *laissez-faire* has led to strange and wonderful results."

And from Rabi: "My opinions on this subject come from a five-year war experience... Should the universities become more like the commercial and the government laboratories? I think not... We should not endanger the existence of the little oasis that is free, and not under the direct necessity of continually justifying itself in the material sense."

And how refreshing to read Res Jost's answer to the question: where is science going? "I don't know an answer", he replied, "that satisfies even the slightest standard of credibility."

Pais gives much insight into what these 20th-century physicists thought about the philosophical implications of their principal creation, namely quantum mechanics. We learn Hendrik Kramers' opinion of the correspondence principle: "A rather mystic wand that did not work outside Copenhagen." This resonates strongly with what we are only now starting to understand as the full richness and subtlety of the classical limit. We also learn how Max Born's probability interpretation of the wavefunction was ambiguously inspired by Einstein and then strangely neglected by those who were furiously developing the new physics.

I do not quite agree with Pais that "with Bohr's [complementarity] paper of 1927 the logic of quantum mechanics as we know it today reached closure". Nowadays, with experiments on individual microscopic systems and the systematic exploration of quantum entanglement and the effects of uncontrolled disturbances from the environment, this seems too final a judgement. But in contrast to some contemporary thinkers who denigrate Bohr for the obscur-

ity of his writings, I do agree with Pais's assessment of Bohr's principle of complementarity as an original and important contribution to philosophy.

The few quibbles I have are minor. The famous singer is not Born's daughter Irene, but *her* daughter Olivia Newton-John. David Mermin told me that after reading Pais's colloquial injunction "Go figure" in the chapter on Mitchell Feigenbaum, he did just that – only to discover that the numbers in the table of period-doublings are wrong. Reading the same chapter, I wondered why the author thought it worth telling us that Feigenbaum was toilet-trained by six months. It would also have provided helpful information to the reader if the references had included titles and last-page numbers.

In addition, Pais's account of Dirac's equation for the electron implies that its magnetic moment emerges naturally only by incorporating relativity, but this is wrong. As Feynman and others knew, a simple non-relativistic form for the kinetic energy of a spinning electron in a field gives the magnetic moment correctly. And although Pais's use of the term "onomasticon" for his index of names and dates is technically correct according to one dictionary definition, every other onomasticon I can find elsewhere is not a mere list but also includes explanations.

Pais's good humour, and his obvious affection for his subjects, are here combined with a frank assessment of their frailties. This makes his book a delightful read, and also an enlightening one, about a group of people whose intellectual constructions represent a summit of human understanding of the world, and are who in the process of transforming our civilization itself.

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