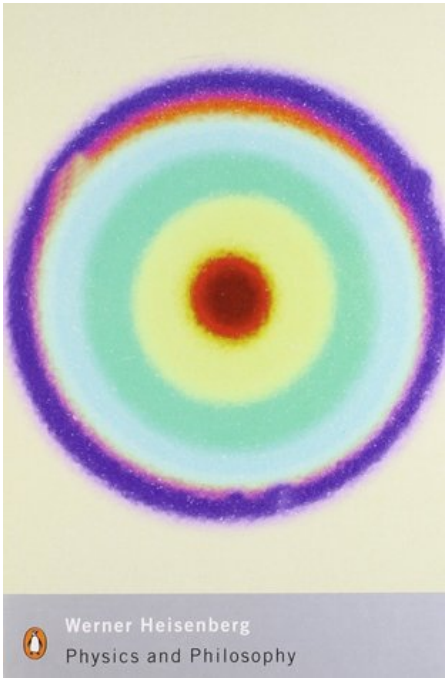

Physics and Philosophy: The Revolution in Modern Science

Werner Heisenberg , Paul Davies (Introduction)

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Physics and Philosophy: The Revolution in Modern Science Werner Heisenberg , Paul Davies (Introduction)
Nobel Prize winner Werner Heisenberg's classic account explains the central ideas of the quantum revolution, and his celebrated Uncertainty Principle. The theme of Heisenberg's exposition is that words and concepts familiar in daily life can lose their meaning in the world of relativity and quantum physics. This in turn has profound philosophical implications for the nature of reality and for our total world view.

Physics and Philosophy: The Revolution in Modern Science Details

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From Reader Review Physics and Philosophy: The Revolution in Modern Science for online ebook

Austin Wright says

Physics and Philosophy by Werner Heisenberg Review

Physics and Philosophy is a book published in 1962 by Werner Heisenberg, a “giant of modern physics”, about the theory of Quantum Mechanics and its philosophical implications. This book is certainly best read with prior knowledge of some classical and some quantum physics. I actually read it knowing little or nothing about quantum physics, and the parts that described in detail the physics seemed technical and hard to understand, yet still i could make sense partly of most of it. But then I took a course in quantum cryptography and looking back at it it all makes well enough sense. So knowledge of physics is very highly recommended. As far as the philosophy goes i found it much easier to understand as he talks about high level concepts in ancient greek and renaissance thinking.

If fully understood this book can really help to inform our perception of reality and how quantum mechanics has changed that. Forever we have imagined the world as objectively “real” that whether or not we observe something it is the same, that one thing must be in one single place at any given time, that time and space are infinitely divisible and constant. This book uses the proven theories of quantum mechanics and relativity to help break those notions on what reality truly is and it is this aspect of the book that i find most enthralling. It uses logic, experimental evidence, and facts to undermine objective reality and replace it with a weird, alien view of everything. This book is incredibly important more so for philosophers thank physicists because it breaks many core assumptions down and replaces them with new and strange, yet experimentally proven results that, taken to logical fruition, produce the likes of Schrodinger's Cat which is in a superposition of dead and alive, that is to say, both dead and alive simultaneously. It are these ideas that radically change the basis of much thought ever since the beginning of human history.

I recommend this book only if you have at least a rudimentary understanding of some physics and algebra, and if you are open minded enough to question the very core beliefs of reality, because that can certainly be alot to fully grasp. Otherwise this book can seem very technical when it talks about physics, and strange about philosophy. But if you can understand and accept the statements made here then it is an absolute must read provoking some deep insight into some of the largest and most fundamental questions of reality.

Maurizio Codogno says

Per dirla in maniera tecnica, la teoria dei quanti è un casino. Non tanto dal punto di vista matematico: dopo un po' ci si fa la mano. Il vero problema è che l'interpretazione dei risultati è così lontana dal nostro sentire comune che si cerca più o meno consciamente di riportare tutto alla sana meccanica classica. Heisenberg non è d'accordo, e ha scritto questo libro proprio con lo scopo di mostrare perché i quanta non possono essere studiati con il paradigma non solo scientifico ma anche filosofico dei due millenni e mezzo precedenti. La lunga introduzione di Northrop era troppo piena di paroloni per un'anima semplice come me; Heisenberg scrive in modo molto più comprensibile, ben tradotto da Giulio Gignoli, a parte un po' di pesantezza lessicale dovuta probabilmente ai più di cinquant'anni passati dall'edizione italiana. Diciamo che Heisenberg spiega ben chiaramente che il modo in cui eravamo (siamo?) abituati a comprendere il mondo fisico non funziona

più nel caso dei fenomeni quantistici; ma non pensate di trovarci un nuovo modo per leggerli che non sia quello di seguire le formule matematiche e fidarsi di esse :-)

Anna Hiller says

This is really a book about physics that only lightly touches on philosophy. A good reason to read it would be to understand why it is that 20th century physics totally changed the world, something that I think is generally forgotten these days in spite of our (ab)use of technology, the prodigal *wunderkind* of the advances in science over the last 200 years or so. The thing to remember about Heisenberg's book is that it was written at the height of the Cold War, and therefore beneath the shadow of nuclear weapons... in fact, he states that right on page one. And so his conclusion with its conflicting apocalyptic/utopian possibilities for the future is very much a product of his time. Heisenberg's style is very indirect and hesitant, kind of surprising considering his prominence in the field. Altogether informative, if a bit dated. Lindley's introduction in the 2007 edition is fantastic, and makes up for the timewarp.

Manab says

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Marawan Awad says

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Mengsen Zhang says

ok. it's a great book. I'm giving three stars based on my personal experience with this book-- I do not fully understand his composition of this book. I have to ignore many passages to have a holistic impression of what he's arguing about.
Based on what I understand, I would give this book another name: "Language and Dispute: the evolution of human knowledge". I would say it's more about language and reality rather than physics and philosophy. The most charming part of this book to me, is his analysis of the notion of "matter" (or atom, or the essence of objects) about how it evolves from ancient philosophy to classical physics and then to modern physics. He compared the representation of reality with mathematical language and natural language. The use of language is stabilized by the connection between words, but what a word itself is representing is very unstable (alright..uncertain if we like). As a description of the world propagates via linguistic representation, the abstraction and precision of the description becomes lost person by person, or generation by generation... until, some how, modern experimental apparatus widen the spectrum of events can be observed, and save the mental effort for people to achieve that order of abstraction.
I also found the bonus read-on "science and religion" quite interesting. Especially the little story about the debate between Heisenberg, Dirac and Pauli over the relationship between science and religion (I love Pauli the most!). It is a miniature reflection of the book (most likely to be unintended). Apparently, among these three giants of quantum physics, there was a very *uncertain* representation of events by the word "religion" or "God". Some of them referred to a description of reality, while others referred to the utility of that description. And it is fun to see them arguing about the *symbols* rather the reality they each have in mind.

Robert says

REVIEW OF THE BOOK AS A WHOLE

Really, the title should have warned me that I was unlikely to get along with this book - but it doesn't actually say, Physics and Metaphysics. I have very little time for metaphysics; it's day is long since past (couple of millenia, at least) and it is really only of historical interest to those concerned with understanding nature. Far too much of the book is spent on either; comparing quantum mechanics (QM) with Western metaphysics or pondering unanswerable conundrums, like, "does anything exist when it isn't being observed?" and "what type of reality is really real?" What science does (with increasing precision over time) is attempt to explain the *contents and behaviour* of nature, not whether it is "dogmatically objective" or some other type of objective or subjective or, who knows, subjunctive or conjunctive or metastatically cancerous...

This comparison with western metaphysics is as profitless as the later (80s-90s) fad for comparison with "eastern philosophy." Metaphysics, regardless of hemisphere did not lead to nuclear reactors and smart phones, so any apparent correspondences are vague, incomplete and of no practical use.

Heisenberg seems inconsistent at times, which is a bit naff in a book on science *or* philosophy, let alone both. For instance, he states categorically that no human observer is actually necessary in QM but later seems to tacitly assume the opposite. He's also wrong about a few things, but only in the light of 50 years' worth of further scientific investigations.

I also don't know who the intended audience is; he assumes quite a bit of knowledge of both physics and metaphysics - certainly too much of the former for a non-physicist audience now or then and too much of the latter for present-day non-philosophy students.

Probably the only really valuable insight I got from the book was the point that General Relativity isn't a limiting case or approximation of (or to) *any* other physical theory: it famously can't be integrated into any current quantum theory but it can't be derived from any other *classical* theory either, not can any other classical theory be derived from it: It just stands there in majestic aloofness. It has done since it was first published and still does now.

The other segment of interest to me was the final chapter on the influence of science in general and modern physics in particular on contemporary society - *here's* where I think general philosophical thought might profitably be focused, along with close examination of recent history.

The book also seems badly organised; why does the chapter on alternatives to the Copenhagen Interpretation of QM not follow immediately after the chapter on the Copenhagen Interpretation itself, for instance?

I find it difficult to recommend this book to anybody: if you want to become familiar with the central concepts of QM, The Character of Physical Law by R.P. Feynman is enormously better. Einstein's own book is a much better introduction to Relativity theory (especially if you can remember school algebra). If you are interested in the philosophy of science, this book won't help. It's too out of date to work as an introduction to the state of contemporary fundamental physics. The only bits that seem to remain really relevant are the thoughts about the use of language in science and the thoughts on science's impact on society at large.

Below the line: more or less chapter by chapter thoughts whilst reading.

Insufficient room in the status update field so I'm gonna have to post my thoughts here as I go along.

Despite the lack of mathematics, I already can't recommend this for non-physicists: I think they'd be terribly confused and horribly lost by the end of Chapter 2. On the other hand, this might be very good for current physics undergrads who've done an atomic physics course already.

Interesting errors and confusions in Chapter 3:Conservation of energy: Heisenberg states that initially this was believed to be true only statistically for quantum systems but in fact turned out to be exactly true always. This is not correct; conservation of energy can only be said to hold to the accuracy given by - fanfare! - The Heisenberg Uncertainty Principle! One of the bizarre consequences of this is the phenomenon of quantum tunneling, which was unknown at the time of publication.

Heisenberg states that quantum mechanical experiments consist of three parts, an initial set up in terms of classical physics, an unobservable part only describable in terms of what we would now call the probability wave-function, and a measurement only describable in terms of classical physics. Only the middle part of this is correct; it is entirely possible to describe an experimental set-up in quantum terms and also the measurement of the result in quantum terms, too. (The middle bit is indeed not describable in any normal sense.) Take the photon double-slit experiment. The emission of the photons can be described quantum mechanically *but so can their reception at the detector* if you use photo-multiplier detectors, for example.

Ah! I hear you cry, but the *real observation* is by the human eye, when the flash from the photo-multiplier hits the retina!

Sorry - the optic nerve is a receptor of quanta, too. The whole system is describable quantum mechanically.

Heisenberg then goes on to more or less follow my argument in a vague way. (It's enormously easier to make it precise in the light of half a century's technological advances.)

And here's something really important that we agree on. The *human observer* is not in any way an *essential* part of the system. The idea that the entire universe stopped being just a cloud of probabilities the day a sufficiently astute observer appeared is not in any way required by or implicit in the Copenhagen Interpretation.

...and we're only about 1/6th the way through...

Chapter 4: Waffling comparison of ancient Greek philosophy and quantum mechanics. The most important thing here is the bit where he explains the *difference* i.e. QM is based on experiment where-as ancient Greek philosophy is based on yabbering on without having a clue.

Some interesting points are raised, though; "What's a particle?" is a very hard question to answer in QM. "It's a probability wave packet," isn't a very good answer; it's a form of energy is better (except, what's energy?). Today you might get, "it's a resonance in a field." Leading straight on to, "What's field?" Well, it's something emitted by particles that controls how they interact with each other... This is just wave-particle duality all over again, with waves disguised as fields.

He also expresses the views that the ultimate quantum theory would take the form of a single equation that would yield solutions representing the fundamental particles and the forces between them and that in fact there will turn out to only be one kind of particle that is truly fundamental. The former is the approach taken by current Guess the Lagrangian approaches to the problem and the latter is adopted in string theories (all 10^500+ of them...).

Chapter 5: Physics vs. Metaphysics: Physics wins! Or summat.
Is there such a thing as objective reality? Yes! OK - I can agree with that. But I don't really understand when he starts trying to distinguish between *types* of objective reality. I mean, in science you get successive different theories of the *behaviour* of objective reality but that doesn't seem to be what is being discussed. It doesn't seem to be the old causality vs. indeterminacy chestnut, either. Colour me baffled - and not caring much, either.

Chapter 6: Relation of QM to other sciences.
Here Heisenberg seems to be groping after a coherent general philosophy of Emergent Behaviour without quite getting there; seems more in the Emergent camp than the Reductionist camp, anyway. One interesting comment is that biology requires physics/chemistry plus "history." The history allows for evolutionary theory by way of genetics. But one could view "history" as actually being emergent from physics by way of the 2nd Law of Thermodynamics, a connection he does not make.

He also discusses the main theories of physics in relation to each other: Newtonian mechanics is an approximation to Special Relativity which assumes an infinite speed of light. It is also an approximation to QM assuming an infinitely small Planck's Constant. Thermodynamics can be understood as a statistical theory of particles and can be derived from either QM or Newton's Laws. But General Relativity sits there looking lonely and mean, yet beautiful, and defying all attempts to integrate it into any other aspect of physics as any kind of limiting case or emergent theory.

The error regarding the description of QM experiments in terms of classical physics is repeated.

Chapter 7: Relativity.
Einstein's book will give you a clearer understanding of Special Relativity and the Principle of Equivalence but you will need to know some (school) algebra. On the other hand, that is a whole book about the same length as this one, not one lecture/chapter. A point re-iterated through out the chapters so far is the use by physicists of ordinary language in specialised ways. This is essential as it turns out that "ordinary" concepts like space and time, on closer examination turn out to be much more subtle and complex phenomena than is readily appreciated in daily life. I think one of the later chapters goes into this in depth.

Heisenberg emphasises that General Relativity is not on a strong experimental footing; it wasn't then but it is now. Some of the cosmological questions raised have been answered, others haven't and recently new and even more freaky ones have been found.

Chapter 8 seems (as far as I can tell) to come down to, "Does the particle exist when you're not looking?" Well, that question isn't any more answerable than the question in classical physics, "Does that brick exist when you're not looking?"
"Looking" here means doing anything in order to verify the existence of the particle/brick. Assuming something doesn't exist when you're not "looking" is essentially Solipsistic/Cartesian and denied by the persistence of macroscopic objects.

The Everett Many Worlds Interpretation hadn't been thought up yet, so isn't discussed. The main focus is on "hidden variables" notions.

I'm getting impatient for this to be over...

The remainder:
A chapter surveying the contemporary state of sub-atomic physics. Of course, it's out of date. Most interesting now for it's speculation that the number of types of truly elementary particles will drop, possibly to one. What happened between then and now is that the number went up for some time, then dropped again as quark-theory was verified and recently went up by one again with the discovery of a "Higgs-like boson." Given the current experimental evidence/hypotheses/theories in cosmology, one would think the number will more likely go up rather than down in the immediate future.
Chapter on language in science and physics in particular in relation to "every-day" language. Perhaps the most obvious pervasive theme of the book.
Final chapter on the effects of modern physics and nuclear physics in particular on society at large and it's mode of thought. More interesting than almost the entirety of the rest of the book.

Amy says

Some Knots Have Knotted Limbs

Toward the end of *Physics and Philosophy* Werner Heisenberg presciently mentions the incompatibility of quantum mechanics with relativity and the need for coherent concepts that allow for both theories without mathematical inconsistencies. Today unified field theories of quantum gravity that attempt to reconcile quantum mechanics with relativity are being explored by physicists in proposals like string theory. Heisenberg also mentions that the physicists of his time were discovering elementary particles by

experimenting with high-speed particle accelerators (which he calls “big accelerating machines”), referencing a machine in Geneva, what we now know as the operational Large Hadron Collider at CERN that is testing aspects of string theory by attempting to recreate conditions of the universe during the Big Bang.

Heisenberg’s discerning comments about the future are not surprising given the intricate attention he pays to contemporary and historical conditions through contextualizing quantum mechanics in relation to everything from Einstein’s relativity—Heisenberg’s uncertainty principle rebuts Einstein’s notion that probability cannot be expressed in physical reality—to atomic weaponry to Western philosophical thought (Descartes, Berkeley, and Kant).

Heisenberg relates quantum theory to the first conceptions of atomic science, starting with Thales, who says that water is the fundamental substance of reality. After Thales, Anaximander says the fundamental substance is ageless and eternal but nothing that can be known; his student Anaximenes says the fundamental substance is air. Heisenberg notes that Hereclitus’ argument for fire being the fundamental substance comes closest to his contemporary understanding of atomic science if only the word, “fire,” was replaced with the word, “energy.” It was Empedocles who shifted the debate from monism to pluralism by proposing the fundamental substance could not be one substance but instead the four basic elements. When Anaxagoras proposed that matter is composed of small seeds and that all change is caused by mixture and separation, he was just one step to the concept of the atom, which occurred with Leucippus and Democritus proposing that the smallest unit of matter is finite, eternal, and indestructible and that motion is made possible by the empty space between these units. Plato then articulated a theory of matter that combined Democritus’ atomism with the teachings of Empedocles and Pythagoras (who inspired schools of ritualistic Dionysian number theorists who took religious oaths to the *tetraktys*, the fourth triangular number of 10) to propose that the smallest units of matter are mathematical forms, about which Heisenberg comments, “here it is quite evident that the form is more important than the substance of which it is the form.” Like a poem?

Describing his understanding of the structure of language, Heisenberg quotes from Goethe’s *Faust*, where Mephistopheles tells the student 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 unnumber’d flow,/A thousand knots one stroke combines.” In addition to the swift darts and unseen threads of the imagination science must also be based on logic, open to pattern and swerve. Yet Heisenberg acknowledges there is no adequate language for quantum theory, which suggests that any novel science must concurrently create a novel language—poems?—where a “thousand knots one stroke combines.”

Zeiad ?Almallah says

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Ashkan Ansari says

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Cassandra Kay Silva says

Heisenberg the famous Nobel Prize winner takes us through the building up of our current understanding of Quantum Reality and the physics that lead up to this. He gives a good discussion of the Uncertainty principle of which he is so famous for and how this will impact the future of physics and how we see the world. The title is misleading however, don't expect much philosophy out of this book, and of course it was written when many ideas of modern physics were not even hardly fleshed out yet. I think this makes it interesting to see where he though physics might go, and compare this to the current state. It makes you wonder what he would have though of the work going on in Geneva, and how he would have looked at some of the physics of today.

Lucas says

Cu?i cùng c?ng "lu?c" ???c xong quy?n này. Nhìn chung là v?a hài lòng, v?a không hài lòng. ???c vi?t b?i cha ?? c?a c? h?c l??ng t?, m?t t??ng ?ài c?a v?t lý hi?n ??i, tôi k? v?ng quy?n sách này hay h?n th?. Tuy nhiên, có quá nhi?u thu?t ng? và ngôn t? c?a v?t lý và quá ít ch?t tri?t h?c trong quy?n sách này, do ?ó, s? là m?t cu?n sách khá khó ??c cho dân ngo?i ??o.

Tuy nhiên, ph?n tri?t h?c ít ?i trong sách l?i không h? là m?t ch? ?? khiêm t?n chút nào, nh?t là khi nó g?n nh? là m?t kh?ng ??nh cho quan ?i?m c?a tôi v? khoa h?c, tôn giáo và t?t nhiên, tri?t h?c. Còn gì sung s??ng h?n khi ???c nghe chính m?t nhà v?t lý ?o?t gi?i Nobel kh?ng ??nh suy ngh? c?a mình là ?úng c? ch?? S? vô h?n ?i kèm tính gi?i h?n c?a khoa h?c; thuy?t b?t kh? tri; vai trò c?a khoa h?c và tôn giáo; hai ni?m tin ? Chúa; s? hình thành ngôn ng?; t? nhiên và k? thu?t; lý thuy?t và th?c nghi?m.. t?t c? ??u ???c nh?c t?i trong tác ph?m này.

M?t cu?n sách hay là m?t cu?n sách truy?n c?m h?ng. ??t nhiên tôi th?y mình ti?n thêm m?t b??c g?n h?n v?i chân lý, sau khi ??c xong quy?n sách này. Thêm m?t quy lu?t n?a mà ??u óc t?m t?i c?a tôi b?ng ng? ra. C?m ?n Werner Heisenberg, xin c?m ?n ông!

P/S: K? ra nên ??t l?i tên cho quy?n sách là "M?t t?n v?t lý và m?t tí tri?t h?c" thì s? chính xác h?n, tôi ngh?

v?y.

Yasser says

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Martina says

This has got to be one of the most singular reading experiences ever. Ever. Heisenberg's book is so unusual, refreshing and unique - I'm not even sure on which shelf to put it. The funny thing is, this book is not so much about physics, or about philosophy, for that matter. Perhaps a more apt title would be *The life and times of Werner H.* It reads like a novel, and, in a way, it is a novel. I would call it a "novelized autobiography", for Werner talks about his life, his work, his thoughts in a series of episodes, referencing many political and historical events and famous persons he had a chance to meet. It's all written in a lively style, which is quite unexpected for someone who is deemed to be a great physicist of the 20th century (and physicists are supposed to have dull writing styles :P).

As most people, I'm curious about the lives of people who had done something worthwhile. It's a benevolent kind of curiosity that drives one to ask questions about the person behind that big name; a person with likes, dislikes and quirks, a person who wasn't born with an innate knowledge of his or her discipline, but who had to work to get where he or she is at. And in that regard, *Physics and philosophy* is a great accomplishment, because we have a chance to get to know the real Werner Heisenberg. Not just the guy who founded matrix mechanics and gave the world the uncertainty principle, but a nature lover with a penchant for music, who had engaged in the works of a youth organization and who had no qualms whatsoever to work as a lumberjack just to alleviate the financial strain from his father.
But all this information is more like a subtext of the book; Heisenberg, for the most part, concentrates on his studies and professional career, and doesn't talk about physics in a textbook manner. Rather, he talks about the problems that preoccupied him at the time, with just enough hints so that readers versed in physics know what he's saying, and that the laymen readers don't get bored.

But for me, the biggest thing Werner accomplished with this book, is the portrayal of the zeitgeist in his country (in his youth) and later on in the world. No, I'm not going to romanticize the time he lived in. We all know about the gruesome things that had happened (time frame: Heisenberg was twelve at the beginning of WWI)... I'm referring to the general climate after the 1st World War. It was a time when people read more, played music together (by and by, Heisenberg was an excellent piano player), and were not afraid to dabble

in things that weren't their specialty. Almost everyone had interests on the side, and pretty substantial ones - like reading philosophy books - and even young people were not shy to discuss their personal thoughts on this or that matter. I was amazed at how perceptive many of those young people were at the time (according to the conversations Heisenberg had relayed in the book).
To make things even more exciting, it was a dawn of a new time, the birth of atomic and molecular physics, quantum mechanics, and relativistic physics. So it's not all together surprising that many of the scientists Heisenberg had encountered, even during his university years, ended up as Nobel prize winners. We meet a whole host of them throughout the book, and somehow, we get to know them as people, or at least Heisenberg's impression of them. His teacher Sommerfeld, and his university colleague Pauli; then Bohr himself, Einstein, Schrödinger, Dirac... Just reading about Werner meeting all these people (especially from today's perspective) is totally mind-blowing. It's true that Heisenberg had edited out a large quantity of "physics talk" with them, but he included other conversations which were not so much on philosophy, but more about *life* and beyond. Those conversation revealed much about the participants. They even managed to endear Niels Bohr to me, and by that alone, you can tell how persuasive Heisenberg's writing is! (view spoiler)

I also loved that we got deeper insight into Heisenberg's own thinking processes. His account on how he got to the groundbreaking idea of the uncertainty principle should be mandatory reading. (view spoiler) The book is also incredibly witty, especially when Heisenberg paints humorous scenes. (view spoiler) And it's chock full of memorable quotes; if I started to quote now, I would probably use up all my characters. If you have a chance to read this book, do it. You won't be sorry.

Ahmed says

17:05

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