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Through the quantum looking glass: revisiting quantum myths

ICFO researcher Hippolyte Dourdent has written a popularization book on quantum science and technology to explain why quantum mechanics is not that weird.

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i¿½When I was a kid, I had two dreams: becoming a researcher and writing a book.i¿
? Hippolyte Dourdent, currently a postdoctoral researcher at the Quantum Information Theo
y group at ICFO led by ICREA Prof. Antonio Acin, has recently fulfilled his second dream
y publishing a popular science book on quantum science and technology (for the momen
, only available in French) calledDe l'autre cote du miroir quantique, which in English means
Through the quantum looking glass.
To understand how he finally made both whishes true, we have to go back to where all the
good stories start: a child's fascination with storytelling and mystery. i¿½I remember being
five years old and telling everyone that I wanted to be a researcher, even though I had no
idea what that meant. In my mind, researchers went on adventures to solve problems,i¿
? recalls Hippolyte. At that time, though, he was not interested in physics at all. He was rath
r fond of history. Physics, he said, felt cold compared to history, detached from the real-wor
d problems, emotions, and personal narratives. i¿½**wanted to do research because I wanted to
tell stories,**i¿½ the researcher add
. One day, he read something in a book that changed his mindset forever: the atoms th
t compose ourselves, our planet, and the entire universe, they all came from stars. Tha
, basically, we are stardust. i¿½hat sentence... it just blew my mind.i¿½ He then realized th
t physics is another way to tell stories -stories told in a different language called mathematic
, but stories nonetheless. In that sense, physics is even more ambitious than history, becau
e instead of trying to explain the story of humans, it tells stories about the universe. i¿½**In a
way, I did end up doing history. I am just doing the history of the universe,**i¿½ says t
e researcher, half-nostalgic, half-joyfu
. Hippolyte admits that he has always been drawn to i¿½eird things -or the weird in general-
as well as deep metaphysical questions.i¿½ It is no surprise, then, that he came to work
n quantum foundations, the field that tries to identify what is strange about quantum physi
s and why that's the case, in order to understand what makes this theory different from othe
s and how we can use that to our benefi

From dream to dream: how quantum foundations research led to his first book

Foundations don't just address big metaphysical questions, though. i¿½One can focus on a specific quantum phenomenon too. In Antonio Acin's group, for instance, many people are specialists in quantum nonlocality,i¿½ remarks Hippolyte. Quantum nonlocality arises fr m quantum entanglement, a fundamental aspect of quantum mechanics that produces su h strong correlations that they would be impossible in any classical syste . But Hippolyte likes the weird within the weird, so he has immersed himself in a task that is s challenging as it is fun: pointing out defining quantum features by exploring what they a e not. i¿½like to play with post-quantum theories. They are like cousins of quantum theory: similar, but not quite the same. Some people call them ?foil theories', because, like a foil character in literature, they help us better understand the protagonist by contrast,i¿½ explains the researcher. i¿½It is not science fiction, but in a way, I do fictional science.i¿ ? Perhaps this closeness to literature is what led Hippolyte to write a book. In fact, his career n quantum foundations played a key role. i¿½Alexei Grinbaum, a Professor at Universite Paris-Saclay and Research Director at CEA-Saclay, had been discussing with an editor of Dunod the idea of writing a book on the second quantum revolution,i¿½ the one that m y bring us quantum computers, quantum internet and quantum cryptography in the futur . Hippolyte met Alexei Grinbaum years ago, when he was an unsatisfied undergraduate w o decided to take a gap year. i¿½ school, I was learning about atoms and photons, which was very interesting, but not philosophical or abstract enough for me,i¿½ recalls Hippolyte. So, e took a year off to explore what traditional coursework had overlooked: the philosophical a d foundational aspects of quantum science. His supervisor during that time was, precisel , Alexei. Having worked closely together, the professor knew Hippolyte's strong background n foundations, as well as his interest in science popularization. i¿½was thrilled when he contacted me to collaborate on the book. And even though he didn't have the time to join in the end, his work has definitely been a huge inspiration,i¿½ says Hippolyt

The dangers of a quantum meta black-box

Despite the second quantum revolution was the initial motivation, quantum foundations quickly became central to the book, mainly as a tool to combat the ?black boxing' of quantum technologies. According to this concept, introduced by the French philosopher Bruno Latour in 1999, the more science and technology evolve, the more obscure they become. Hippolyte is concerned that i¿½quantum mechanics is already inside a scientific black box, because everyone says it is so strange that nobody understands it.i¿ ? We might not know how our mobile phones work, but we never assume the science behi d them is incomprehensible. Yet, we tend to (mistakenly) see quantum science as somethi g inherently unreachable, even to scientists themselves. Hippolyte takes this almost personall : i¿½**What does it mean that ?we don't understand it'? I hate this sentence. It is just a way to let**

go of the question, to let go of foundations!i¿
? He wonders about the danger of putting quantum science in a black box within another bla
k box - a ?meta black box', as he calls it. He warns that people could easily fall in
o conspiratorial thinking around a technology that will likely be controlled by industries a
d governments (and not personally used by ourselves), and that apparently relies on a bizarr
, mysterious theory. Hippolyte insists that i¿½if you learn the math, it is actually consistent.i¿
? According to the researcher: i¿½**We do have a kind of understanding of quantum mechanics. Not necessarily the understanding we wanted, but we understand it in a certain way, which is perfectly logical when you accept the mathematical rules.** People need to be aware of that.
i¿

Through the quantum looking glass tackles this issue by debunking the myths surrounding quantum physics. In a clear reference to the Lewis Carroll classic, Hippolyte uses the mirror picture as a guiding thread throughout the book, i¿½to turn the figurative language people often misuse in quantum contexts back onto itself,i¿½ exposing where those metaphors fa
l or mislead. Essentially, i¿½eflecting them back to reveal their flaws.i¿

Demystifying quantum myths

In the book, Hippolyte presents the quantum realm as a demonized world, where the ?weird' quantum phenomena are demons that the reader must confront. i¿½Each chapter corresponds to one demon and begins with an invocation, a sentence we've all heard about that phenomenon,i¿½ explains the author. i¿½For example, ?the cat is both dead and alive' invokes quantum superposition.i¿½ He then unpacks the meaning behind the sentenc
, pointing out what is genuinely strange about it and in what way, ultimately demystifying it.
t the end, there is what he calls i¿½n exorcismi¿½, which is simply a summary of what h
s been learnt in the chapter. Overall, the book is structured so that i¿½the reader embarks on a journey encountering weirder and weirder demons.i¿
? To accomplish this, Hippolyte had to confront the fact that our everyday language can fa
l short when trying to describe quantum phenomena, and that sometimes quantum effec
s follow a different logic. Moreover, in order to reach a broader audience, he had
o communicate without relying on mathematics, the theory's native language. To do so,
e made use of science fiction, mythological and even biblical references to illustrate technic
l concepts and engage with the reader. i¿½also introduced logical paradoxes, like Escher's waterfall,i¿½ says Hippolyte. He claims that, sometimes, the construction of these impossib
e figures is i¿½very similar to how concepts like quantum contextuality are actually proven.i¿
? In this way, **the book deepens our understanding of what the word ?quantum' really means, erasing the myths ingrained in our minds, so that we can look at this field without prejudice and preconceived notions.**

However, it is clear to Hippolyte that we should not just aim at demystification, but we should avoid myth-making in the first place. The researcher believes that i¿½contextualization from

historical, philosophical and sociological perspectives is essential to achieve so, not just for quantum theory, but for all sciences.i¿½ Quantum foundations is also a powerful tool f r preventing myths, i¿½ecause it tells us that we have a good understanding of quantum theory, but, at the same time, it can be further improved,i¿½ he adds. By recognizing t e limits of our knowledge, and learning to distinguish between myths and unresolved scientif c questions, we can make the black box a little less black. i¿½ometimes you need to think outside the box to realize that the box is actually there; then you just have to try to open it.i¿½