

POST

Proof why "weirdness" will be so special . .

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June 20, 2021

Quantum AI Environmental Protection Machine

“Normal” Classical Physics is Just as Weird as Quantum Physics ... let’s be honest with ourselves about this fact.

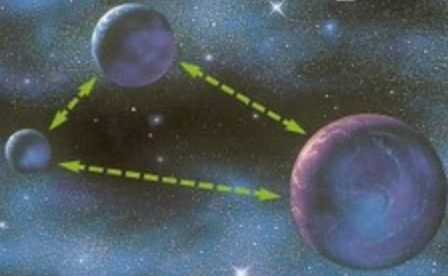
99.9% of people are thinking of a quantum computer as just a more powerful computer. It’s therefore hard for them to see anything special about harnessing quantum computing, and why EnviroAI could use it to help build an environmental protection machine. **THAT’S NOT WHAT A QUANTUM COMPUTER IS.** (Again I would point you to the links below). **YOU MUST GRASP ITS WEIRDNESS.**

And if you are like me and have trouble grasping quantum weirdness, here is one thought that helps me. Remind yourself how completely weird “normal” physics is around you (classical newtonian physics). I love this description from the “Hitchhiker’s Guide to the Galaxy”:

---“The fact that we live at the bottom of a deep gravity well, on the surface of a gas covered planet going around a nuclear fireball 90 million miles away and think this to be normal is obviously some indication of how skewed our perspective tends to be.”— Douglas Adams

**DOUGLAS
ADAMS**

*The Hitch
Hiker's Guide
to the Galaxy*



A TRILOGY IN FIVE PARTS

Now including **MOSTLY HARMLESS**

Nature Decryption

Nature's language will be decrypted. I can hardly wait.

PREPARE

Lots of focus on developing quantum computing, but not much on what questions we will be able to ask it and what environmental problems we will be able to solve when the language is decrypted.

Two more books that I'm holding in the picture above that I would recommend reading:

1. **“Helgoland: Making Sense of the Quantum Revolution (https://r2o.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrefqjVyUZnaTJJ1t3EsGMS1JLunWlNyUnO-eYnsa8xiBnQioCOFAFivoAy66RoAGazirexhW2SkSbm5Dr_3qXb_gDLcftCKqWB49sWi_tBmWHqJZOivIexYzWejEb2CywCrh4HIAoKsAVpWgHdItOp2vGnPeA7kN7vioMMBhFANF&c=&ch=)”**---Carlo Rovelli [Fascinating story---treeless island in the North Sea where Heisenberg came up with some of the basic tenets of quantum physics]
2. **“Quantum Computing for Everyone (https://r2o.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrefqjVyUZnaT2f8dmGfl5cGJtNAIKHmgE-I7Ivm6uGNoO_hkg-Po9oshWd6BugPb_GpNS1pd3hjq-M4KDsotBWYw-dw3wQjQNd1Dh-VGateSnE-ZXVp64OMypPEFVax-VrujQkyqu3HIbnkjouXEkdOg2_n_1D2-hQ==&c=&ch=)”**---Chris Bernhardt [Great introduction to the inner workings of quantum computing. It's got a bit too much linear algebra in it for my liking (see below)—but anyone with high school math can grasp it]

the concatenation of the two names. Though this is a rather weak play on words, it does help us to remember that, for this product, that the "bra" is to the left of the "ket."

In linear algebra this product is often called the *inner product* or the *dot product*, but the bra-ket notation is the one used in quantum mechanics, and it is the one that we will use throughout the book.

Now that we have defined the bra-ket product, let's see what we can do with it. We start by revisiting lengths.

Bra-kets and Lengths

If we have a ket denoted by $|a\rangle$, then the bra $\langle a|$ with the same name is defined in the obvious way. They both have exactly the same entries, but for $|a\rangle$ they are arranged vertically, and for $\langle a|$ horizontally.

$$|a\rangle = \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{bmatrix} \quad \langle a| = [a_1 \ a_2 \ \dots \ a_n]$$

Consequently, $\langle a|a\rangle = a_1^2 + a_2^2 + \dots + a_n^2$, and so the length of $|a\rangle$ can be written succinctly as $\|a\| = \sqrt{\langle a|a\rangle}$.

To illustrate, we return to the example where we found the length of $|a\rangle = \begin{bmatrix} 3 \\ 1 \end{bmatrix}$: $\langle a|a\rangle = [3 \ 1] \begin{bmatrix} 3 \\ 1 \end{bmatrix} = 3^2 + 1^2 = 10$. Then we take the square root to obtain $\|a\| = \sqrt{10}$.

Unit vectors are going to become very important in our study. To see whether a vector is unit—has length 1—we will repeatedly use the fact that a ket $|a\rangle$ is a unit vector if and only if $\langle a|a\rangle = 1$.

Another important concept is orthogonality. The bra-ket product can also tell us when two vectors are orthogonal.

Bra-kets and Orthogonality

The key result is: Two kets $|a\rangle$ and $|b\rangle$ are orthogonal if and only if $\langle a|b\rangle = 0$. We will look at a couple of examples and then give an explanation of why this result is true.

Let $|a\rangle = \begin{bmatrix} 3 \\ 1 \end{bmatrix}$, $|b\rangle = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ and $|c\rangle = \begin{bmatrix} -2 \\ 6 \end{bmatrix}$. We calculate $\langle a|b\rangle$ and $\langle a|c\rangle$.

$$\langle a|b\rangle = [3 \ 1] \begin{bmatrix} 1 \\ 2 \end{bmatrix} = 3 + 2 = 5$$

$$\langle a|c\rangle = [3 \ 1] \begin{bmatrix} -2 \\ 6 \end{bmatrix} = -6 + 6 = 0$$

Since $\langle a|b\rangle \neq 0$, we know that $|a\rangle$ and $|b\rangle$ are not orthogonal. Since $\langle a|c\rangle = 0$, we know that $|a\rangle$ and $|c\rangle$ are orthogonal.

★ Why does this work? Here is an explanation for two-dimensional kets.

Let $|a\rangle = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$ and $|b\rangle = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$, then $|a\rangle + |b\rangle = \begin{bmatrix} a_1 + b_1 \\ a_2 + b_2 \end{bmatrix}$. We calculate the square of the length of $|a\rangle + |b\rangle$.

$$\begin{aligned} \|a\rangle + |b\rangle\|^2 &= [a_1 + b_1 \ a_2 + b_2] \begin{bmatrix} a_1 + b_1 \\ a_2 + b_2 \end{bmatrix} \\ &= (a_1 + b_1)^2 + (a_2 + b_2)^2 \\ &= (a_1^2 + 2a_1b_1 + b_1^2) + (a_2^2 + 2a_2b_2 + b_2^2) \\ &= (a_1^2 + a_2^2) + (b_1^2 + b_2^2) + 2(a_1b_1 + a_2b_2) \\ &= \|a\|^2 + \|b\|^2 + 2\langle a|b\rangle \end{aligned}$$

Clearly this number equals $\|a\|^2 + \|b\|^2$ if and only if $2\langle a|b\rangle = 0$. Now recall our observation that two vectors $|a\rangle$ and $|b\rangle$ are orthogonal if and only if $\|a\|^2 + \|b\|^2 = \|a + b\|^2$. We can restate this observation using our calculation for the square of the length of $|a\rangle + |b\rangle$ to say: Two vectors $|a\rangle$ and $|b\rangle$ are orthogonal if and only if $\langle a|b\rangle = 0$.

Though we have shown this for two-dimensional kets, the same argument can be extended to kets of any size. ★

Orthonormal Bases

The word "orthonormal" has two parts; ortho from orthogonal, and normal from normalized which, in this instance, means unit. If we are working with two-dimensional kets, an orthonormal basis will consist of a set of two unit kets that are orthogonal to one another. In general, if we are working with n -dimensional kets, an orthonormal basis consists of a set of n unit kets that are mutually orthogonal to one another.

Harnessing Quantum Tech & Artificial Intelligence to Protect the Environment

(click here) (https://r2o.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRC
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e2O_UNklS9WYgih6zQI4faMSBxBeUf_vigDbszfshYUaAZvU=&c=&ch=)

Everything we call real is made of things that cannot be regarded as real.” —Niels Bohr

“Those who are not shocked when they first come across quantum theory cannot possibly have understood it.” —Niels Bohr

“If you are not completely confused by quantum mechanics, you do not understand it.” —John Wheeler

“I do not like [quantum mechanics], and I am sorry I ever had anything to do with it.” —Erwin Schrödinger

“Quantum mechanics makes absolutely no sense.” —Roger Penrose

“It is safe to say that nobody understands quantum mechanics.” —Richard Feynman

I again can recommend many books, lectures, and videos on quantum physics and quantum technologies, but I would start with these three: 1. [Google/NASA](https://r20.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrcmjVyab56OKO26FeWJTpAexqXxegZFysJ2fQrSyI9HOxHeLTM7bxjABa6NiIr5YLEx9oHc6roXGh4ybEyR8WX6g8Q4PqrIwV_QH_QOKsvSGJruZ2DSBWUbGmVHy9Jx8HQ==&c=&ch=)Video) (https://r20.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrcmjVyab56OKO26FeWJTpAexqXxegZFysJ2fQrSyI9HOxHeLTM7bxjABa6NiIr5YLEx9oHc6roXGh4ybEyR8WX6g8Q4PqrIwV_QH_QOKsvSGJruZ2DSBWUbGmVHy9Jx8HQ==&c=&ch=Video)) **Video** (https://r20.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrcmjVyab56OKO26FeWJTpAexqXxegZFysJ2fQrSyI9HOxHeLTM7bxjABa6NiIr5YLEx9oHc6roXGh4ybEyR8WX6g8Q4PqrIwV_QH_QOKsvSGJruZ2DSBWUbGmVHy9Jx8HQ==&c=&ch=Video)) 2. **Nova Video** (https://r20.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrcmjVyab56OKO26FeWJTpAexqXxegZFysJ2fQrSyI9HOxHeLTM7bxjABa6NiIr5YLEx9oHc6roXGh4ybEyR8WX6g8Q4PqrIwV_QH_QOKsvSGJruZ2DSBWUbGmVHy9Jx8HQ==&c=&ch=Video)) 3. **PBS Video** (https://r20.rs6.net/tn.jsp?f=00189FAO7nrkvKlALbdyKlFBqd2I5OrfKb5ue7736SRCVQTdestXGAYrcmjVyab56OKO26FeWJTpAexqXxegZFysJ2fQrSyI9HOxHeLTM7bxjABa6NiIr5YLEx9oHc6roXGh4ybEyR8WX6g8Q4PqrIwV_QH_QOKsvSGJruZ2DSBWUbGmVHy9Jx8HQ==&c=&ch=Video))

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--- "Nature . . . quantum.

Computer , , , quantum.

Computing nature . . . quantum."

- Jed Anderson, Creator, EnviroAI

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Original source: Constant Contact campaign

Markdown source: <https://jedanderson.org/posts/proof-why-weirdness-will-be-so-special.md> (https://jedanderson.org/posts/proof-why-weirdness-will-be-so-special.md)

Source on GitHub: [/src/content/posts/proof-why-weirdness-will-be-so-special.md](https://github.com/jedanderson432/jedanderson-site/blob/main/src/content/posts/proof-why-weirdness-will-be-so-special.md) (https://github.com/jedanderson432/jedanderson-site/blob/main/src/content/posts/proof-why-weirdness-will-be-so-special.md)