



## **The Quantum Leap** **June 14, 2023**

### **The Quantum Leap's Beginner Guide to "Quantum"**

When I started this Blog in 2021 the intention was to provide descriptions and details about Quantum Computing for an audience without any technical or physics background. It was also a personal exercise in expanding my own knowledge, as per the adage "if you want to learn something, teach it." In researching the content of the various posts I've been fortunate to meet some amazing people, learn about fascinating companies pushing the boundaries of physics to do remarkable things, and I've learned an enormous amount about this evolving Quantum ecosystem.

There have been countless excellent summary articles from the likes of *Time Magazine*, *MIT Technology Review*, *New Yorker Magazine*, McKinsey, BCG and many others. There is an abundance of excellent web-based Quantum educational resources, and there have been tens of billions of dollars invested into Quantum companies and resources. Yet as I discuss "Quantum" with friends and colleagues, I've come to realize that most people still have no familiarity with quantum, and they are usually baffled as to why I find it so compelling. Most basic explanations rapidly devolve into terms and ideas that are so foreign, that such conversations quickly feel one-sided. So, this is the first in a planned series of "Quantum Leap Beginner Guides" to help introduce this exciting topic and explain why I am convinced we are on the cusp of a generational wealth opportunity. I hope it will pique your interest in the topic and that the ensuing Guides are helpful and informative.

#### **What is Quantum?**

Basically, "Quantum" is a branch of physics covering the very small and/or the very cold. "Physics" to most of us, describes what happens when we hit a golf ball, play billiards, or watch the ocean tides. We don't understand the Newtonian physics involved, but we can generally strike the cue ball into the target ball and sink the billiard shot. "Quantum Physics" governs what happens when the scale is incredibly small (i.e., the size of an individual atom or photon) or extremely cold (or both). At the scale of atoms or photons, physics are different and things like "Superposition", "Entanglement" and "wave-particle duality" happen. But rather than explain these properties, suffice it to say that these are very interesting and powerful features which scientists are using to do amazing things.

The sheer act of manipulating an individual atom or photon takes exquisite control. Once such an atom or photon is stopped/frozen/controlled, its quantum mechanical properties can be manipulated and measured allowing us to do profound things. Think about that...we can now control individual atoms. We can stop them, rotate them, induce them to interact with nearby atoms, and use them to perform calculations among other tasks.

## **Follow the Money: The Potential This Unlocks is Already Attracting Billions and is a National Defense Imperative**

Venture capital investing in quantum technologies grew to \$2.4 billion in 2022 and government investment in quantum has been even larger with over \$30 billion committed by global governments including over \$15 billion by China alone<sup>1</sup>. In a test on January 11, 2021, China launched an anti-satellite device (ASAT) and successfully destroyed its Fengyun-1C weather satellite. China has since boldly claimed that it could destroy or capture US satellites, many of which comprise our current GPS system. Accordingly, US Defense programs are now aggressively pursuing various forms of Positioning, Navigation and Timing (PNT) technologies which don't utilize GPS, and quantum sensing is a leading format. Other implications in secure communications and broad scientific advancement contribute to "Quantum" being such a national imperative.

On the private side, Google, IBM, Microsoft, Honeywell, NVIDIA and other large established companies have major quantum programs underway and dozens of dedicated start-ups are making strong progress. A recent study by Boston Consulting Group (BCG) indicated that more than half the companies they surveyed spend more than \$1 million annually on early quantum readiness. BCG expects **quantum to provide \$450 billion to \$850 billion in value creation** by 2035 and expects it will be "enterprise grade" by 2025.<sup>2</sup> And McKinsey recently predicted that the four industries including automotive, chemistry, financial services and life sciences **stand to gain up to \$1.3 trillion in value** by 2035<sup>3</sup>.

However, despite this enormous economic upside, it is exceedingly difficult to find suitable quantum investments today. There are very limited publicly traded stocks (i.e., IONQ, RGTI, etc.) and the overall landscape is broad and challenging to evaluate. There are more than 30 companies pursuing a variety of different modalities for controlling atoms or photons for quantum applications and 100's more are supplying various parts of the quantum market, so not all will succeed. And many are garnering heady valuations (i.e., 20x revenues or more, while burning cash rapidly). However, given the generational wealth potential, any current investor should seek quantum exposure for their portfolio. If you had invested \$1k in Microsoft at their IPO in 1987, **that position would be worth over \$3 million today**. Quantum is this generation's Microsoft moment.

### **Quantum Use Cases**

The power of quantum physics has already begun to unlock incredible new technologies and use cases:

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<sup>1</sup> While this China investment metric is difficult to verify, most in the industry agree it is credible based on the huge volume of quantum-related publications and patents emanating from China.

<sup>2</sup> [Quantum Computing Is Becoming Business Ready](#), Boston Consulting Group, May 4, 2023.

<sup>3</sup> [Quantum technology sees record investments, progress on talent gap](#), McKinsey & Company, April 24, 2023

Select Quantum Capabilities
<b>Sensing (many in-market or demonstrated proof-of-concept)</b>
Medical imaging
Position, Navigation, Timing (PNT) (alternative to GPS)
Geology/spectroscopy
Ultrasensitive radar
Stealth technologies
<b>Communications (many in-market or demonstrated proof-of-concept)</b>
Ultra secure communications
Un-hackable cryptography
<b>Timing (also in market or demonstrated proof-of-concept)</b>
Clocks with 10,000x precision over existing atomic clocks
GPS-free navigation/6G cellular/Greater network throughput/Highspeed trading
<b>Computing (low-power machines already available; roadmaps published)</b>
Parma/drug design
Material design (batteries, fertilizer, etc.)
Optimization/logistics
Financial portfolio optimization
Machine learning (including ultrapowerful ChatBots)

The list above is non-exclusive. The important takeaway is that there are immense new capabilities in a broad variety of industries, where quantum can provide game-changing new powers. Stay tuned to the *Quantum Leap* for continued coverage about this emerging and vital technology, hopefully in a language all readers can understand.

**Disclosure:** *I have no meaningful beneficial positions in stocks discussed in this review, nor do I have any business relationship with any company mentioned in this post. I wrote this article myself and express it as my own opinion.*

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