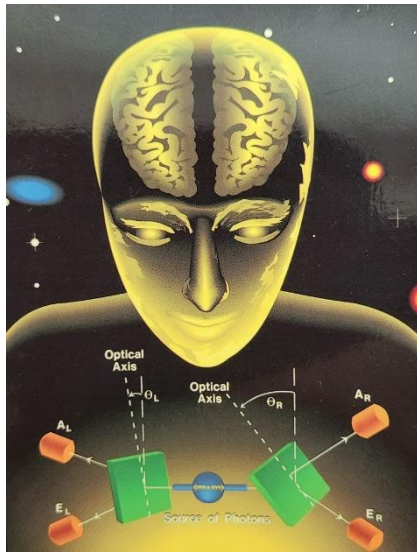


# The Quantum Universe – Atoms, Humans & Light

Donn M. Silberman, Fellow of the [OSSC](#) & [SPIE](#)



M. Kafatos, The Conscious Universe<sup>1</sup>



**The quantum universe** is the place we all find ourselves living and experiencing life. This is 'true' whether any given individual life form acknowledges it or not. This 'truth' is based on a consensus of many people that have studied, experimented, and published their findings across many years, locations, ideologies, religions, cultures, and any other set of diverse categories we might consider. Our current modern civilization exists because a subset of people have embraced the quantum theories and implemented them into our societies worldwide in the form of technologies including computers, communications, transportation, logistics, healthcare, financial transactions and many more processes that make up our human centric world.<sup>2</sup>

Throughout recorded history humans have asked questions and put forward some answers about where we came from, how the universe was created, and what rules govern its ongoing evolution. Some of the early answers have been passed down verbally through the generations and then recorded on various media including stone, parchment, paper and most recently digitally in any number of methods like magnetic tape, computer disks, computer chips, microfilms, holographic media and many other forms. The content of these answers has many similarities and many differences. The goal of this paper is not to review the various questions and answers regarding the universe and our place in the universe; but to review the trends of technological progress over the years and to point out some possible futures for the readers to consider with respect to the current trajectory of the quantum ecosystem developing globally<sup>3, 4</sup>, in the space around our earth, into our extended solar system and beyond.

The base chart in Figure 1 is from Buckminster Fuller's *Synergetics*<sup>5</sup> published in 1975 and shows technological progress "as exposed by the chronological rate of acquisition of the basic inventory of cosmic absolutes – the 92 elements" of the periodic table. As more elements were discovered at an ever-faster pace beginning in 1700s, human technological progress increased at a similar rate. The red and green numbers and letters have been added, along with the population growth chart, to improve readability and provide some context. Clearly, as the population has gone exponential, so has technological progress. This may be due to more people studying science and improvements in communications between those people.

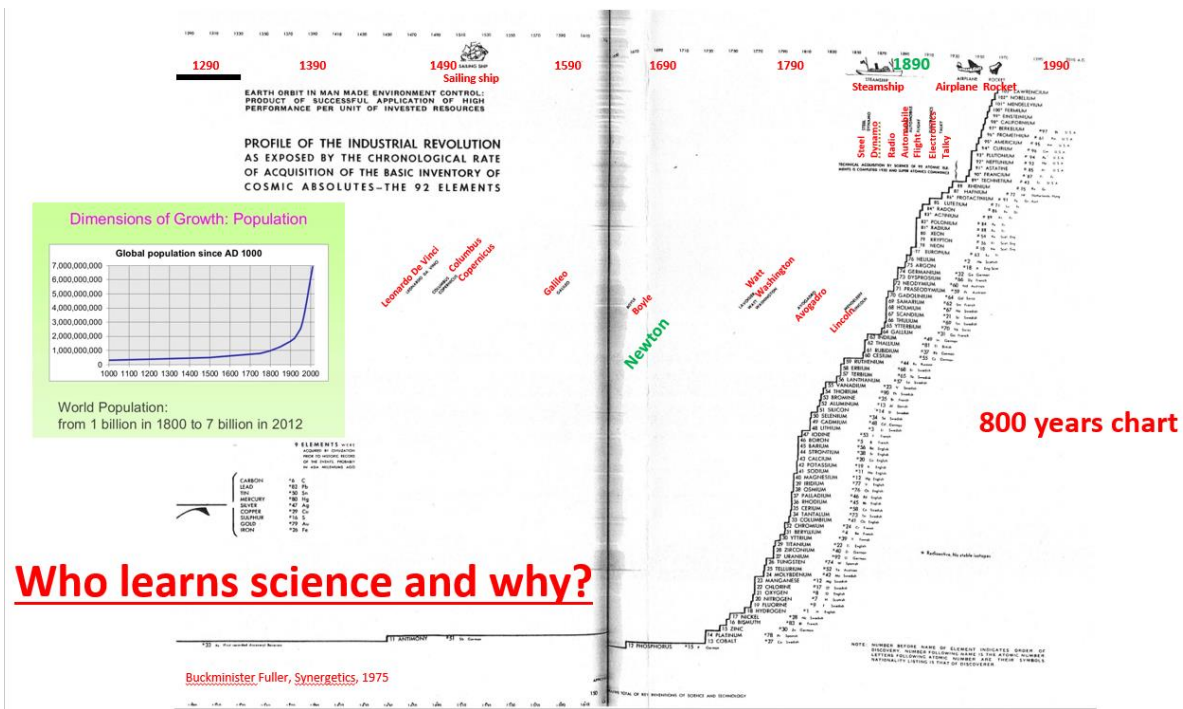


Figure 1. Technological progress over time. B. Fuller, Synergetics, 1975.

Focusing on more recent times, Figure 2 uses 100 years of the US Stock Market Index as a backdrop along with the growth in the US population. The total US Federal Reserve Assets in trillions of dollars is also plotted from 2008 to 2022 to help illustrate that the rise in overall value of assets parallels the rise in technologies. The question: “What will the implementation of quantum computing and the quantum internet (and other related quantum technologies including AI) bring to the world as measured by economic activity?” is of interest to many people.

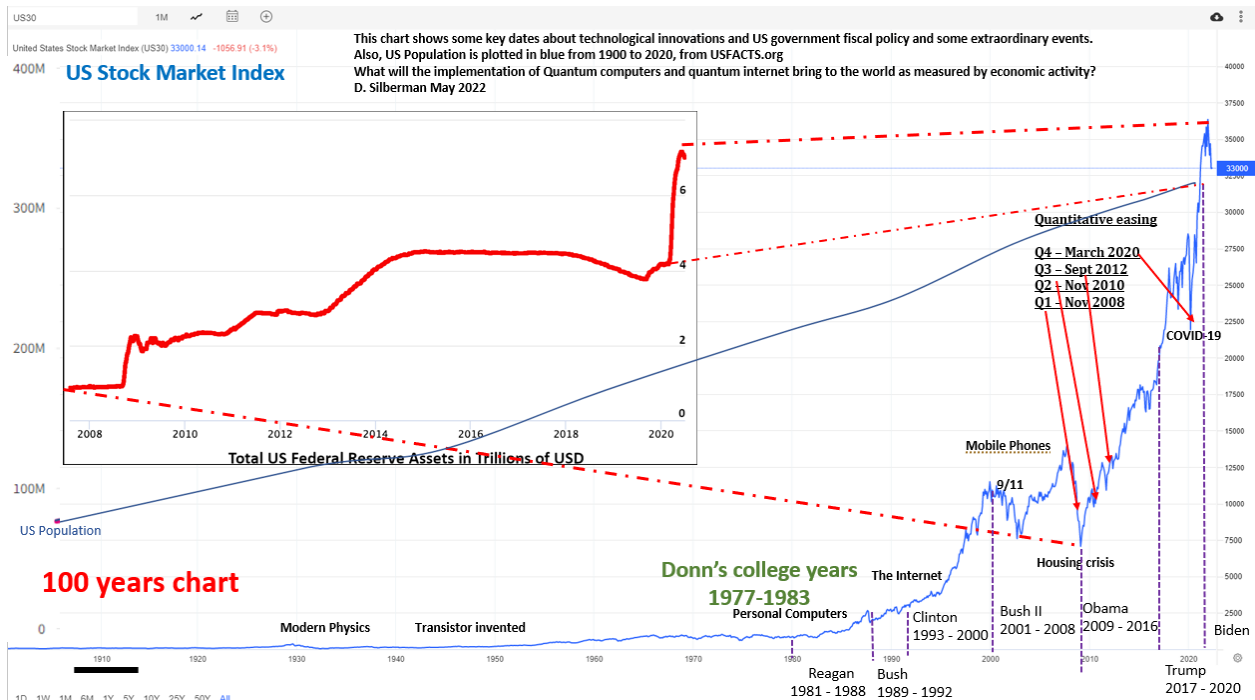


Figure 2. US Stock Market Index, Population, Government economic activity with technological progress over the past 100 years.

Some technological markers are included in Figure 2, like the introduction of: Modern Physics (1920s – 1903s), the invention of the transistor, personal computers (including Donn’s college years 1977-1983), the internet, mobile phones, financial ‘quantitative easing’ and the COVID 19 pandemic. These happenings have brought us, humans, to the place we are today and now it is up to us to chart our course for our future. One important thought to consider is that the development of Modern Physics brought us atomic and nuclear science and weapons. And while one possible scenario was that we humans could have (and still might) use these Modern Physics weapons to destroy our civilization, we have not yet done that!!

**The global quantum (+AI) ecosystem<sup>6,7</sup>** has many components that together will help us move towards our next place in the universe. The famous scientist and science fiction author, Isaac Asimov wrote on many topics. In 1977, as an incoming astronomy student at the University of Arizona, I worked at the Flandrau Planetarium<sup>8</sup> as a tour guide, public telescope operator and planetarium show presenter. There I was tasked with presenting a special planetarium show written by Isaac Asimov titled, “*The Last Question*”<sup>9</sup>, first published in 1956.

**THE  
LAST  
QUESTION**

*Script by*  
**ISAAC ASIMOV**

October 1—December 4  
January 5—February 26

“The Last Question” has as its theme entropy: what happens when the Universe runs out of energy? There are five episodes to this program, ranging in locale from a computer vault on earth to the edge of the universe. It begins in the 21st century and moves billions of years into the future. In each episode, Mankind asks a progressively sophisticated computer “can entropy be reversed?” At the end of the program, the computer finally provides a stunning answer to “The Last Question.”

The talent of Isaac Asimov in the fields of science and science fiction combine brilliantly in “The Last Question” to produce what has been acclaimed as the “most popular planetarium show ever written.”

THE LAST QUESTION

(Lights fade to setting sun and twilight; then stars. Partial panorama of dark Assembly Hill with radio telescope-like receivers.

REPORTER

Ladies and gentlemen, an expectant hush has fallen over the huge crowd gathered here beneath the huge transparent dome of the Star Palace. Here, atop Assembly Hill, we are directly above the vast subterranean vaults which enclose and protect the Multivac computer.

While waiting for our broadcast of this historic event to begin this evening, I was struck by the sunset and couldn't help but think that today, May 14, 2061, is truly the sunset of an old age; the twilight of an era when man hacked his energy supplies from the earth, and in doing so, almost destroyed this planet as an abode for life.

That age is now behind us. We need no longer tear our energy from the earth, but now may go directly to the original energy supply, the sun.

For a century now we have tried to harness the power of the sun directly, but we had only limited success until the development of the amazing computer Multivac. Multivac made possible the safe transmission of concentrated solar energy through the atmosphere to this master receiving and transmission station here beneath Assembly Hill.

To explain the significance of Multivac, let me call upon project engineer Alexander Adell for a few words. Mr. Adell, give us some idea of the size of the Multivac Computer.

Figure 3. An advertisement for the Flandrau Planetarium show, “The last Question” and its introductory script.

You can see in Figure 3, the advertisement on the left and the beginning text of the show on the right, that a very special computer was created to take mankind off fossil fuels and onto the ultimate energy source, the Sun. This may now be one of the tasks quantum computing + AI may help us with, as many researchers at universities, government laboratories and companies are trying to do. But there are many more human related topics that quantum science is digging into that I will now mention.

**Studies in quantum** have some very peculiar implications that are not intuitive to humans. For starters, electromagnetic waves<sup>10</sup>, fields and radiation<sup>11</sup> is made up of photons<sup>12</sup>, or particles of light<sup>13</sup>. The wavelengths range through the entire electromagnetic (EM) spectrum. Figure 4 is a chart from the National Institute of Science and Technology (NIST) and shows different types of

electromagnetic waves, their wavelengths, frequencies, related temperatures, and examples of common things at various wavelength scales.

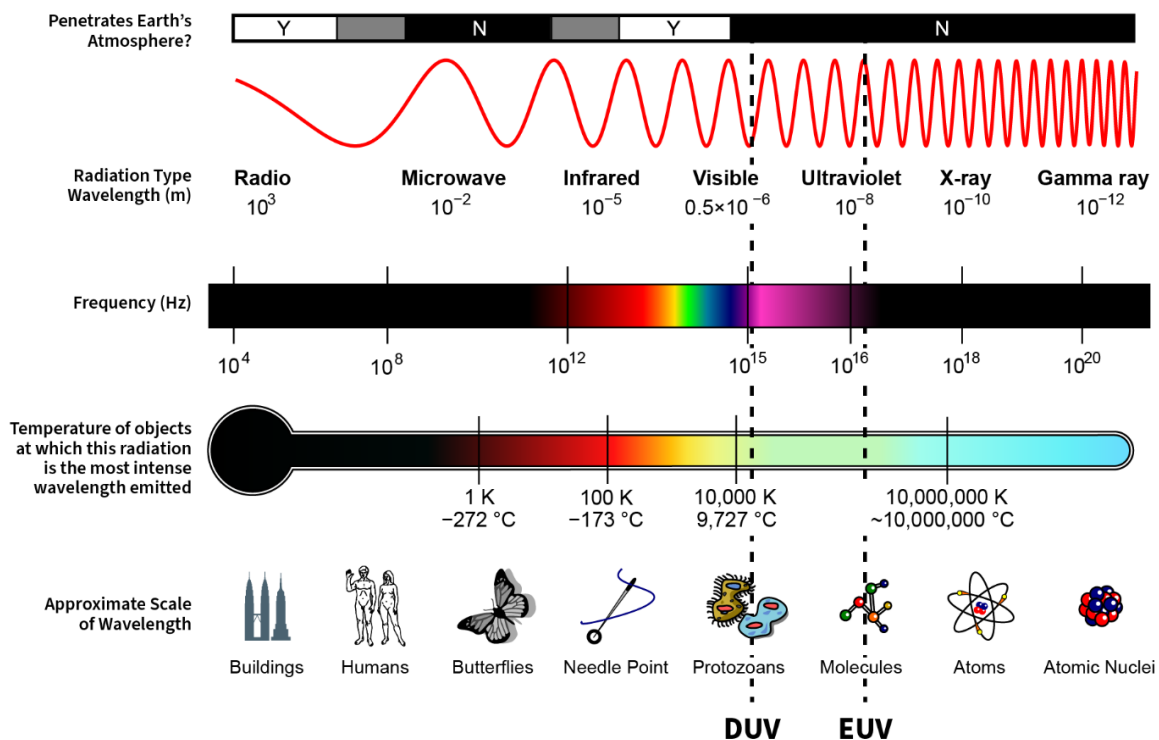


Figure 4. Electromagnetic Spectrum from NIST

[https://www.nist.gov/sites/default/files/images/2020/04/14/EM\\_Spectrum\\_Properties\\_Edited-02.png](https://www.nist.gov/sites/default/files/images/2020/04/14/EM_Spectrum_Properties_Edited-02.png)

Two important concepts to consider are that all matter is composed of atoms that together can form molecules and then biological cells and more complex entities like humans; and the EM spectrum does not stop at either end the above chart but continues in each direction for an unknown distance. With these concepts in mind, it should be noted that photons of some wavelengths are constantly being emitted, absorbed, and re-emitted most of the time from most matter. An example includes the Sun (and all stars) are constantly emitting photons in all directions both from their surfaces and internally throughout the entire volume of the Sun (or stars). Another example is that all living organisms also do the same. So, humans are constantly bathed in photons, like from the Sun and indoor lighting; and all matter either reflects, refracts, diffracts, absorbs or scatters these photons (or EM waves).

Also, humans have created many technological EM radiation emitters and receivers including our communication devices like AM / FM radio waves, microwaves from cell phones and towers and many others. These are relatively new to humans, having only been around for the past 100 years or so.

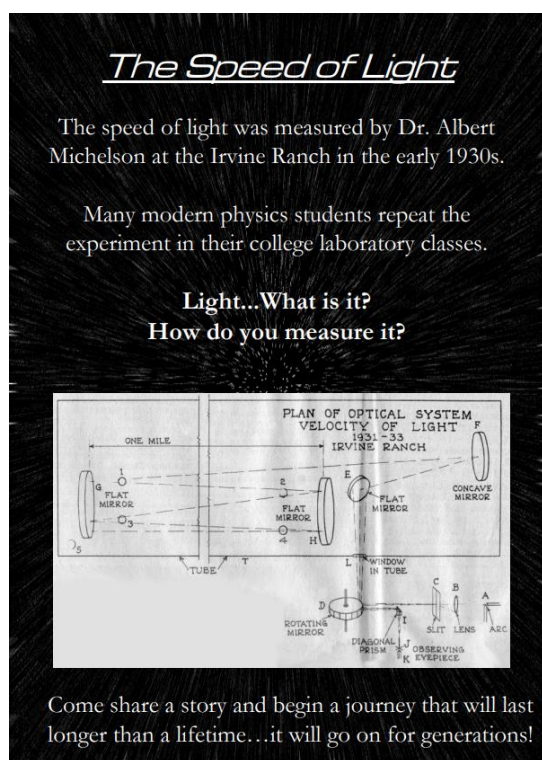
**Quantum biology** has been a topic of discussion since the beginning of modern physics, documented by Erwin Schrodinger in his 1944 book, "*What Is Life: The Physical Aspect of the Living Cell*."<sup>14</sup> Over the decades since then, there were a number of publications<sup>15</sup>, but on the whole, not much research was done until the last 20 years or so<sup>16</sup>.

And even now, quantum biology is not widely studied, as describe by Clarice Aiello, a Quantum Engineer and Assistant Professor at the University of California, Los Angeles in her recent

articles.<sup>17, 18</sup> In these articles Aiello is careful to keep on the scientific path studying, “*the inherent quantum degrees of freedom of biological matter with the goal of understanding and controlling these phenomena.*” And “*Quantum biology is not the study of classical biology using quantum tools, nor is it the application of quantum computers or of quantum machine learning to drug discovery or healthcare big data processing, and it definitely has nothing to do with the manipulation of free will, with the origin of consciousness, or with other New Age buzzwords.*”

However, in “**The Conscious Universe<sup>1</sup>**,” by Menas Kafatos and Robert Nadeau, (published in 1990) and many similar books, articles and papers, authors have put forth concepts attempting to connect the atomic level physics theories to molecular, cellular, biological and even consciousness phenomena that are experienced and reported by humans across the globe and throughout history. The potential for “quantum consciousness” could be viewed as science fiction, so we could review some information about the role quantum phenomena might play in consciousness. This will be left to the reader to explore further in the references provided<sup>19, 20</sup>.

In 2004, I created a public exhibit at the Irvine Civic Center called “The Speed of Light.” Details can be reviewed at<sup>21</sup>: [http://www.oisc.net/Speed\\_of\\_Light.htm](http://www.oisc.net/Speed_of_Light.htm)



This exhibition included a small brochure, and the page shown in Figure 5 captures the essence. The complete brochure can be downloaded from<sup>22</sup>: <http://oisc.net/Hyper.pdf>

The front page asks the question: “When will we make the jump to Hyperspace?” And inside the headline quote states, “When Science Fiction Leads to Science Fact.” This takes us back to the first part of this article where we described the technological progress of humans, and we can clearly see that what was (in the past) science fiction has now become everyday science fact. Can you imagine only 50 years ago having someone tell you that almost every person on earth would be carrying a powerful computer in their pocket??

**What will the future hold as we continue to develop and live in the Quantum Universe?**

Figure 5. Front cover page of the Speed of Light Brochure

[Link to references](#)

**Donn M. Silberman** is an SPIE Fellow, Past President and Fellow of the Optical Society of Southern California and Senior Member Emeritus of Optica (formerly the Optical Society of America.) He is also a member of the Quantum Economic Development Consortium (QED-C), where he volunteers on their Workforce Development Technical Advisory Committee (TAC). He has provided technical engineering, management, and education to many precision optical and optical instrument companies and educational entities in Southern California for over 35 years. Retired from his industry career in early 2021, he has been focusing on current and new quantum technological applications as they are impacting the lives of people globally. He has also been a volunteer with Vital Link, a 501(c)3 Non-profit in Orange County, California, for 10 years and now serves on their Board of Directors inspiring students to explore and experience education and career pathways that secure their future.

Donn consulted with EdQuantum, an NSF funded educational program to develop curriculum and lab experiments for community college students that have completed at least some laser electro-optics courses and he continues this path on the QED-C Workforce Development TAC. He holds a BS in Engineering Physics from the Univ. of Arizona (Honors in Physics) and an MS in Technology Management from Pepperdine University.

He was an advisor to Irvine Valley College's Laser Electro-Optics Technology programs from the early 1990s to 2020, and he helped move the program to Pasadena City College and continues to advise and assist. Donn founded the UC Irvine's Optical Engineering and Optical Instrument Design programs in 2009 and continues to support those programs; and he received the UC Irvine Extension's (now the Division of Continuing Education - DCE) Dean's Outstanding Service Award in Nov 2012; and was the 2012-2013 Univ. of Arizona Honor's College Advocate for Education Award Winner.

Donn was a Senior Applications Engineer for PI (Physik Instrumente) L.P. for over 10 years, where he worked on many world-class optical instruments for science and industry, including the world's largest astronomical and solar telescopes and the highest precision measurement systems for today's Quantum Photonic (Silicon) Integrated Circuits (QPICs) that are being used in Quantum Computers.

For exercise, Donn trained for and participated in over 65 Sprint and Olympic distance triathlons starting in 2008 and is still training now. Organized races stopped during the COVID pandemic and started up again in 2022. Donn lives with his wife Ana Maria in Rancho Mission Viejo. Their son, Michael "Six" Silberman lives in London and is currently a Postdoctoral Research Fellow at the University of Oxford, Faculty of Law and Department of Computer Science.