

The Border Between Science and Science-Fiction is Fading Out

Michael Gurevitz

Department of Plant Molecular Biology and Ecology, George S. Wise
Faculty of Life Sciences, Tel Aviv University, Ramat Aviv 69978, Tel Aviv, Israel

The scientific development of human civilization cannot be described as a linear progression, but rather as a stepwise catapulting process, depending on the control and severity of regulations imposed by rulers and religious authorities. While the development of arts like painting and sculpturing constantly proceeded, advancements in science, medicine, and philosophy have shown a slower progress. This imbalance shrank toward the end of the Industrial Revolution with the lift of religious and monarch control and the establishment of urban societies with educational systems, communication networks, and improvements in human rights and freedom of mind. Strikingly, while nearing the end of the previous millennium, the spiritual and social advancements were accompanied by an overwhelming upgrade of life standards. Clearly, such a progress required vast developments in science, which rested on creative thinking and rich imaginative ideas of individuals capable of predicting future needs, who published initially their thoughts in the science-fiction domain. Fortunately, their creativity and 'out-of-box' thinking overcame dark periods of systematic spiritual oppression and antagonistic prejudice ideas.

Leonardo da Vinci (1452-1519) is a highly suitable representative of talented individuals, with extraordinary creativity. Despite the social limitations and public constraints during the Renaissance period, his exceptional skills in mathematics, engineering, architecture, theoretical science, anatomy, sculpturing and painting were highly appreciated, and thus he was constantly supported by wealthy patrons. He conducted careful experiments and designed futuristic groundbreaking devices that were realized during his life and also years later. Centuries afterwards, Jules G. Verne (1828-1905), the founder of modern science fiction, published adventure stories with revolutionizing ideas years prior to their practical realizations (e.g., 'The journey to the center of the world', 'Around the world in eighty days', 'From the Earth to the Moon').

Then Herbert G. Wells, (1866-1946), who is considered as well among the founders of modern science fiction, published more than a hundred books (e.g., 'The time machine', 'The invisible man', 'The war of the worlds'), which reflected his view about humanity, putative evolution of humanoid subspecies, and the possibility of intergalactic clashes). Importantly, the creative writing of J.G. Verne and H.G. Wells was very attractive to the public and was followed by increased permissiveness and freedom of mind, which encouraged many skilled individuals to express their exceptional ideas via publication of science-fiction stories (e.g., Ray Bradbury 1920-2012, Frank Herbert 1920-1986, Philip K. Dick 1928-1982, Ursula K. le Guin 1929-2018, Robert Silverberg 1935-present, Liu Cixin 1963-present). Although most ideas raised in their write-ups were fictional, those having a scientific background were later attained. Among these writers, Arthur C. Clarke (1917-2008), was a top science fiction writer due to his fruitful and

outstanding writing abilities with thrilling descriptions of imaginary scenarios. His innovative ideas (e.g., 'Meeting with Medusa', 'The Fountains of Paradise', 'The Wind from the Sun', 'Rendezvous with Rama', and particularly '2001: A Space Odyssey') had a profound influence on science fiction readers and developing scientific enterprises. Of note was his cooperation with Stanley Kubrick to create the timeless film that was a real masterpiece and raised prophetic scientific ideas associated with antigravity and centrifugal forces or the creation of a space station. Equally appreciated is Isaac Asimov (1920-1992), a professor of Biochemistry at Boston University and also a top science fiction writer. He published more than 500 articles, part as scientific reports and many sciences fiction stories. His futuristic world controlled by computers and robotics (e.g., 'The Three Laws of Robotics', 'The Foundation Trilogy', 'The Naked Sun', 'The Caves of Steel') included intergalactic travels and spread of mankind in the universe. Of note was his massive impact and framing of people thoughts about the development of artificial intelligence.

The third among most famous science fiction writers was Robert A. Heinlein (1907-1988), an aeronautical engineer and naval officer, who emphasized the scientific accuracy in his fiction articles and thus pioneered the hard science fiction subgenre. His broad interest and writing about racism and political, military, scientific, educational, philosophical, and sexual issues had strong impact on the surrounding society. Besides his own prolific career (32 novels, 59 short stories, 16 collections, 9 films, 2 TV series, several radio episodes, and a board game), he was active in assisting other writers mostly in styling and shaping their write-ups.

In comparison to these science fiction writers, stand ingenious scientists, who expanded the human lore with scientific theories that were considered at the time either speculative or just imaginary. For example, the groundbreaking theory of General Relativity by Albert Einstein, a professor at Princeton, New Jersey, was primarily not accepted because it collided with basic principles of modern physics established long before by Isaac Newton (1642-1726).

However, Einstein's theory was approved scientifically shortly after, which changed dramatically our understanding of the creation of the universe, the universal importance of gravity, and the link between time and space. Einstein also provided an explanation for the photoelectric effect (photons appear as waves as well as particles) that led the foundation for the development of quantum physics (Nobel prize in 1921). Notably, his discovery that mass and energy are equivalent and linked by the speed of light, led to the development of nuclear energy. Another example is Stephen W. Hawking (1942-2018), a theoretical physicist and cosmologist from the University of Cambridge, UK, whose main contributions concentrated on gravitational forces in the frame of the general relativity theory of Einstein, and the theoretical prediction that black holes emit radiation (named Hawking radiation), which initially was controversial, but accepted after further physical studies and considered a major breakthrough in theoretical physics. By using the general theory of Relativity and Quantum Mechanics Hawking provided a novel view of the universe and its possible extinction in the late future when the black holes will lose their energy and disappear.

Notably and quite interestingly, Hawking also supported the multiverse (many-worlds) interpretation of Quantum Mechanics. Although the publications of Einstein and Hawking cannot be considered science fiction write-ups *per se*, the approval of their scientific theories in

parallel to the on-going realization of imaginary ideas raised in the past by science-fiction writers (e.g., flying objects, submarines, medical therapy, world networks, space station, nuclear energy, and reaching to the stars) demonstrate the importance of 'out-of-box' ideas, and indicate that the border between science and science-fiction faded out. Creative ideas that sound imaginary today {e.g., travel in time; bending of time-space and formation of Einstein-Rosen bridges (worm-holes) between far regions of the universe or between two distinct universes} may potentially be realized the other day. No wonder then that we approached a developmental era that undoubtedly raises our curiosity about how the future of humanity would look like.