Birds and Frogs: Selected Papers, 1990–2014

Freeman J Dyson
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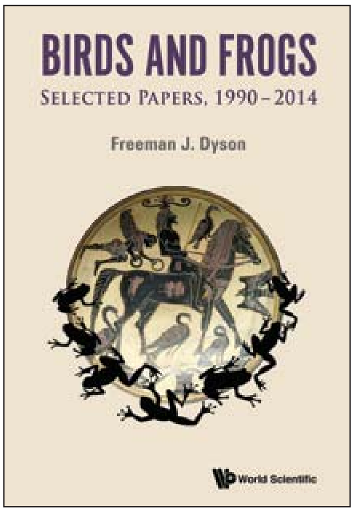

Freeman Dyson is a very famous theoretical physicist with a long and distinguished career, having started out as a number theorist in Cambridge University. His first love was mathematics but his intellectual temperament probably found it too confining. Well-known for his contrarian views, his eclectic interests span a wide range from the arts to the sciences. In 2013, his 90th birthday was celebrated in Singapore with a 4-day conference organised by the Institute of Advanced Studies of Nanyang Technological University, a long way away from his home institution, the original Institute for Advanced Study in Princeton. This book is a fitting and logical sequel of two earlier volumes of selected papers published in 1992 and 1996.

This latest volume is a collection of 3 named lectures (Einstein, David Wilkinson and Helen Edison Lectures), 9 invited talks, 8 published essays, 8 technical papers and one banquet address. Only one essay ("Science in trouble") in the book has not been published before and is written as a kind of introduction to the section on "Politics and History". The seemingly odd item in the book is the text of a speech which Dyson gave at a banquet in honour of Chen-Ning Yang in 1999.

The Einstein Lecture is entitled "Birds and Frogs" from which the title of this book is borrowed. It is painted on a broad scientific canvas that stretches from the 17th century intellectual world of Francis Bacon and René Descartes to the string theory speculations of the present. It is partly autobiographical and draws from his personal knowledge of people who exemplified the two broad intellectual categories he labelled as "birds" and "frogs", in particular, Abram Samiolovich Besicovitch (1891–1970), Yuri Ivanovitch Manin, John von Neumann (1903–1957) and Chen-Ning Yang. In a nutshell, birds are theory builders and frogs are problem solvers. Although Dyson considers himself to belong to the "frog" category, it is arguable to classify him as a "bird" as well in view of the fact that his interests and intellectual vision are so broad and far-reaching.

The David Wilkinson Lecture was given to the Judiciary Leadership Development Council of Princeton University on "The Current State of Physics" (in 2009). He expresses an optimism in the limitless prospects of discovery in science. However, for advances in particle physics where the conventional wisdom is "the bigger the better", as represented by the Large Hadron Collider (LHC), Dyson holds the contrarian view that important discoveries may yet be made by small-scale equipment or what he calls "passive detectors".

The Helen Edison Lecture was about "Nukes and Genomes" and dealt with the dual dangers posed to human existence by new knowledge and technology arising from advances in physics and biology. The discovery of fission in 1938 quickly led to the development of atomic bombs whose destructive capabilities were demonstrated on Nagasaki and Hiroshima barely 7 years later. A recent genetic discovery of the DNA called HAR1 and HAR2 is likened by Dyson to the discovery of fission. He points out the potential dangers and abuse which such knowledge could lead to, but advocates an open source attitude to research in this new kind of knowledge rather than a restrictive or secretive form of censorship.

The first talk reproduced was given at the Jet Propulsion Laboratory on a biological topic, the origins of life on earth. In the late 1990s, Dyson had resuscitated and reformulated a long forgotten idea of the Russian biochemist Alexander Oparin (1894–1980) and the British-Indian biologist J B S Haldane (1892–1964) on a two-stage RNA origin of life on earth.

Four talks dealt with the lives and impact of mathematicians and physicists (John von Neumann (1903–1957), George Green (1793–1841), James Bradley (1693–1762) and Subrahmanyan Chandrasehar (1910–1995)) and were given at Brown University, Nottingham University, American Philosophical Society and Chicago University respectively. There we get to know some lesser known facts about these great men. In the talk on Green, it is clear that Dyson expressed an indifference to, if not disdain for, the PhD as a professional prerequisite. Green had very little formal mathematical education and yet he was the first to introduce mathematical tools (the concept of "Green's function") in classical applied mathematics that turned out to have fundamental relevance and importance in quantum electrodynamics. It was Dyson who spectacularly exploited this connection and gave a mathematical proof of the equivalence of the three apparently disparate approaches of Richard Feynman (1918–1988), Julian Schwinger (1918–1994) and Sin-itiro Tomonaga (1906–1979) in quantum electrodynamics. Like Green, Dyson has no PhD degree. Unlike Green, Dyson had solid training in mathematics at Cambridge University even as he did not submit any PhD thesis when he was on a postgraduate scholarship at Cornell University to study physics.

The circumstances under which the talk on James Bradley was given are rather unusual. It was given by a theoretical physicist on an observational astronomer to a gathering of philosophers. Bradley's great contribution was the discovery of the astronomical phenomena of the aberration of light and the nutation of the earth's axis, which demanded high precision measurements in astronomy. He achieved an amazing precision in the mid-eighteenth century using only the most basic tools (plumb-line, micrometre screw and the naked eye).

John von Neumann was one of the first permanent members of the Institute for Advanced Study at Princeton. Dyson joined the Institute in 1953 and was a colleague of von Neumann for only a brief period. The talk on von Neumann gave a brief overview of some of his contributions in pure mathematics (set theory), foundations of quantum mechanics and the building and use of the first modern computer. We also get a glimpse of the cultural environment at the Institute in the early years.

The talk on Chandrasekhar was given at the Chandrasekhar Centennial Symposium in the University of Chicago in 2010. It highlights his fundamental work in astrophysics (in particular, his revolutionary predictions on the collapse of stars to form black holes) and depicts the atmosphere of nascent changes gradually occurring in astronomy in the early years. We get to know the style of research of Chandrasekhar and we are pleasantly surprised to learn of an unexpected connection between him and the Indian mathematical genius Srinivasan Ramanujan.

The other four talks reproduced in this volume deal with a wide range of topics ranging from the human brain and computers, two contrasting cultural worldviews as exemplified by Tolstoy (1828–1910) and Napoleon Buonaparte (1769–1821), individual freedom versus group responsibility, and the dichotomy between science and religion. The last talk was given in a cathedral under the auspices of the John Templeton Foundation which awarded him the Templeton Prize in 2000. Though Dyson describes himself as a "practising but non-believing" Christian he sees no contradiction in the co-existence of science and religion in meeting the challenges of human existence.

Not only did Dyson talked about famous scientists, but he also wrote about them in four of the 8 essays reprinted in this volume. The shortest of these (just about 2 pages) is a nugget on a brief meeting with Enrico Fermi, gaving a glimpse of Fermi's physical intuition and its influence on Dyson's early research on mesons. In a memoir for the US National Academy of Science, Dyson throws some light on the man and the physicist behind Edward Teller, once an enigma better known as "the father of the hydrogen bomb".

In another brief (4-page) memoir that appeared in the American Philosophical Society, Dyson pays tribute to John Archibald Wheeler (1911–2008), a father figure in American physics, who supervised a record number of 46 graduate students (among them Richard Feynman) at Princeton University and mentored a generation of physicists in the "Golden Age of General Relativity".

The fourth biographical memoir included in this volume is one written by Dyson for the Royal Society. It is a rather detailed account of the life and work of Nicholas Kemmer (1911–1998). It is unlikely that one would have heard of Kemmer unless one works in theoretical physics. Russian-born and Swiss-trained, he eventually moved to the University of Edinburgh where he did important work that paved the way to the formulation of the Standard Model in nuclear physics. He was a well-known teacher and master of the quantum mechanics which was then rapidly evolving into a highly mathematical discipline. He was the mentor and teacher of Nobel Laureate Abdus Salam. It was from Kemmer that Dyson learned the mathematics of particle physics which was pivotal in the latter's famous paper of 1949.

Of the remaining four essays reprinted in the volume, two are insightful reminiscences on his early interests in mathematics and subsequent switch to physics and on his wartime work with RAF Bomber Command.

Another is a rather mundane piece on children's literature. The final essay is a foreword which he wrote for a science fiction anthology on one of his early favourite topics — his vision and the prospects of humankind making the evolutionary leap of migration to other extra-terrestrial worlds.

The last section in the volume consists of 8 technical papers — five on physics, two on number theory and one on game theory. One of the physics papers was written for a symposium in honour of John Wheeler, and one of the number theory papers (on partitions) is also about statistical mechanics. The game theory paper is, in fact, a joint work with a computer scientist, William H Press on the two-person Iterated Prisoner's Dilemma game. The last paper in this volume is a theoretical analysis of whether gravitons can be detected by known experimental means, and his answer is "No". It is, in fact, based on a talk given at Nanyang Technological University during his 90th birthday celebration.

Dyson is not only a master of his own professional trade but also a master of the English language. He writes with lucidity and ease of flow. Whether one agrees with his contrarian views or not, the non-technical reprints in this volume are a delight to read. The scope and spectrum of knowledge covered is indeed vast and can be formidable even for a highly knowledgeable layman. For the professionals like scientists and mathematicians this book opens a window that gives a glimpse of the intellectually exciting and often turbulent times of the past century by someone who has lived through and contributed to those times. It is a book to be read and re-read.

Reviewed by Y K Leong