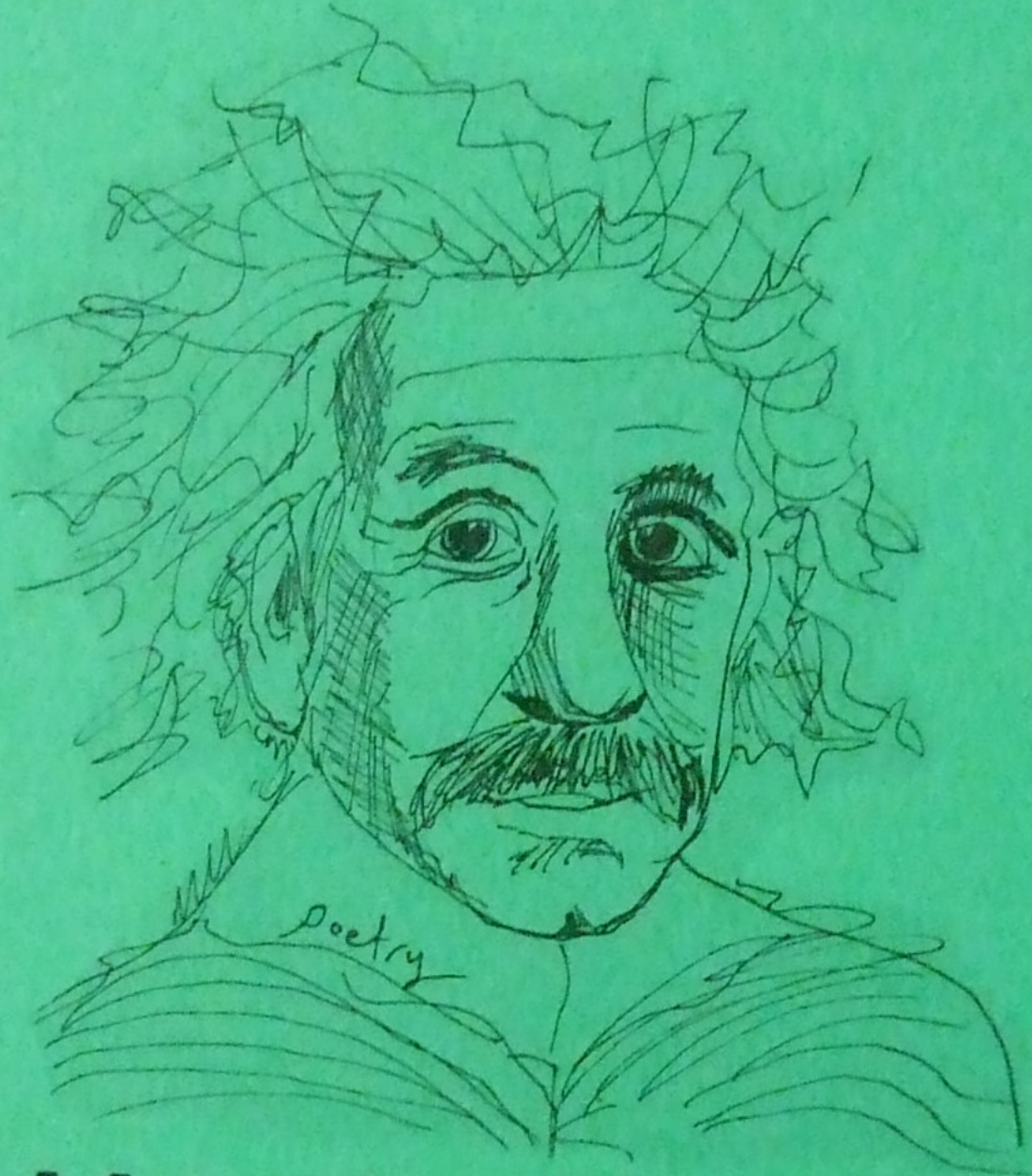


Making Waves

Albert Einstein: Science & Life



Martin Zarrop

V

Reader's Notes

Martin Zarrop

2019

Making Waves – page 1

As an applied mathematician, I have always been fascinated by the ability of the human brain to model and predict the complex behaviour of the physical world by manipulating certain strange man-made squiggles and structures that our minds often judge to be 'beautiful'. This phenomenon is what the physicist Eugene Wigner termed the 'unreasonable effectiveness' of mathematics in explaining the world. It's also why Albert Einstein's genius and curiosity, his thought experiments and his ability to tease out and mathematically express the essential aspects of a problem, appealed to me from an early age. Later in my university career I enjoyed lecturing (briefly) on the technical intricacies of his General Theory of Relativity but can't vouch for the pleasure experienced by my students!

Apart from some pieces of schoolboy doggerel, I began writing poetry in 2006. It arrived precisely on May 9th as an unexpected impulse triggered by grief and the urgent need to find an outlet for and a means of emotional expression. Maths alone was obviously no longer enough (or even relevant?) and music required another language. Poetry, however, could immediately make use of familiar words in ways that could capture what I felt, pared down to the bone without any florid 'shenanigans', without redundancy. I believe that this aspect of good poetry writing resonates with the 'beauty' and 'truth' of good scientific theory and this brings us back to Einstein.

The technical biography written by Abraham Pais thirty years ago is essential reading for anyone interested in the historical and scientific background of Einstein's achievements but it doesn't give a rounded picture of Einstein as a human being. I can highly recommend the later biography by Walter Isaacson. It's the basis of a recent excellent ten-part National Geographic series ('Genius') available on DVD. Isaacson fills out our picture of the flawed Einstein, dealing

with his emotional life as well as the science and politics of a tumultuous century that saw two world wars, the Russian Revolution and the Holocaust, as well as the relativity and quantum revolutions in physics.

Maths and science have influenced my poetry from the beginning and a few of the poems that later appeared in the pamphlet were written as individual pieces in which I was attempting to either employ humour to transmit scientific ideas or use the ideas as metaphors for aspects of the human condition. Either way, my opinion is that ‘science poems’ should not be just lectures or lists of obscure facts but must engage the non-expert on some level without dumbing down. For example, the poem ‘Entanglement’ (first drafted in February 2011) refers to a quantum phenomenon but is about grief.

In 2015 I felt it was time to put together an Einstein pamphlet and (in a surge of creative energy I unfortunately don’t experience frequently enough!) eighteen of the final twenty five poems were written in early 2016. The last poem to be written was ‘Einstein on the Beach’ (March 2018). Given Einstein’s impact on the world and the detection of gravitational waves in 2016 after a century’s wait, the pamphlet’s title ‘Making Waves’ was never in doubt!

Making Waves – page 5

Seeking Miss Aether

The first introductory poem takes the form of a humorous monologue, following a Lonely Hearts advert as epigraph, in which a classical (pre-Einstein) physicist makes a desperate plea for the existence of the aether, that undetectable substance supposedly forming the tapestry against which all matter moves. Its existence was implied by orthodox (Newtonian) assumptions of absolute space and time. The necessity for these assumptions was removed by Einstein’s Special Theory of Relativity and the aether evaporated.

Making Waves – page 6

Celebrity

The second poem introduces Albert Einstein (1879 – 1955) through his technical achievements and personal failings with a few broad brush strokes and I took the

liberty of writing in the first person, thereby standing in for the great man (if only!) and, hopefully, making him appear less remote to the reader. There is no doubt that he was a great theoretical physicist but was criticised in some circles for being too theoretical and not sufficiently empirical. In Germany, this criticism became part of the anti-Semitic attack on Einstein as the Nazis gained political strength during the thirties.

Making Waves – page 7

I originally placed the two epigraphs at the beginning of the pamphlet before deciding to take a chronological approach to the material and to include the introductory poems. The epigraphs now separate the introductory poems from the chronological material and summarise two contrasting sides of Einstein as a human being. His basic philosophy concerning the nature of the world was that it existed independently of human observation and was ultimately comprehensible. The comments on his marriages suggest that there were aspects of reality that escaped him!

Making Waves – page 8

Compass

Einstein's father Hermann gave his young son a present of a compass and this stimulated his curiosity and love of research into the world's mysteries, a love that lasted all his life. I didn't start out to write a love sonnet but the end product has fourteen lines!

Making Waves – page 9

Johnnie & Dollie

This poem is based on the love letters between Einstein and his wife-to-be Mileva Marić. Their relationship was passionate both physically and scientifically and the letter reflects the swerving of Einstein's preoccupations from emotional/family problems to the more pleasant activities of mountaineering and solving physics problems.

Einstein spent vacations with his mother and sister Maja at the Hotel-Pension Paradise, near Zurich. The common Yiddish expression *loch im kopf* means ‘hole in the head’.

Making Waves – page 10

Thought Experiments

The imperative: *Consider this* is an essential element in Einstein’s ability to force himself to focus on the core elements of any technical problem he faces as part of his work at the Swiss Patent Office in Bern and in his personal research away from the office. The poem is an internal monologue, almost an incantation, reinforcing his basic philosophy concerning the nature of the world. Unfortunately, once again, his personal life raises painful questions that lie outside this framework. He can’t answer them.

Lieserl Einstein (1902 - ?) was the first child of Albert and Mileva, born before their marriage in 1903. She was probably put up for adoption and may have died of scarlet fever in 1903. The couple later had two sons Hans Albert (1904 -1973) and Eduard (‘Tete’) (1910 – 1965). Einstein’s father Hermann died in 1902.

Making Waves – page 11

Quantum Leap

The poem concerns the wave-particle duality of matter (including light) and Einstein’s explanation of the photoelectric phenomenon (for which he received the Nobel Prize in 1922). I chose the poem structure to be rhyming, rhythmic quatrains [a b c b] and therefore easily committed to memory (like a nursery rhyme) as a key event in the history of twentieth century science.

Making Waves – page 12

Unseen

The random motion of a pollen grain in water is due to collisions with unseen water molecules. In the poem this phenomenon is modelled as a drunk taking equal random steps away from a lamp post. For the pollen grain, the higher its

mass the shorter the steps. For higher temperatures, the jostling is more vigorous, so the steps are longer. I employed the change of rhyme pattern from [a b c a] in the first two stanzas to [a a b b] in the third to emphasize these material changes.

Making Waves – page 13

Torch Bearer

Galileo argued in 1632 that motion with constant speed in a straight line can't be detected and feels the same as not moving at all. In 1905 Einstein incorporated this relativity principle into his Special Theory of Relativity along with the constancy of the speed of light for all observers. This latter assumption is probably why 'Galileo looks uncomfortable' when Einstein 'switches on his new torch'.

In the poem, the relativity principle is exemplified by the dripping water and swimming goldfish appearing stationary, i.e. 'as if they were back in Bern' rather than moving on a boat. The classical physicist ('old captain') remarks about the 'fine mist' (aether). Einstein sees 'no mist' but notices the torch varying in length, depending on the observer, one of the consequences of his new theory.

Making Waves – page 14

An Amusing Thought

Recognisably the simplest and most famous equation in all science: $E = mc^2$ expressing the equivalence of mass and energy, arose out of Einstein's 1905 Special Theory of Relativity and was published later that year. At the time, as his letter to Habicht states, Einstein found the thought 'amusing and seductive' but the implications for the atomic destruction of Hiroshima and Nagasaki in 1945 are spelled out in the final couplet of this mushroom-shaped poem.

Making Waves – page 15

Equivalence

After his annus mirabilis of 1905, Einstein turned his attention to extending his Relativity Theory to accelerating systems. The poem refers to one of his famous thought experiments, in which he imagines he is floating inside an empty lift. Is the lift (and its occupant) falling under gravity or is it in outer space away from any gravitational force? This Equivalence Principle, the equivalence of acceleration and gravity, led in 1915 to his General Theory of Relativity and the well-known image of space-time as a rubber sheet deformed by moving matter. The last three lines of the poem are my comment on the limitations of all theories, ultimately corrected or rejected by the real world. This could also be said of Einstein's personal life and his later fruitless search for a unified field theory.

Making Waves – page 16

Genesis

This poem concerns Einstein's General Theory of Relativity of 1916 and strikes a biblical stance that (in my opinion) befits the magnitude of his scientific achievement. The paper predicted a precise amount of the bending of light rays by the sun (verified in 1919) and explained a discrepancy in Mercury's orbit, which had been shown to be slowly rotating by 43 seconds of arc per century. Astronomers had assumed this was due to interactions with an undetected planet. Einstein's theory predicted the anomaly precisely.

Making Waves – page 17

Objective Reality

Mileva Marić ('Mitsa') (1875 – 1948) came from Serbia to study physics at Zurich Polytechnic. She was the only woman in Einstein's class and was technically excellent but sacrificed a promising academic future to marry him. Scientific discussion was an essential part of their relationship and it has been argued that Mileva's role in Einstein's fame has been ignored. Certainly in 1905 she would have had her say on the content of the relativity paper but only Einstein's friend Michele

Basso is acknowledged. The couple separated in 1916 and divorced in 1919. Mileva initially resisted the divorce and the poem reflects the bitterness developing in the marriage. As usual, Albert tries to hide behind his work!

Making Waves – page 18

The New Violin

Following the chaos of the First World War, ‘empires have fallen’ and scientific collaborations resumed. During the total solar eclipse of 1919, the British astronomers Arthur Eddington and Frank Dyson undertook independent expeditions to verify Einstein’s predictions concerning the degree of bending of light rays due to the sun’s gravitational pull. Einstein was found to be correct and became an international celebrity overnight. A keen violinist, he bought a new violin and married his first cousin Elsa (1876 – 1936).

Making Waves – page 19

When You Look at Something

The 5th Solvay Conference met in 1927 in Brussels to discuss the newly formulated Quantum Theory. Einstein demanded a reality independent of observers and not based on uncertainty. He lost the argument but never accepted defeat. The argument about the relationship between QT and reality still continues, but most physicists follow the rule: *Shut up and calculate!* since the theory gives accurate numerical results (and pays their salaries)!

The poem mimics the dialogue form of Robert Graves’ humorous poem ‘Welsh Incident’ in which there are a lot of words but not much explanation of a mysterious phenomenon.

Making Waves – page 21

‘Not Yet Hanged’

Following Hitler’s rise to power in 1933, Einstein returned to Europe from a visit to Princeton but realised that, as a Jew, a return to Germany was out of the

question. A German magazine at the time noted that Einstein was ‘not yet hanged’. He returned to America to pursue his research at the Princeton Institute of Advanced Study and never left.

Making Waves – page 22

Einstein on the Beach

This is the title of an opera by Philip Glass. I haven’t yet seen the opera but the phrase appealed to me because of Blake’s poetry and the richness of reality in his grain of sand. In November 1938, Kristallnacht, the night of broken glass, signalled a ramping-up of the campaign against the Jews in Germany after five years of the dictatorship of the Third Reich. Einstein was safe in America but did his best to help refugees to safety. Reading the poem again, the abrupt ending brings the term ‘truncated sonnet’ to mind!

Making Waves – page 23

Dilemma

Werner Heisenberg (1901 – 1976) was a leading atomic physicist who headed the unsuccessful German atom bomb program during WW2. The fear of a Nazi atomic bomb led Einstein to sign a letter to President Roosevelt in 1939 that led to the Manhattan Project and the A-bombing of Hiroshima and Nagasaki in 1945.

Making Waves – page 24

Stammesgenossen

Literally ‘tribesmen’. Einstein, like many Jews, was brought up in a secular Jewish family. He considered himself an internationalist but was well aware of anti-Semitism, particularly after he became famous and professional jealousy raised its head. This served to reinforce his feelings as an outsider but, before 1948, he didn’t support the idea of Israel as a Jewish state and visited Palestine only once (in 1922) to raise funds for a Hebrew University. After 1948 and the establishment of Israel, he supported its existence, although he declined to become its president in 1952.

When I wrote the poem, with its insistent rhyme scheme, I imagined an angry Einstein addressing the world accusingly and demanding that it comes to its senses.

Making Waves – page 25

No

Einstein's second wife Elsa was his first cousin. They had an affair and married soon after his divorce from Mileva in 1919, following years of bitterness. Einstein gave Mileva his Nobel Prize money in 1922 as part of the settlement. Eduard ("Tete") was their second son. He suffered from schizophrenia and spent much of his life in a Swiss institution. Helene Savić (1871 - 1944) was a lifelong and intimate friend of Mileva. Towards the end of her life, Mileva suffered from strokes and died in a coma, repeatedly muttering: *No, no*.

The poem has Mileva looking back on her life in 1948, the year of her death. There is much questioning and regret at her lot, the paths taken, and the repetition of 'No' emphasises the negative as well as repeating her final words. There is also resignation to the fact that the negative sides of 'great' people are often ignored in comparison to their public achievements.

Making Waves – page 26

Entanglement

Referred to by Einstein as 'spooky action at a distance', entanglement is a quantum phenomenon that relates to the information link that persists between particles that may be a long distance apart. It is used in this poem as a metaphor for connection through grief. The poem appeared in my collection 'Moving Pictures' in 2015. Although the grief was originally my own, not Einstein's, I decided to include it in the pamphlet after some minor modifications to reflect his (possible) response to Mileva's death in 1948.

No Theory of Everything

It is obviously not provable that there is a theory of everything as we can never know when we get there. All theories are valid within certain bounds and, when those bounds are breached and unpredicted phenomena need to be explained, new theories are needed. Relativity Theory and Quantum Theory played this role in the twentieth century. We are now faced with new unexplained phenomena such as dark matter and dark energy and await developments.

Despite its success in explaining experimental facts, Einstein never accepted that Quantum Theory was the finished and final explanation of reality at the atomic level. ‘God doesn’t play dice’, he famously said and for the last years of his life concentrated on attempts to unify his General Theory of Relativity with other field theories to generate a Unified Field Theory that would also provide a deterministic replacement for Quantum Theory. He was still working on this project on his death bed.

Un-American

The McCarthyite Red Scare of the early fifties followed the unexpected detonation of a Soviet A-bomb in 1949 and was symptomatic of the subsequent paranoia concerning Communist infiltration and espionage. Einstein didn’t approve of the Soviet government’s interference in intellectual and artistic matters but appreciated the achievements made possible through central planning. Nevertheless, he refused invitations to visit Moscow and condemned the use of the Soviet veto at the UN and Soviet resistance to the idea of world government. His private letter asking for the Rosenbergs to be spared the death penalty for spying was made public by the press and caused a furore. He advised those being investigated by McCarthy to plead the First Amendment (guaranteeing free speech) rather than the Fifth Amendment (protection against possible self-recrimination). His main fear was the attack on civil liberties in the USA and the return of those conditions that gave rise to fascism in the thirties. Einstein was investigated by the FBI for possible Communist links but was judged to be merely ‘pacifist’ and ‘liberal’ and that was that.

Playing Dice

Erwin Schrödinger (1887 – 1961) was an Austrian physicist who joined Einstein in expressing unease at the uncertainty at the heart of Quantum Theory, exemplified by the so-called Copenhagen interpretation, which excludes any single underlying reality independent of an observer. It becomes meaningless to state that a system has definite properties (such as position or velocity) until it is observed.

Schrödinger took this to its logical conclusion in his ‘Schrödinger’s Cat’ thought experiment, in which a cat is placed in a closed box with a poison that is released through a random mechanism. The orthodox quantum interpretation is that it is neither alive nor dead until the box is opened, whereas, in our macroscopic ‘common sense’ world, the cat is either alive or dead whether we raise the lid or not.

In the poem the unfortunate cat is replaced by a parrot that Einstein received as a present on his seventy-fifth birthday. Although ‘time is a stubborn illusion’, a reference to his relativity theory, Einstein is aware that he is aging, that his research is considered out of step with current scientific developments, particularly in Quantum Theory, and that his political influence is limited despite his fame and prestige.

Einstein’s Brain

After Einstein’s death in 1955, his brain was removed by Thomas Harvey, the pathologist at Princeton Hospital. Over 43 years, Harvey kept the brain and occasionally doled out pieces to researchers in the honest hope that good academic results would emerge. As expected, no firm conclusions have been drawn concerning the correlation between Einstein’s brain structure and the mind of a genius, although his musical activities had an effect. The frontal lobe included a ‘knob’-shaped fold in the right hemisphere. The ‘knob’ is known to surgeons as the sign of omega. This effect is seen in long-term right-handed violinists, such as Einstein.

Making Waves

The existence of gravitational waves was predicted by Einstein in 1916 as part of his General Theory of Relativity. They were first observed in February 2016. This stretching and squeezing of the fabric of space-time originated from the merging of two massive black holes. The sensitivity required is that of comparing the width of a human hair to twenty five billion miles. The difficulty of detection is compared in the poem to the difficulties of either establishing world government or living in harmony with a woman, two aims close to Einstein's heart, neither of which he lived to see!