ALBERT EINSTEIN (1879 – 1955)

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1. Scientific Work

The works which were to make Albert Einstein famous throughout the international scientific community were first published in *Annalen der Physik* in 1905 and 1906. This collection comprises six articles, submitted by the author for publication in 1905, when he was just 26 years old. Some of these works anticipate what has come to be considered by science historians, along with quantum theory, as the scientific revolution of the twentieth century. Further revolutionary articles were published—also in *Annalen*—from 1907 on, culminating with the article he published in the journal in 1915, setting the bases for a new theory of gravity.

During the last third of the nineteenth century, classical physics, based on the works of Galileo and Newton, was showing signs of weakness in the face of certain phenomena related to the mechanical view of the world viewed from a novel perspective based on the concept of energy. The result was a bitter dispute between “atomists” and “energists”. But where the most profound conceptual difficulties arose was in the attempts to harmonise Maxwell's electro-magnetic theory and the principles of Newtonian physics, an incompatibility that was resolved by Einstein’s bold proposals, propounded in one of his celebrated articles of 1905. From his earliest work, Einstein showed a great intuitive capacity to discern physical laws, a power of concentration that enabled him to shut himself off whenever he needed, an unusual sharpness in thinking up “mental experiments”, and above all a broad and up-to-date knowledge of the science of his time.

After he had concluded his work on relativity—successfully confirmed both in the calculation of the perihelion shift of Mercury and the eclipse of sun in 1919—and following the publication of other highly important articles on the interaction between light and matter and on the fundaments of quantum physics, Einstein devoted his efforts to searching for a unification of the classical fundamental forces of nature: it was a frustrated aspiration which was to occupy much of the rest of his life, and which still today continues to be a challenge for twenty-first century physics.

1.1. Physics before Albert Einstein

Throughout the nineteenth century, physics gradually consolidated its position as an experimental and exact science; it was institutionalised as an activity carried out by scientists, who by then had been given that name; and it reached the classrooms of universities and secondary schools as a discipline to be taught and learnt separately from the philosophical and theological disciplines to which it had once been allied. Thus, a profession was created from which people could earn a living and even achieve some social prestige.

When Albert Einstein was born in 1879, experimental work still took precedence over theoretical grounding. The equivalence between heat and mechanical work was known, associating heat with energy phenomena, although there remained discrepancies over whether the heat was a substance, a type of energy or a physical process; light was now considered to be a form of wave motion, the battle having been won against those who argued that it was “corpuscular”; The discovery of the reciprocity between magnetism and electrical currents at the beginning of the century had led to Maxwell's electro-magnetic theory; and many experiments were being carried out regarding the production of radiation in a vacuum: Röntgen discovered X-rays the same year, 1895, in which Lorentz propounded his electron theory, confirmed in experiments by Thomson and Wien at the end of the century; Becquerel discovered the radioactive behaviour of uranium (1896).

Besides academic teachings, which he followed irregularly, Einstein devoted his time to studying the works of Maxwell (who had died the same year as Einstein was born), Hertz, Kirchhoff and Helmholtz, thus providing himself with a grounding in the latest developments in physics. At the recommendation of his lifelong friend, Michele Besso, he read the work of Ernst Mach, who, along with Newton, Maxwell, Lorentz and Planck, Einstein considered to be one of his precursors.

1.1.1. Classical Physics

The pillars of what was known as *classical*, or *Newtonian* physics, were founded on the works of Galileo Galilei (1564-1642), *Dialogues Concerning Two New Sciences*, published in Leiden (Netherlands) in 1638, and the *Mathematical Principles of Natural Philosophy* by Isaac Newton (1642-1727),

published in London in 1687.
Galileo’s work, translated into English in 1661, contains the first formula for the free fall of bodies, setting the base for his experimental and geometric study. This publication was crucial in surmounting Aristotle’s' disquisitions on movement and laying the foundations of scientific knowledge on observation, experimentation, measurement and mathematical formulation.

Newton provided a mechanical vision of the world based on the laws of dynamics and achieved the first scientific synthesis culminating with the establishment of the law of universal gravity, which put paid to the old differentiation between the earth and the heavens as worlds governed by different principles. After Newton it was only possible to speak of a single universe and a single physics.

In the last third of the nineteenth century James Clerk Maxwell (18311879) tackled the question of the mathematicisation of electromagnetism which had arisen from the initial experiences of Oersted and Ampére, continued by Faraday who introduced the concept of the electrical field and the magnetic field to delimit the areas of influence of the forces from electrical charges and currents, for the former, and those related to magnets for the latter.

In his theory of electromagnetism, Maxwell managed to relate the properties of magnets, electrically charged bodies and electrical currents, and he also predicted the propagation of electro-magnetic phenomena by means of waves travelling at the speed of light, considered from then on to be electro-magnetic disturbance. This grouping together in a single theory of the electrical, magnetic and optical behaviour of matter represented the discovery of a new scientific synthesis as transcendental as Newton's. Both were pillars of classical physics, but so different in nature that the contradictions between them rocked its very foundations, leading to a new form of physics based on the principles established by Planck and Einstein.

1.1.2. Doubting Newton

Ernst Mach (1838 – 1916), the Austrian physicist and philosopher, contributed to the mathematical formalisation of optical and mechanical phenomena and above all certain phenomena related to wave propagation, such as his study on the Doppler effect and the propagation of sound. But where he exercised the greatest influence was as a philosopher, falling into what was known as the

"positivist" school for whom only that which we know through sensorial perception has any had scientific validity; his work *Contributions to the Analysis of the Sensations* (1886) was widely read.

He rejected absolute concepts of space and time, which were basic to Newtonian mechanics, considering them to be metaphysical concepts, which were inadmissible for the principle of "economy of thought" which should, in his opinion, underpin any scientific activity. Einstein himself said that Mach's ideas had inspired his first steps towards the theory of relativity, although he soon distanced himself from them. He did not share Mach's beliefs on the fulfilment of the general laws of physics as simple generalisations of experimental results. Rather, he held that these laws, although they can be verified experimentally, have their origin in the mental faculties of individuals, thus positioning himself closer to the philosophy of Kant. His favourite philosopher, however, was David Hume for whom science was constructed on experience and logical/mathematical deduction.

Mach also had an influence on those who rejected the concept of force, as in Newton's dynamics, and the atomism of matter, considering such hypotheses unnecessary and impossible to prove at that time. His followers preferred a concept of energy which had different manifestations, governed by a principle of conservation and by the fact that they could be measured. This challenge to Newtonian mechanics was led by Wilhelm Ostwald (1853 – 1932), at the head of the selfstyled *energists*, who manifested their radical opposition to atomism with the categorical, quasi-Biblical phrase: "Thou shalt use neither images nor similes".

1.1.3. Crisis in Physics

At the end of the nineteenth century, Lord Kelvin argued that the basic foundations of physics had been definitively laid". It was not long, however, before those solid foundations were to be rocked. There were essentially two phenomena which were to put physics in quarantine: blackbody radiation and the electrodynamics of moving bodies.

For physicians a *black body* is a perfect ideal absorbent, capable of swallowing up any electromagnetic radiation which reaches it, and for that reason it is also a perfect transmitter; a small hole in a completely sealed box at any temperature is an example of a black body. If we accept the explanation

given by classical physical principles, based on the idea that the energy absorbed or issued corresponds to a process of wave (and therefore continuous) motion, this should lead to a situation known as the *ultraviolet catastrophe*, which—if it were existed—would mean that when we opened the kitchen oven, in which the radiant energy is constantly bouncing off the walls, we would suddenly be hit by a blast of deadly radiation. Fortunately, of course, this does not happen, in contravention of the principles of classical physics.

With regard to the electrodynamics of moving bodies, the facts also contradicted Newtonian explanations. Let us see how Einstein examined the problem in his celebrated article "On the Electrodynamics of Moving Bodies":

"Take, for example, the reciprocal electrodynamic action of a magnet and a conductor. [...] if the magnet is in motion and the conductor at rest, there arises in the neighbourhood of the magnet an electric field with a certain definite energy, producing a current at the places where parts of the conductor are situated. But if the magnet is stationary and the conductor in motion, no electric field arises in the neighbourhood of the magnet. In the conductor, however, we find an electromotive force, to which in itself there is no corresponding energy, but which gives rise—assuming equality of relative-motion in the two cases discussed—to electric currents of the same path and intensity as those produced by the electric forces in the former case". Einstein was surprised by this asymmetry in the description of two apparently reciprocal phenomena, the relative movement of conductors and magnets, with identical results, since the current produced in both cases is the same.

Moreover, if the transformations of coordinates in Maxwell's equations are applied to the relative movements between charges and magnets in accordance with Newtonian mechanics, the theoretical results do not match the phenomena observed. This unexpected electrodynamic behaviour of moving bodies opened further questions for physicists who in Gamow's words "were suffering the angst of metamorphosis from the classical larva to the modern butterfly".

1.1.4. The First Solution

In order to find a solution to the inadmissible ultraviolet catastrophe, Max Planck (1858-1947) was forced to propose the *quantum* hypothesis, which attributed a discontinuous character to the radiation emitted and absorbed.

Thus, very much against his will, he opened up – an irreparable breach in the classic foundations of physics which had always maintained that “nature doesn't jump”. Planck himself was so astonished, that when he presented his ideas to the Berlin Physics Society, he confessed: “This entire issue can be summarised in three words: an act of desperation. Because I have consciously turned my back on nature... A theoretical interpretation therefore had to be found at any cost, no matter how high. [...] The two laws [of thermodynamics], it seems to me, must be upheld under all circumstances. For the rest, I was ready to sacrifice every one of my previous convictions about physical laws”.

At the beginning of his career, Planck shared the ideas of the antiatomists. In his doctoral thesis, read in 1879, the year Einstein was born (the two would go on to profess unconditional admiration and friendship) he opposed the atomic hypothesis of matter on the grounds that it contradicted the principle of conservation of energy: “Nonetheless the success enjoyed to date by the atomic theory”– he wrote–“will eventually be abandoned in favour of the hypothesis of the continuity of matter”. Little could he have dreamt that not only would he one day be forced to accept the discontinuity of matter, but that he himself would propose the discontinuity of energy!

The “quantum” led to quantum mechanics, of which Heisenberg's indetermination principle forms the cornerstone of all the uncertainty regarding the measurements of observable sizes, a principle which Albert Einstein challenged throughout his life.

1.2. 1905: the *Annus Mirabilis*

Max Born (1882-1970), one of the leading figures behind quantum mechanics, wrote in Volume 17 of *Annalen der Physik* in which three of Albert Einstein's famous articles were published: “This is one of the most remarkable volumes in scientific literature”. These articles which, together with Planck's theories, helped show the way out of the predicament of fin-de-siècle physics, were:

- “On a Heuristic Point of View Concerning the Production and Transformation of Light”, which introduced the theory of the photon or light quantum.
- “On the movement of small particles suspended in stationary liquids required by the molecular-kinetic theory of heat”, related to Brownian movement, which provided sufficient arguments to leave the atomic

theory of matter definitively settled.

- "On the electrodynamics of moving bodies", where he established the bases for the special theory of relativity.

Another article was published the same year, in Vol. 18:

- "Does the inertia of a body depend on its energy content?", in which he devised the formula which would later come to be written as $E = mc^2$.

And finally, in 1906, two other articles were published, complementing the ones Einstein had published in *Annalen* in 1905:

- "A new determination of molecular dimensions"
- "On the theory of Brownian motion"

The impact these articles have had on the subsequent course of physics amply justify the fact that 1905 is referred to as Einstein's "annus mirabilis". At the time, this 26-year old was, to use his own term, a "venerable federal penpusher", working as a third-class technical expert assistant at the patent office in Berne, with a yearly salary of 3500 francs, enough to allow him to live decorously but without excesses. Until he got the job, the Einsteins (he had married his fellow student at the Eidgenössische Technische Hochschule in Zurich, Mileva Maric (1875-1948) lived off the income they gained by giving private classes.

1.3. General Relativity: a new theory of gravity

Confirmation from experiments that the speed of light in a vacuum, *c* —the maximum speed known to date for transmitting data—is the same for all inert observers, i.e. those for whom the principle of inertia, as formulated by Newton, is fulfilled, led Einstein to consider that the concept of *simultaneity* was a relative one. Furthermore, the finitude and constancy of *c* alters the classic notions of space and time, producing effects such as the *dilation of time* and the *contraction of space*, which increase with the velocity, and cannot be reconciled with Newtonian mechanics. Together with the discovery of the relationship between the mass and energy of a given quantity of matter, $E = mc^2$, these phenomena form the surprising and relevant contributions of the special or restricted theory of relativity, governed by the principle that the

laws of physics, such as the speed of light, are the same for all stationary observers.

Einstein extended the special theory to accelerated movements and curved trajectories, taking as a reference planetary movement and free fall towards Earth. He thus established his general theory of relativity, essentially based on the *principle of equivalence* between acceleration and gravity, which he considered "the most fortunate idea of my life". It was certainly his most original idea and the one for which he finally gained the recognition of the scientific community.

Classical physics' notion of space, as a receptacle which exists regardless of whether or not is has content, and time, as an imperturbable measure of the duration of events, whatever the dynamic circumstances in which they occur, ceased to be valid. According to the general theory of relativity, space-time, as a single whole, is configured by the matter itself: a space-time described with Riemannian, rather than Euclidean, geometry. Despite the change these ideas wrought in the physics of his time, Einstein considered his theories of relativity to be "an evolution, not a revolution, in dynamics". In answer to a journalist, Einstein summarised his relativist theories as follows: "Time, space and gravity do not exist without matter".

1.4. Quantum Dilemma: Einstein *vs.* Bohr

To mark Einstein's seventieth birthday, *Albert Einstein: Philosopher-Scientist* was published under the editorship of Paul A. Schilpp, a professor of philosophy and Methodist minister. The work was essentially meant to explain the importance of Einstein's contributions to physics, and his own impressions on his life and work, contained in the "Autobiographic Notes" with which the book begins.

Amongst the prestigious scientists and philosophers who worked on the publication were Niels Bohr (1885-1962), author of the article "Discussion with Einstein on Epistemological Problems in Atomic Physics", in which the Danish physicist told of the conversations he had held over the years with Einstein regarding the course being taken by atomic physics, currently immersed in a process of development and consolidation. As scientists' understanding of the constitution of atoms developed, classical physics began to prove increasingly lacking when it came to providing explanations,

especially following the discovery by Ernest Rutherford (1871-1937) in 1911 of the nucleus of the atom.

Bohr and Einstein first met in Berlin in 1920, and hit it off well, personally and scientifically. Despite their differences of opinion regarding quanta, this mutual admiration was to last the rest of their lives. Einstein was reluctant to renounce classic ideas of continuity and causality, which could not be sustained using the quantum approaches that were gaining increasing numbers of devotees. Quantum mechanics became Einstein's obsession, as he himself recognised: “I have thought a hundred times more about quantum problems than I have about relativity”. For his part, Bohr took some time to accept Einstein's photon theory, but Einstein stubbornly insisted that “God doesn't play dice”, predicting an eventual return to Newtonian determinism.

In September 1927, a congress was held in Como to commemorate the centenary of the death of Volta, at which Bohr set out his principle of complementarity to describe the nature of both matter and radiation, according to which the wave and corpuscular models coexisted and complemented each other. The Spanish physicist Blas Cabrera was there; Einstein did not attend. In October of that year, however, he did attend the Solvay Congress where he publicly rejected the new approaches which he ironically summarised in picturesque phrases such as “ghost waves guiding the photons” to ridicule the quantum interpretation of light as something that “travels as a wave but departs and arrives as a particle”.

1.5. The Unified Field: An Unfulfilled Aspiration

In Max Born's (1882 – 1970) comments on the letter he wrote to Einstein from Gottingen (7/4/1923), he says: “The rumours about Einstein's new research to try to merge his own theory on the gravitational field with Maxwell's electromagnetic field proved to be true. It was at this juncture that he began his attempts, often repetitive but ultimately futile, to create a unified field theory”. Einstein saw this attempt as “a compilation of all the forces of nature, born out of the theory of relativity”.

He hoped that the “physics of the future” would be a combination of classical physics—in the purest Newtonian sense and thus irrefutable in questions of physical reality and causal determinism—and quantum mechanics, which he considered to be not so much erroneous as incomplete.

Because of Einstein's popularity, the press was always out for news, the more unexpected or bizarre the better. In 1950, Einstein he expressed his irritation at this constant pestering in a note to Born: “The excesses of the press with regard to my latest work is very annoying”. He was referring to the commotion American and European journalists had raised about a remark he had made about finally achieving a “unified field theory”.

By the end of his life he had had to accept defeat in the challenge he had set himself, frustrated at not having achieved the scientific ideal he always pursued by applying the principle of economy his erstwhile mentor, Ernst Mach, had applied to nature. Einstein pursued the unification of physical laws, convinced that nature was ultimately ruled by the aesthetic of the simple and the universal. But he had to resign himself to “hoping that someone else” would achieve unification of the gravitational and electro-magnetic fields. He aspired to an extemporary goal, and this was not the time to achieve it; even today, when we know the other forces of nature, weak and strong, no one has achieved this great goal and physicists are not even sure how it can be. Doubting that unification as proposed by Einstein was possible, Pauli declared: “what God has put asunder, let no man join together”.

2. Einstein the Man

The certificate of naturalisation issued to a 61-year old Einstein in Trenton (New Jersey) describes him as a white male of average complexion, brown eyes and grey hair, standing 5 feet 7 inches high and weighing 175 pounds.

The popularity Einstein achieved in his lifetime was comparable to Newton's, but because of the centuries that separated the two, Einstein is known throughout the world by people of all ages and classes, whether or not they come from the academic or scientific field, achieving far greater public recognition than Newton enjoyed in his own time or at the present.

From the point of view of general comprehension of the two scientists’ work, however, Sir Isaac's was more and better assimilated than that of Albert the bold dreamer. This may be due to the fact that the latter's work is more complex, especially his general theory of relativity, which qualifies, broadens and modifies the significance of Newton's theory of gravity.

Einstein travelled extensively, partly because he had become an attraction in

himself. He was distinguished with the highest honours a scientist can receive. A host of books and articles are still published about him, surpassing the popularity of any other person – in 1999, *Time Magazine* named him "Person of the Century". For better or worse, people have even tried to penetrate his life and the process of gestation of his work as they have done with no one else. He is unquestionably a singular character, and one of the most enigmatic of the twentieth century. He was a person of simple tastes: he dressed untidily, in casual shabby clothes; he lived in a modest house; he loved macaroni and a dish of lentils with sausages, apple or plum pie, coffee and a good cigar... and his beloved pipe, which he continued to fiddle with even after he had been ordered to stop smoking; he liked playing in musical soirees at home with anyone from the neighbourhood, but he fled pomp and celebration because he was an *Einspänner*, a loner in all his behaviour, among his students, his colleagues, his friends and his family. One of his greatest joys was go out sailing on a small boat on the calm water of the lakes he used to frequent; despite the fact that he was not a skilled sailor (on more than one occasion he had his wife on tenterhooks). He preferred sailing to any other activity: not only did it offer the pleasure of solitude; it was also, as he said, "the sport that requires least energy". It typified the comfort and easy life he preferred within the modesty that always characterised him.

2.1. Biography

Albert Einstein has aroused so much interest amongst scientists and laypeople alike that he is possibly the one individual about whose life people know most: what he did, where he went, who he talked to, his tastes, what he did in his spare time, etc. — practically everything, indeed, that happened in his fruitful, intense and eventful life. Such is his fame that if one were to ask anyone for the name of a single scientist, it would undoubtedly be that of Einstein, and if one were to present them with a series of scientists' portraits, his would be the first to be identified.

He has been written about by very people from very diverse fields, sometimes with conflicting interests: he has been praised as a scientist, but he has also been accused of plagiarism and deceit; some have deified him as a pacifist and a defender of the defenceless, while others have decried him as "the father of the atom bomb"; he has been held up as a recluse in a world privileged by science, and reproached for his unfaithfulness and his lack of interest in his family.

This knowledge of his life, however, has not been paralleled by a knowledge of his work, as he always regretted, seeing himself “rather like King Midas, except that everything turns not into gold but into a circus”. The solitude he preferred to keep; the incomprehension and harassment he had to put up with from hostile spheres of political, social and academic life; the blatant abuse of his name and his image to promote products or champion causes of all kinds did not succeed in driving him away from his most precious refuge: science. And he practiced that science in a very personal way, to some extent as an “outsider” from academic processes, renouncing even the usual methods of ascending the academic ladder.

2.1.1. Childhood and Teenage Years

Albert Einstein was born on 14 March 1879, at 11:30, in the Swavian town of Ulm, in southern Germany, on the banks of the Danube. His birthplace, number 135, Bahnhofstrasse, was razed to the ground during World War II. He was the eldest son of a Jewish couple, Hermann and Pauline (neé Koch). According to his maternal grandmother, Tette Koch, he was born too fat, with a swollen and slightly deformed head.

When he was barely a year old, his family moved to Munich seeking their fortune from the electrochemical industry in which his father and uncle, Jakob, had been working for some years. The city had begun a massive transformation from gas lighting to electricity and thought this was a good chance to make their fortune.

At primary school, Albert received a Catholic schooling; the Jewish education that the government demanded for people of his condition had to be acquired at home, even though his parents were agnostic. In those first years, Einstein showed an unusual interest in the existence of God, which even caused his family some concern. However, that initial passion soon waned as he began to take an interest in books on science and philosophy. Nonetheless, he was to continue turning over the idea of God – “Spinoza's God” – and once even said that his scientific aspiration was to “know the thoughts of God”.

After the family business again failed, the Einsteins moved to Italy, where they set up a factory manufacturing electrochemical material in Pavia. Albert, who was 15, was supposed to stay behind in Munich to finish secondary school and do his military service. He did neither. As well as being incapable

of enduring the Prussian inflexibility of the school, he wanted to avoid joining the army and so he joined his parents in Italy, causing them to worry about his future. He did not stay long in the family home, but he always looked back fondly on those months. As a result of his readings he wrote his first essay: *On the Investigation of the State of Ether in a Magnetic Field*, a foretaste of the work that in years to come was to mark him out as a great scientist.

2.1.2. The Swiss Years

After his stay in Italy, Einstein and his parents agreed that he should enrol in the prestigious Federal Polytechnic School (Eidgenössische Technische Hochschule) in Zurich to complete studies that would allow him to work in the family business. He failed in his first attempt and instead enrolled in the Cantonal School of Aarau to prepare his matriculation exams for the Polytechnic. During this time he stayed at the home of a schoolteacher, Jost Winteler. It was to prove a fruitful stay, academically (he achieved the education required to be accepted into the ETH) but also emotionally: he fell in love with Marie, the eldest of the Winteler children—his first experience in a long, diverse and stormy love life. Einstein's sister Maja, ended up marrying Paul Winteler and Michele Besso, his close friend from their first meeting in 1896 until the death of the two in 1955, married Anna Winteler.

That same year, 1896, he managed to have his renunciation of German nationality accepted, and so became "stateless" until in 1901 he achieved Swiss nationality and exemption from military service on account of his flat feet and varicose veins. It was to be a transcendental year in his life: he was finally admitted to the Polytechnic, which he remembered as "a beautiful corner of the world". Among his companions was Marcel Grossmann – a lifelong friend – and Mileva Maric, who was soon to become his first wife. He struck up a close friendship with Conrad Habicht and Maurice Solovine, with whom he formed what they called the "Olympia Academy". They met nearly every day to talk smoke and read their favourite writers: Spinoza, Hume, Mach, Poincaré, Sophocles, Racine and Cervantes. Einstein had fond memories of those meetings; He headed a letter to Solovine, written just a few years before his death (3/4/1953): "to the immortal Olympia Academy"

Einstein's plans did not coincide with those of his family; he aspired to qualify as a teacher in physics and maths. After graduating with good marks in 1900, he sought a position as a junior lecturer in the Polytechnic, but was not

accepted. That same year he begins publishing in *Annalen der Physik*, the journal of his subsequent successes, with an article entitled “Conclusions Drawn from the Phenomena of Capillarity”.

He was unsuccessful in his attempt to find a position at other universities, but he did manage to get work as a substitute teacher in various secondary schools in Swiss towns, before joining the patent office in Berne on 23 June 1902. He stayed there for seven fruitful years, during which he laid the foundations for a new form of physics. His father died in 1902 and the next year he married Mileva; they had already had a daughter, Lieserl, of whom little is known (indeed, there are doubts as to whether she survived an illness she suffered in her first years of life). Their first son, Hans Albert (1904 – 1973), was born in Berne and the second Eduard (or “Tete”) in Zurich (1910 -1965), where Einstein was working as an associate lecturer of theoretical physics in the university.

2.1.3. The Berlin Years

After a short spell as the professor of theoretical physics in the university of Prague, he returned to Zurich after being appointed associate lecturer at his beloved Polytechnic School. In Prague he fell in with the Jewish community, experiencing first-hand their problems, and it was there that he first began to defend the Zionist cause. He did not spend long in the Polytechnic; in 1913, Planck and Nernst visited him in Zurich to propose a lucrative job at the Prussian Academy of Sciences (as director of the new Kaiser Wilhelm Institute for Physics) and the post of lecturer without teaching obligations at Berlin University. The offer could not have been more tempting, especially because it would free him from the strict timetable of the classes he loathed and the wages were good.

After the rich year of 1905, he had started to extend his theory of relativity, previously restricted to inert systems, to non inert systems. Although in previous successful work he had used Planck's preliminary drafts of the quantum theory of light to explain the photoelectric effect and drew inspiration from Lorentz's work for his special theory of relativity, he now found himself in an entirely novel and unprecedented situation. Working on his own (as he was to throughout his career), in 1907 he began to lay the first foundations of what would eventually become his general theory of relativity, published in *Annalen der Physik*.

This intense labour took its toll on his health; he developed a liver complaint and was diagnosed with a stomach ulcer. He was tended to by his cousin Elsa Loewentahl, whom he married in 1919, after divorcing Mileva. That year his predictions on the deflection of light passing through an intense gravitational field were confirmed. He penned a jubilant “Good news today!” in a letter to his mother, at that time convalescing in a sanatorium (she died the next year at Einstein's home in Berlin). The news reached scientific societies, was mentioned in the universities and finally made it to the international press: Very much against his will, Einstein had become irrevocably famous.

But neither public fame nor his scientific contributions prevented him from being persecuted and repudiated, even by some of his colleagues, for his Jewishness. As an antimilitarist, aligned with the Zionist cause and above all, as a morally upright person, he refused to give in to the anti-Semitic Nazi bullying of former corporal Adolf Hitler and his henchmen, who went so far as to put a price on Einstein's head: five thousand dollars. Weary of the situation, he eventually abandoned Europe for ever. On 7 October 1933 he set sail on the *Westernland* from Southampton in England to New York, in the company of Elsa, his wife, his secretary Helen Dukas and his then assistant, Walther Mayer. Days before he had given a speech at the Royal Albert Hall of London on “Science and Freedom” helping to raise one million pounds for German refugees, of whom he himself was now one.

2.1.4. The Princeton Years

Einstein and his entourage arrived in New York on 17 October 1933. Paul Langevin (1872-1946), lamenting the occasion, wrote: “The Pope of physics has moved house and America has become the world centre of the natural sciences”.

He set up home at 112, Market Street in Princeton, near the Institute of Advanced Studies, founded with an endowment of five million dollars given by Louis Bamberger and his sister Mrs. Felix Fuld, wealthy Jewish financiers, to Abraham Flexner, a well-known reformer of the American educational system, to create an elite institution devoted to research and education. Despite several attempts to tempt Einstein back to Europe, Flexner finally managed to lure Einstein to the institute. Einstein suggested that he should receive an annual salary of three thousand dollars, but to his own surprise and

Elsa's joy, it was set at $15,000 dollars and he was guaranteed retirement at 65 (he was then 54) with a pension of $7,500. The offer was unquestionably generous, especially given that he had no teaching duties, except to attend occasionally to small groups of students.

However, his stay in Princeton was not as fruitful as he, and the lecturers at the Institute and the university, would have liked. Philip Franck, who replaced Einstein at the university of Prague and became an expert on his life and work and one of his most reliable biographers, puts this disappointing outcome down to Einstein's “absolute independence from his surroundings”. Einstein himself recognised how little sway he had at the institute when he wrote (12/4/1949) to Born, whom he had promised a long stay: “I suggested it, but I have little influence; they consider me to be petrified because over the years I have become deaf and blind (in a figurative sense). I do not mind much; it suits my temperament quite well”.

His public fame, however, was on the increase; he was pursued by journalists and busybodies, graduates wanted to work with him and scientists from all over the world took advantage of—or deliberately organised—their time in Princeton to visit him. He was very popular in the leafy suburb he lived in; the shopkeeper who attended to his first purchase in town, an ice-cream and (surprise, surprise!) a comb. —remembered him fondly. He received so much correspondence that Helen Dukas was forced to screen it and in some cases to “cushion it” (soften it down) when the contents might not be to his liking. His telephone number was never listed and visits were carefully chosen. Although he became an American citizen in 1940 and recognised noble qualities in the American people, he never felt American. He missed his life in Switzerland and eagerly received anyone who could take him back to that time and place. It is said that Einstein fell for his last love, Johanna Fantova, above all because she was central European.

In Princeton, although he continued in his failed attempts to unify gravity and electromagnetism, he inspired the successful scientific future of those who worked with him, continued fine-tuning his cosmological theories and contributed to clarifying the fundaments of quantum mechanics, while still refusing to accept the inevitable indeterminism. The most regrettable incident of his American years—albeit justified, he felt, by the Nazi menace—was the role he played in the American government's decision to manufacture the atom bomb, a contribution which was in sharp contrast to his ongoing antiwar campaign.

He died at 1:15 am on 18 April 1955. His last words, unintelligible to the nurse who was attending him, were in German, the language in he had always preferred to express himself in speech and in writing, although when necessary he could also speak fluent French and a rather quaint English. He left instructions—which were respected—that there should be no funeral; that his ashes should be scattered without saying where, and that no plaque should be erected on his house to say that he had lived there. Many years later, after Margot and Helen Dukas had died, the house was occupied by the physicist Frank Wilczek, who was later to win the Nobel prize (2004).

2.1.5. Travels, Honours and Distinctions

Despite his independence and his aversion to social niceties, Einstein achieved a level of scientific and public recognition which was unusual at that time for a scientist. He was called on to participate at a whole range of different public events; his name and his image reached every corner of the world. But the most important thing was that among scientists he was respected and his opinions were listened to carefully. People looked forward to his attendance at conferences and meetings with interest and admiration. Speaking about the Solvay Congress of 1927, Bohr, his most recalcitrant quantum opponent, remembers: " At the Solvay meetings, Einstein had been one of the most prominent figures from the outset, and several of us arrived at the congress eager to know his reaction to the last developments [in quantum theory]". In 1911 Einstein already enjoyed the privilege of being one of the twenty physicists invited to the first Solvay congress on radiation theory and quanta.

In 1909 he was awarded an honorary doctorate from the University of Geneva. It was to be the first of many, from some of the most prestigious universities of his time (including the Central University of Madrid), especially after 1919 when he achieved the popularity that was to accompany him for the rest of his life.

In 1921 he first visited the United States, in the company of the Zionist leader Chaim Weizmann, to help raise funds for the creation of the Hebrew University of Jerusalem. He also visited Japan, China, South America, Palestine and travelled extensively within Europe. The purpose of his travels was to disseminate and debate his scientific theories, attend events and celebrations that would benefit from his famous presence and support the Jewish cause for a national homeland. In 1952, on the death of Weizmann, he

was offered the presidency of the state of Israel, which he gratefully and respectfully declined, arguing that: “I know a little about nature, but hardly anything about men”. In passing, he asked the Israeli ambassador in the United States, who had passed on the proposal, to do everything possible to ensure that “the journalists lift the siege to which they have subjected my house”.

Of all Einstein's travels in the 1920s, his stay in Paris from 28 March to 10 April 1922 was particularly important. His theory of relativity, which proved everywhere to be his most appealing and provocative scientific contribution, was soon publicised in France, but many French scientists chose to have nothing to do with it, considering it to be little more than an extravagant passing fad: for them the laws of science had hit their ceiling and only needed a final push to leave a complete edifice built according to the Comptian conception of science. In an attempt to combat this ignorance, Paul Langevin (1872-1946) tried to bring Einstein to the *École de France* in 1914, but the outbreak of World War I frustrated the attempt.

Confirmation of his general theory of relativity in 1919, made Einstein famous throughout the world, especially in Britain; in contrast, his extraordinary discoveries were scarcely mentioned in France, though they did spark some heated disputes between French scientists which led to news items and articles in the press. Taking advantage of this inflamed situation, Langevin managed to attract Einstein to Paris, arousing further passion in the aftermath of a war which had greatly heightened tensions between France and Germany. For those who looked on Einstein's presence in France in a good light, he was a wise Swiss; for the opponents, he was simply a German whose presence might offend “very respectable patriotic feelings”. The complexity of the theory, the paradoxical figure who aroused “the adoration of an idol no one can understand” and the division between scientists which publicly showed how science was subject to alteration and change, were all echoed in the press, in the university, in scientific institutions, at philosophical gatherings and among people on the street, resulting in a debate which scholars considered “exceptional, but ephemeral”.

On 10 November 1922, during his tour of Asia—just months after his trip to France—Einstein received the news that he had been awarded the 1921 Nobel prize “for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect”; he had been a candidate on eight other occasions. The German ambassador in Sweden received the prize on his

behalf. Einstein delivered his Nobel lecture to the Nordic Assembly of Naturalists at Gothenburg in July 1923 on “Fundamental ideas and problems of the theory of relativity”, which he considered more deserving of the prize. He sent the prize money, $32,500, to Mileva, in compliance with the terms of their divorce settlement. Mileva used the money to buy three properties, the rent from which provided her with a living and covered the costly expenses of psychiatric treatment for their son Eduard.

During the 22 years he lived in Princeton up to his death in 1955, Einstein never travelled outside the United States or received any noteworthy distinctions. At last, he was able to lead the quiet life he had always craved, devoting himself to his studies, to his championing of world peace, to music and sailing as long as his strength allowed. He became one of the many inhabitants of the area, loved and admired by his neighbours, for whom he was always “the professor”.

2.1.6. Timeline

Given Albert Einstein's intense and diverse private, professional and social life, no chronology of his life can be reduced to a few notes on key events: his fame and importance meant that everything he did and everything that happened to him was significant. Nonetheless, the following timeline is meant to summarise some of the most important events:

1879	Born on 14 March in Ulm, Germany
1880	Moves with his family to Munich
1885-88	Attends a Catholic school
1889-94	Student at the Luitpold Gymnasium (now the Albert Einstein Gymnasium)
1894	His family moves to Milan. Einstein leaves the Institute without completing his studies and goes to Pavia, where he lives with his family
1895-96	He attends the cantonal school of Aarau, Switzerland

1896 He renounces his German citizenship. Admitted to the Poly technic School in Zurich, where he completes his studies in 1900

1901 Obtains Swiss nationality

1902 Employed at the Swiss patent office in Berne

1903 Marries Mileva Maric

1904 His son Hans Albert is born

1905 Annus mirabilis. Receives a PhD from the University of Zurich

1909 Leaves his job in the patent office. Obtains a post as associate lecturer in Theoretical Physics at the University of Zurich

1910 Son Eduard is born

1911-12 Lecturer in Theoretical Physics at the University of Prague

1912-14 Lecturer in Theoretical Physics at the Federal Technological Institute of Zurich (formerly the Polytechnic)

1914 Lecturer at the University of Berlin and member of the Prussian Academy of Sciences. Mileva and the children stay in Zurich

1915 Begins publications on the general theory of relativity

1917 Director of the Kaiser Wilhelm Institute of Physics in Berlin

1917-20 Einstein's health deteriorates. He is looked after by his cousin, Elsa Loewenthal

1919 Divorces Mileva and marries Elsa. Solar eclipse confirms Einstein's predictions on the deflection of light rays. Remarkable jump to world fame

1921 Visits US for first time with Chaim Weizmann

1922 Awarded 1921 Nobel prize for Physics. Publishes his first work on the unified field theory. Becomes member of the League of Nations' Committee on Intellectual Co-operation. Begins a tour of Europe, Asia, the Middle East, South America and the United States

1927 First debates with Niels Bohr on quantum mechanics

1928 Diagnosed with a heart condition

1932 Hitler, born in Austria, is granted German citizenship. He takes power in Germany and Nazi anti-Semitism intensifies

1933 Einstein and his family flee to Princeton, USA

1936 Elsa dies

1939 Outbreak of World War II. Einstein signs letter to President Roosevelt warning of the threat to the world of Germany's manufacturing an atom bomb

1940 Takes American citizenship

1944 Re-writes the 1905 manuscript on the special theory of relativity which is auctioned for six million dollars to aid the allied cause

1945 Atom bombs dropped on Hiroshima and Nagasaki

1946 Chairs the Emergency Committee of Atomic Scientists. Continues his campaign against re-armament and in favour of a world government

1947 Mileva Maric dies in Zurich

1950 Appoints Otto Nathan and Helen Dukas as his executors

1952 Offered and declines the presidency of the state of Israel

1955 With Bertrand Russell, draws up a manifesto against the nuclear threat. On 18 April, Einstein dies at Princeton hospital as the result of a burst aortic aneurysm in the abdominal aorta. He was cremated and his ashes scattered into the Delaware River.

2.2. Einstein and Spain

The *Junta para Ampliación de Estudios e Investigaciones Científicas* (Council for the Extension of Scientific Studies and Research) was founded in Spain in 1907. This state body facilitated visits by Spanish lecturers and researchers to universities and research centres abroad and visits by foreign lecturers and researchers to Spain. It was the culmination of a long-held wish which had only barely been achieved before. The laboratories, study centres, research institutes and primary and secondary schools answerable to the Council were headed by the most prestigious scientists, professors and teachers Spain had known, and they were succeeded by worthy heirs. Regrettably, General Franco's uprising against the legitimate government of the Second Republic in 1936 cut short this golden age in Spanish science and culture. Einstein himself, who was always quick to support democracy when the occasion required, sent a message to the 1937 International Writers Conference in Spain in 1937, decrying the lukewarm attitude of “democratic countries”, referring particularly to the United States, which had shown little enthusiasm in its support for the Spanish Republic. To the surprise of many, Ortega y Gasset, who was in voluntary exile, contested this manifesto in the journal *The Nineteenth Century*: “Some days ago, Albert Einstein felt he had the ‘right’ to give his opinion on the Spanish Civil War and to take a stance on it. Albert Einstein, however, displays a radical ignorance of events in Spain now, a century ago and always. The spirit that has led him to this insolent intervention is the same that for a long time has been resulting in the universal disrepute of the intellectual man, which in turn means that today the world is adrift, lacking in *pouvoir spirituel*”. It was certainly a surprising reaction to

Einstein's support for the democratic republican cause, which Ortega himself had initially supported.

As a result of the growing internationalism of Spanish science, there were physicists, engineers and mathematicians who had good relations and contacts with their foreign counterparts, including Albert Einstein. As a result of his popularity and a curiosity to learn at first-hand how he had reached his daring theories, as well as his predictions for the future, in 1923 he was invited to make a short visit to Spain. Later on, in 1933, when he was being harassed by the Nazi regime, he was offered an extraordinary professorship in what would have been the Instituto Einstein.

2.2.1. Travels, people and institutions

After spending almost a month visiting Palestine, where he lent his support to the creation of Jewish settlements, encouraging them to keep up their agricultural advances and opening the Hebrew University of Jerusalem, Einstein travelled on to Barcelona, where he disembarked on 23 February 1923. On 1 March he left for Madrid, where he stayed ten days. On 12 March he travelled to Zaragoza, from where he made his way to the French border on the 15th, thus concluding his visit to Spain. He left from Bilbao, where he had been invited by the Basque Board of Culture to deliver some lectures, but in the end he did not stay, possibly fatigued after such a lengthy international lecture tour. He also had to turn down an invitation by the *Ateneo Científico* (Science Society) of Valencia.

Einstein, who was accompanied by his wife, had a similar programme in the three cities: he gave a series of lectures – four in Madrid and Barcelona and two in Zaragoza; he visited some of the most important landmarks and whenever possible visited some outlying areas: for example the party visited Toledo, which Einstein remembered as being “like a fairytale”; he was charmed by the streets, the river, the cathedral and the synagogues. He also found time to visit the Sierra Madrileña and the Escorial.

The visits to Barcelona and Madrid were organised by Lana Serrate, Rey Pastor, Terradas, Cabrera and Cajal acting on behalf of the Institute of Catalan Studies and the Council for the Broadening of Scientific Studies and Research. The lectures in Zaragoza were organised by Jerónimo Vecino and José Rius, representing the University of Zaragoza.

In accepting the invitation, Einstein had explained his problems with languages to Rey Pastor:

> "I will accept your invitation on condition that I limit my lectures to the area of science and that I can use drawings and mathematical formulae. Given my complete inability to speak Spanish and my deficient knowledge of French, I would not be able to give my lectures if it were only possible to use words. German is the only language in which I can speak intelligibly about my theory. I look forward to meeting you again and to see your beautiful country for myself".

The lectures in Zaragoza were on special relativity and general relativity. In Barcelona and Madrid, he also delivered a lecture on his recent research and another, more informational one, on the philosophical consequences of the relativity. The audience figures surpassed the organisers' expectations, though most understood little of this illustrious visitor said. The press assiduously covered all the events he participated at; the science academies of the cities he visited bestowed honorary positions on him; the king himself went to see Einstein being named a corresponding academic of the Royal Academy of Exact, Physical and Natural Sciences, where the Minister of Education, Joaquín Salvatella, closed the proceedings with these words:

> "In congratulating Professor Einstein, I can tell him that by the will of the Sovereign and of the Government of Spain, this country is prepared to continue the work for peace that His Majesty undertook during the war and to provide help in their research to German scholars whose work is currently hindered by economic conditions in that country".

It was no empty promise, as the creation of the Einstein Institute in 1933 was to prove.

In a short travel journal, Einstein spoke of the king as "simple and dignified. I admired him"; speaking of the participants at the lectures, he wrote: "an attentive audience who I am sure understand almost nothing"; he refers to Cajal as a "wonderful old man"; he was enthusiastic about the Prado Museum with El Greco, Velázquez, Raphael, Goya and Fra Angelico; he mentions the pleasant welcomes he received, the good meals, the "tea with an aristocratic young lady", his visit to a ballroom... all, in short very cordial, although in a final note, he mentioned how lonely he felt inside, and wrote: "The party was awful, as usual".

2.2.2. Echoes in society

The twenty days Einstein spent in Spain were dutifully covered by the press: *El Correo Catalán*, *La Veu de Catalanuya*, *La Vanguardia*, *Diario de Barcelona*, *Las Noticias*, *La Publicitat*, *Las Provincias*, in Barcelona: *ABC*, *El Debate*, *El Sol*, *El Heraldo de Madrid*, *El Liberal*, *El Imparcial*, *El Noticiero Universal*, in Madrid: *El Heraldo de Aragón*, in Zaragoza. Other papers also reported on the chance that he might extend his visit to other Spanish cities—*El Noticiero Bilbaíno* and *La Voz Valenciana*—and many other provincial newspapers also mentioned this illustrious visitor.

The German ambassador in Madrid, reporting to the German Ministry of Foreign Affairs, wrote:

> "Every day, the papers gave over entire columns to his acts and movements, the scientific correspondents in the most important newspapers wrote long articles on the theory of relativity; in their reports on Einstein's lectures the journalists tried to instruct the lay public on the great problems of physics 'on which Einstein's discoveries have shone new light' in a generally comprehensible fashion; the press photographers take pictures of Einstein and the other participants at the solemn events in his honour in every possible position. The caricaturists reproduce his remarkable features, and even in the popular press, Einstein and the word relative are on everyone's lips"

Most of the news generated by the occasion reflected the reverent welcome Einstein received in Spain. In an extreme example, Royo-Villanova, the rector of the university of Zaragoza, asked Einstein not to clean the blackboard he had used in a lecture in the science school but instead to sign it as a souvenir, "a constant, lasting token of Einstein's visit to the university".

Most of the coverage in the press talked about Einstein's life, customs and tastes and what he did in the different places he visited. They also, of course, included some mention of the content of his lectures, but always with the greatest caution—the press hacks did not find it easy to understand the world of Einsteinian physics. Some scientists seized the occasion to make bold claims: the professor of natural history Odón de Buen, writing in *La Voz*, echoed the praise and the promises of Minister Salvatella, and proposed that Einstein should stay on a year heading a group of Spanish researchers to investigate general relativity following the solar eclipse due on 10 September 1923, which would be visible in much of Mexico. The professor, was aware of the difficulties of such an undertaking:

> "There remains one issue, which in Spain is always difficult, always tiresome: that of the staff. No great harmony exists here among men of science, and the interests created around the official scientific institutions are often a hindrance and, worse still, are in danger of bringing us disrepute abroad. This situation must be brought to a radical and swift end. The Government can do much in this delicate issue. But since the question involves working outside Spain, alongside the most prestigious figures in the world, only the best prepared, the most capable and the most enthusiastic should go".

2.2.3. Publications on Einstein and his work

An immense amount has been written about Einstein and his work, perhaps more than any other topic of scientific interest. The publications listed here are just a few of the many in Spanish dealing with Einstein's life. A search on Internet for the name "Albert Einstein" turns up 800,000 hits, as compared to 420,000 for his nearest rival, Winston Churchill. The next most quoted physicist is Niels Bohr, with just 80,000 hits.

The first news to spread to Spain about Einstein's famous 1905 articles in *Annalen der Physik* was published in *Anales de la Sociedad Española de Física y Química*. In Vol. 18 (1910), Note 74 of the "German Physics Notes" sent to the journal by the German professor Werner Mecklenburg, refers to "Physics at the 81st assembly of German Naturalists and physicians, held in September 1909 in Salzburg". Einstein, who had left his job in the patent office in Berne in July 1909 to occupy a position as an associate lecturer in Theoretical Physics at the University of Zurich, has spoken at the assembly; it was his first public appearance at a scientific meeting and people were interested to hear what he had to say.
The note in the *Anales* begins: "One of the most interesting and important lectures was given by Professor A. Einstein, from Berne, author of the famous theory of relativity, regarding the development of our hypotheses of the intimate essence and constitution of radiation [...]. According to Einstein, the hypothesis of the ether is now yesterday's truth". Much of the rest of the note, which continues in successive issues of the magazine is given over to treatises on "the nature of light". Interestingly, at that conference, Einstein argued that light might be considered to be both a wave and a particle (or "corpuscle"), "although—writes Mecklenburg—a mathematical theory of radiation has yet to be established which reproduces at the same time the structure of wave motion and the other structure of the quanta". This is a clear forerunner of

what over the years would become Bohr's principle of complementarity, which Einstein, however, never accepted with all its consequences.

In 1920, *Anales*, the most widely read journal among university and secondary school teachers during the first three decades of the twentieth century, published an article by the astronomer Pedro Carrasco on "the present state of the theory of relativity", having already written another entitled "The Theory of Relativity" in El Ateneo de Madrid in 1916. In the same issue of *Anales* José María Plans published his "Note on the shape of light rays in the field of a gravitational centre in accordance with Einstein's theory". The two articles dealt with Einstein's recent (1919) discussion of the deflection of light in the proximity of an intense gravity field. In 1922, Plans, one of the people who best understood the theories of relativity in Spain, translated (Calpe, Madrid) such fundamental works as *Space, Time and Gravitation*, by Arthur Eddington, and Erwin Freundlich's *The Foundations of Einstein's Theory of Gravitation*. In 1933, Eddington's *The Expanding Universe* was translated for Revista de Occidente.

The philosopher Manuel García Morente translated *Space and Time in Contemporary Physics* (1921) by Moritz Schlick and *Einstein's Theory of Relativity* (1922) by Max Born for Calpe. The latter was one of the books about his work that Einstein himself most admired.

Other translations published in Spain included: *Einstein for Everyone* (1922), by Georg N. Felke, *Einstein and the Universe. A Popular Exposition of the Famous Theory*, by Charles Nordmann *Introduction to the Theory of Relativity* (1923), by Rudolf Lämmel, *Introduction to Relativity* (1923), by Paul Langevin and *Space and Time* (1931) by Emile Borel. The latter deals with the geometrical view of the universe based on relativist theories, and followed other original books in Spanish on the same theme such as: *Espacio, Relación y Posición [Space, Relationship and Position]* (1924) by the Viscount of Güell and *Espacio, Hiperespacio y Tiempo [Space, Hyperspace and Time]* (1928) by Francisco Vera.

Of the originals in Spanish, the most important were written by José María Plans and Blas Cabrera. Their publications on Einstein's theories included *Nociones fundamentales de mecánica relativista [Basic Notions of Relativist Mechanics]* (Madrid, 1921) by Plans; *Principio de relatividad. Sus fundamentos experimentales y filosóficos y su evolución histórica [Principle of Relativity. Its Experimental and Philosophical Bases and its Historical*

Development (Madrid, 1923), by Cabrera. Esteban Terradas, an acquaintance of Einstein's and one of the people who was most influential in bringing him to Spain, published some articles and papers on the subject, but with less intensity than Plans and Cabrera.

In addition to serious publications like these, written from a position of scientific rigour and a knowledge of Einstein's theories, there were many other less significant works written from philosophical, political and religious positions, supporting or opposing relativity. In reality, relativity, was the only one of Einstein's theories to draw the attention of the general public, among other reasons because it was the one that received most coverage in the press, and in scientific and educational journals and institutions. There were also alternative proposals to the theories of Einstein, notably those of the insistent anti-relativist Horacio Bentabol, author of *Observaciones contradictorias a la teoría de la relatividad del profesor Alberto Einstein [Observations contradicting Professor Albert Einstein's Theory of Relativity]* (Madrid, 1925), and other less aggressive ones such as *La Cósmica. Nueva teoría de la relatividad formal e intrínseca, fundada en el origen espiritual de la materia o en el tiempo como factor cósmico por excelencia [The Cosmic. New theory of Formal and Intrinsic Relativity, founded on the spiritual source of matter or on time as the cosmic factor par excellence* (Madrid, 1932), by Osvaldo García de la Concha and *Teoría de la Relatividad de Einstein. Compilación y comentarios y Principios esenciales de Acrofísica (Física superior o ultramatemática) [Einstein's Theory of Relativity. Compilation and Commentary and Essential Principles of Acrophysics (Higher or Ultra-mathematical Physics)* (Madrid, 1931), by Camilo Calleja García. There were others which appropriated the term “relativity” to fields far removed from science such as, for example, bullfighting.
This was the case, for example, of *El Toreo Científico*. *La teoría de la relatividad de EINSTEIN aplicada a la Tauromaquia* [Scientific Bullfighting. Einstein's Theory of Relativity applied to Bullfighting], written by Otto Kaetsner, lecturer at Higher Technical School of Charlottenburg, which ran to various editions in Spanish from 1920 on. And this was not the only case of “Einsteinean bullfighting”.

Of the biographies translated into Spanish, written during Einstein's lifetime, some of the most important included one by H. Gordon Garbedian, who had the inestimable help of Einstein himself in writing *Einstein, Maker of Universes* (Buenos Aires, 1940), Philip Franck, his successor at the University of Prague, entitled *Einstein* (Barcelona, 1949) and *Einstein, a biography*

(Buenos Aires, 1955), written by Antonina Vallentin, a friend of the Einstein family since their Berlin days

2.2.4. The professorship offered by Madrid

After he went into exile from Germany, France offered him a tailormade course at the College de France; Britain offered him citizenship; and other countries aspired to tempt him to their universities. As we all know, it was America which finally succeeded. Spain also tried to attract him.

In April 1933 the Minister for Education and the Arts, Fernando de los Ríos, announced that Einstein had agreed to take charge of an extraordinary professorship in a research institute, which would bear the name Instituto Albert Einstein, under the science school of the central university of Madrid. Among those involved in the task were Ramón Pérez de Ayala, writer, the then Spanish ambassador to Great Britain, and Abraham Shalom Yahuda, a lecturer in Hebrew at the university in Madrid, chosen by Einstein as his spokesman on this issue. The details of this laudable undertaking by the republican government to support science, by attracting figures as renowned as Einstein, are told by J. M. Sánchez Ron and T. Glick in *La España posible de la Segunda República* (Universidad Complutense, Madrid, 1983).

In reality, Einstein's initial intention was to spend short sojourns in a number of different places: Leiden, Oxford, Paris, Caltech, Princeton and even Spain, when he was still toying with the possibility of accepting the chair in Madrid. He made this very clear in a letter he sent to Pérez de Ayala, in reply to the latter's offer to provide him with a house, a gift from the Spanish government: “For a gypsy such as myself, who can only stay in Spain for a relatively short time, it would be much better for me to stay in a hotel... A house, as Schopenhauer so rightly observed, is rather like a woman: rather than possessing her, one is possessed by her”.

Although Einstein did consider the possibility of heading the Institute himself, his idea was to set up someone he trusted in the post. The first name Einstein proposed was the Nobel prize winner, Max von Laue, who had a good grasp of his theory of relativity. Laue was not a Jew, as Einstein warned Yahuda in the letter (5/5/1934) putting forward his name, but his persistent defence of his Jewish colleagues had made it untenable for him to remain in Berlin. It was difficult to find suitable names for the post at that point, because “the most

important exiled Jewish colleagues in the field, have already found positions", wrote Einstein. As we can see, the creation of the chair in Madrid was linked to attempts to help the Jewish cause, but Einstein began to give up hope:

> "I have wracked my brains about the Spanish professorship. Apparently Laue doesn't want to go. He is hesitating a lot and even doubts whether he will leave Germany: It is even rumoured that Hitler is beginning to teeter. The situation is very different with regard to Born. Apparently, he is trying to use this offer to set himself up in England. However, if he does not manage, he would probably accept the position in Spain. It would be good for us to know soon how things stand. If it doesn't work out with Born, I will appoint Dr. Leopold Infeld". (Einstein to Yahuda, 10/6/1934)

The possible names were first rate, but Einstein declined to take possession of the chair, a precondition for appointing someone permanently to the Institute. This may have been because he had already opted for Princeton and also because the political situation was becoming so strained that it hindered a satisfactory conclusion of negotiations over the professorship. Franco's uprising, which came just a short time later, was to put paid to these and many other great plans for Spanish science.

2.3. A character on the fringes of physics

Einstein was a lover of knowledge, who never lost his sense of curiosity, with that insatiable "hunger of the soul" he considered to be the great spur for knowing more and knowing better. To his disappointment, however, he was often treated as a mere spectacle: he received proposals from a whole range of products that wanted to exploit his name and his image—unabashed proposals from prestigious commercial firms trying to bribe him with succulent economic rewards for advertising their products: hair tonics, soap, fountain pens, pipes, chocolate, shoes... He only had to express an interest in some product for the firm to present him with a gift and ask him to advertise it for them. With time, the tradespeople have won out and Albert Einstein's face and name can now be found on a host of products. He has given his name to streets, buildings, schools, universities, hospitals, work groups, clubs, parks and competitions.

That name has become legendary and his image iconic, both inextricably linked to *relativity*, that totemic word which transcends the bounds of science to become an emblematic term of the groundbreaking movements that rocked

the foundations of society in the early twentieth century. “Everything is relative” has become a colloquial cliché, as gratuitous as it is lacking in foundation. Einstein's relativity, which he himself refused to call a “theory” (it was Max Planck who labelled it thus), is a theory of invariables, that is to say of that which remains unaltered in a physical phenomenon: in a way, it might be considered as a theory of the “absolute”.

Although Einstein has long been the subject of caricatures, jokes, crosswords, puzzles and a host of events, objects and circumstances that have nothing to do with him or his work, he also earned his reputation through his behaviour. In a letter to Einstein's son-in-law and biographer, Rudolf Kayser, Thomas Mann wrote:

> “His quasi-mystical fame throughout the world is very peculiar given that so few people understand anything of his achievements, but his moral and political attitude undoubtedly has much to do with the respect he enjoys”

2.4. Quotes and voices

Most publications on Einstein and his work are filled with quotes by and about him. The reliability of everything that has been published is at the very least questionable. The publication of his complete works, *The Collected Papers of Albert Einstein*, begun in 1976 under the supervision of John Stachel, offers a faithful look at a figure who for different reasons has been misinterpreted by different authors. One of the most reliable collections of quotations is Alice Calaprice's *The Quotable Einstein* (Princeton University Press, 1996), and the biographies written by those who worked with him or formed part of his closest circles. All the quotations given on the following pages have been taken from these sources.

2.4.1. Einstein said…

“It was formerly believed that if all material things disappeared out of the universe, time and space would be left. According to the relativity theory, however, time and space would disappear together with the things”. (B0.194)

“Do you talk about anything other than physics?”, a reporter asked Einstein at a press conference. To which Einstein replied: “Yes, but not to you”. (B0.424)

“We want to be given less praise but to be read with greater application”. Einstein appropriated this phrase which he attributed to a “poet” in the speech he delivered to the Real Academia de Ciencias Exactas, Físicas y Naturales in Spain in 1923.

“"Put your hand on a hot stove for a minute, and it seems like an hour. Sit with a pretty girl for an hour, and it seems like a minute. THAT'S relativity."

“I wonder about my attitude to life. I prefer giving to receiving, under any circumstance; I do not place importance on my person, nor the accumulation of wealth; I am not ashamed of my weaknesses, or of my errors and I instinctively take things with good humour and equanimity. There are many people like me and I do not understand at all why I have been turned into some sort of idol. It is without doubt, as incomprehensible as the mystery of an avalanche, which can be triggered by a single grain of dust, and which takes a given path”.

“As far as the theorems of mathematics refer to reality, they are not certain, and as far as they are certain, they do not refer to reality”.

2.4.2. They said about him…

“Following confirmation of his general theory of relativity in 1919, Einstein became a national asset for German science, badly hit by the Great War and the political, social and academic tensions that had arisen in the country, [...] the man best able to help restore the reputation of German science in hostile foreign countries” (Fried Stern, *Einstein's German World*, 60)

Niels Bohr, after recounting his discussions– sometimes heated– with Einstein, who was radically opposed to the quantum uncertainty, wrote: “I hope, however, to have given a fair impression of how much it meant for me to profit from the inspiration we all obtain from any contact with Einstein” (Niels Bohr, *Atomic physics and Human Knowledge*, 82).

“EINSTEIN, the magician physicist of the sad, rounded face, in his innocent and unconscious moral halo of white curls— the most pathetic face of today's world, even when he sticks his tongue out at reporters—repeats, to any one who wants to or has to or can hear him, that he can only be human in abstract, but can never unite in any way with anything individually human, not even

with the most familiar or intimate" (Juan Ramón Jiménez, *La corriente infinita*, 265).

"I have on my desk a book by Einstein that confirms my thesis. The book is called *The World As I See It.* It is a series of opinions about everything, and these opinions are utterly, utterly worthless. My concierge says things which are just as valuable, when he starts giving forth about the human and the divine. Mr. Einstein is probably a great physicist, though I won't make any such claim, because I do not consider myself enough of an expert on physics to give an opinion that is worth anything. But such a consideration does not halt the physicist's pen. While we men of moral and political science are hold physics in deep respect, physicists, on the other hand, move into our territory with the same liberty as if it were their own, and emerge with some simplistic remarks that would make anyone laugh" ("El bueno de Einstein", *Obras*, Ramiro de Maeztu, 236).

"In the petals of a rose
stands the formula:
E = mc2

I shall refuse to look away.
I shall refuse to let
my eyes
be crushed by the asphalt.

And God knows
I love the city"
("Ciudad", Libro de Alineaciones, Clara Janés)

"Before my window passes a man dressed with a blue jersey and flannel trousers, his hair tangled by the wind (two beautiful white locks in brilliant disorder)... He walks past every day at eleven o'clock. If it is cold, he wears a black coat. His hair tells me the direction of the wind, and his gaze makes my little daughter run and hide. What is he thinking about? From that brain came the equation that began to change the world. The equation looks new to me every time I see it: $E = mc^2$ ...nobody has ever said so much with so few signs" (*Lettres sur la bombe atomique*, Denis de Rougemont)

They cheer me because they all understand me, and they cheer you because no one understands you", Charlie Chaplin to Einstein.

2.4.3. Einstein speaks about:

The goals of human existence: http://www.albert-einstein.org/
His famous formula: http://www.aip.org/history/einstein/voice1.htm
The fate of European Jews: http://www.aip.org/history/einstein/voice2.htm
World peace: http://www.aip.org/history/einstein/voice3.htm

Original recordings of public speeches from 1921 to 1951 (two CDs).
ISBN 3-932513-44-4

3. Scientific Impact of Albert Einstein's Work

The influence of Einstein's work in physics has been enormous. It spans from the smallest (standard model of elementary particle physics, with the theory of relativistic quantum fields as a framework) to the largest (the structure of the Universe, with general relativity ruling the global geometry and dynamic evolution in cosmology). From the simplest (the gyromagnetic ratio of the electron) to the most complex (the collapse of a supernova). From the lowest energies (Bose-Einstein condensates at temperatures as low as a few nanoKelvin) to the highest (the quark-gluon plasma). From the commonest application (global positioning system) to the most sophisticated techniques (non-linear atomic optics).
Einstein's impact is not restricted to physics and associated disciplines. His ideas have also made a mark on modern culture from art to poetry. They have shaped the theory of knowledge and philosophy as well. Einstein rejected an empirical explanation for the origin of physical concepts, which he considered a free creation of the human mind. But mere logical thinking does not provide us with knowledge of the external world, which only experience gives us. Nevertheless, concepts help organise sensory experiences and, so far, Nature has always appeared on the side of simplicity and mathematical beauty. Along with Leibniz and Planck, he believed and sought a preestablished harmony. In the realm of philosophy, relativity theory forced philosophers to revise their conception of space, time and matter, and later, to take party on the local realism which impregnated the critical position of Einstein on quantum physics. Experimental results appear to stubbornly reject this position (albeit

without the strength required to convince sceptics).

4. Miscellanea

Einstein is popularly known for the famous equation $E = m\,c$. However, its significance is almost entirely unknown, outside specialist spheres, by most of those who claim to understand it, and the same is true of the rest of his scientific work, even the most renowned of all his works, the special and general theory of relativity, of which that equation forms part. Einstein wrote a great number of varied scientific publications. *ALBERT EINSTEIN, Philosopher – Scientist*, published to mark his seventieth birthday contained 618 publications, including scientific and non-scientific publications, interviews, letters and lectures, but by the time *The Collected Papers of Albert Einstein* came out the number had grown greatly.

Apart from scientific matters, Einstein, as a citizen of the world, and as a German Jew who had had to go into exile in America, made his voice heard in many arenas. He wrote a host of articles, endorsed manifestos, delivered lectures and appeared on radio programmes to give his opinion on education, politics, celebrities, music, Judaism, pacifism, literature, art, philosophy, religion and even on himself. Spanish translations of many of these declarations are compiled in the collections of his essays and articles *Cómo yo veo el mundo*, *Ideas y Opiniones* and *De mis últimos años*, as well as the published correspondence with Besso, Born, Solovine, Freud, Mileva and others which cast light on his life and the way he went about his work. It was a life which was not free from the contradictions, successes and failures that beset any person. As a simple example of this other face of Albert Einstein, so important for understanding his human, scientific and social dimension, there follows a brief summary, organised into different categories.

4.1. Education

Although in his youth he aspired to be a teacher of physics and mathematics, when he eventually achieved his goal he showed little enthusiasm for the classroom, preferring to work with a small number of students and where possible only at specific times. As a result, he was an inconsistent teacher, appreciated more for his direct dealings with the students than for large

classes. However, he did not supervise any doctoral theses, as one might have expected form someone who preferred to work with small groups.

In a letter to a young woman, who had complained about the treatment she had received from her teachers, Einstein recalled that he had received similar treatment in his time: “they despised me for my independence and ignored me when they wanted assistants”. This corroborates our picture of someone who did not fit in well with formal education, or at least the education that was practised in the Prussian schools of his youth and childhood. Further on he writes: “At the same time, I have come to Princeton only to investigate, not to teach. There is too much formal education, especially in American centres”. Nonetheless he had great regard for those who felt a vocation for education: for him “education has always been the most important means of passing on the treasure of tradition from one generation to the next...The continuity and the health of mankind depends, therefore, to an even greater extent than before, on the institutions of education”. It was a maxim which he always held up as a remedy for the ills and disappointments he suffered and witnessed during his life.

He valued school not only as a centre for gaining knowledge; he considered that “qualities and skills that are valuable for the common good should be cultivated among young people”. He put personal and civil training above mere learning, but the method for influencing the development of personality should not, in his opinion, be by word of mouth. “Great personalities are not formed by what they hear and say, but by work and activity... by the execution of specific tasks”, tasks to be carried out freely, without fear or coercion to encourage “that divine curiosity that every child possesses, but which is often prematurely weakened”.

On scientific education for young people, he wrote:

> “The mind of a young person must not be stuffed with facts, names and formulas: all of these things can be found in books, without requiring any university course. The years of study must be employed only for teaching young people to think, to give them the training that no manual can replace. It is a true miracle that modern education has not managed to completely smother the holy curiosity of the seeker. I think it would even be capable of doing away with the voracity of a healthy wild animal, by obliging it, under threat of a beating, to constantly eat even when it was not hungry and, above all, by carefully choosing the food it forced it to swallow”

4.2. Politics

Although Albert Einstein devoted much of his time to the defence of democracy, freedom and justice whenever an opportunity arose, he was never tempted to align himself with any party (though he declared himself to hold common cause with socialism) nor was he interested in accepting political office, or indeed any type of public post, including academic ones.

On the death of the first president of Israel, Chaim Weizmann, in 1952, Prime Minister David Ben Gurion, with the mediation of the Israeli ambassador in the United States, offered Einstein the vacant post. Einstein was categorical in his reply: “I know a little about nature, but hardly anything about men”. Word of the proposal had spread, and as a result the area surrounding his family home was invaded by reporters. Einstein took the opportunity of his conversation with the ambassador to ask him to see that “the journalists lift the siege they have placed my house under”. Certainly, he was not the right person to hold political office, nor to discuss with the press the vague remarks he said filled the pages of the newspapers.

He defended socialism as an alternative to the competitiveness and individualism inherent to capitalism, which could only be combated through a socialist economy that was more equitable in terms of the ownership of goods and performance of work—difficult to guarantee for all in a capitalist society. As always, the means he proposed for achieving those ideals was education and the decentralisation of political power, a measure which was lacking in Soviet socialism and ultimately led to its downfall, excessive bureaucracy and a concentration of power degenerating into a police state. His ideal political figure was no common leader, but Gandhi. Following Gandhi moral's lead, he fought against American McCarthyism which he equated with the Nazi persecution of Jews, Gypsies and homosexuals. Notoriously, Julius Robert Oppenheimer suffered abuse and infamy for refusing to continue to be involved in the nuclear arms race, having previously directed the Manhattan project which produced the first atom bombs.

Einstein's independence and rebellious spirit earned him the rejection of Germany, which accused the physicist of being a “Bolshevik” when he was first attacked for being a Jew, and caution from Russia, anyone working on the concept of relativity—which did not have Stalin’s approval— were persecuted.

Amongst he political ideals, he believed that at some point a world government and a united Europe might be possible. In 1922 he was made a member of the League of Nations' Committee on Intellectual Cooperation. He resigned in 1923, but was left with the disillusionment that gradually consumed his best ideals. At times, his words and his deeds seemed to contradict each other.

After World War II, Einstein, together with other scientists, many of whom had worked on the Manhattan project (possibly seeking to escape that horrendous shadow), created the Emergency Committee of Atomic Scientists (ECAS) to warn the public against the possible excesses by politicians in the use of nuclear power. Its essential missions were:

1. To promote the peaceful use of nuclear energy for the benefit of mankind.
2. To promote knowledge and information of nuclear energy [...] so that informed citizens can take intelligent decisions in their own benefit and that of all mankind.

It was an antecedent of the Einstein-Russell Manifesto of 1955, dealt with in greater detail below in the section on Einstein and the pacifist movements.

4.3. Personalities

On the occasion of the seventieth birthday of Romain Rolland (18661944) Einstein wrote:

> “I have only seen you once with these mortal eyes. That was at the time of the outbreak of the European catastrophe and you were still marked by that recent impression. Solitary, observing, suffering the unspeakable, oppressed by an awareness of being unable to create or release light, you were never able to achieve complete consolation by influencing improvement through your high art and your word; you wanted to help those human creatures who languished in the wretchedness they themselves had created. The rough masses are motivated by sordid passions, to which they are entirely subjugated, as are the states they personify... You, venerable master, have not remained silent, but rather you have struggled and suffered... At this time, so humiliating for us Europeans, we have seen that the athletics of the spirit are no protection against the meanness of the soul or barbarous sentiments. I believe that noble and humane feelings prosper no better in the universities and academies than in the workplaces of unknown and unheard villagers. Today you are greeted by those who see you as an example. It is the group of solitary men, immune to the epidemic of hatred, who aspire to abolish war, as the first objective on the road to improving the

moral health of mankind...”

Romain Rolland had helped mould Einstein's first pacifist leanings. Rolland recorded his own impression of their only meeting:

> “Einstein is still a young man, not very tall, with a long, wide face, and a great mane of crispy, frizzled and very black hair, sprinkled with grey and rising high from a lofty brow. His nose is fleshy and prominent, his mouth small, his lips full, his cheeks plump, his chin rounded. He wears a small cropped moustache.”

Among scientists, he admired Max Planck (1858-1947) whom he considered to be a true revolutionary, and he venerated Hendrik A. Lorentz (1853-1928), who shared the 1902 Nobel prize with Pieter Zeeman for their “pioneering work on the connection between optical and electromagnetic phenomena”. Of all the praise Einstein heaped on Lorentz, this declaration on the centenary of Lorentz's birth, is a defining one:

> “At the end of the century, theoretical physicists from all countries considered H. A. Lorentz to be the greatest among their number, and they were right. Physicists of our times are not, generally speaking, fully aware of the decisive role played by H. A. Lorentz in structuring the essential ideas of theoretical physics. The reason for this curious fact is that Lorentz's basic ideas have come to be so familiar that it is difficult to see how audacious they were and to what extent they have simplified the fundaments of physics.”

Another influential character in Einstein's life and attitude was Mahatma Gandhi (1869-1948). On Gandhi's seventieth birthday, Einstein wrote:

> “A leader of his people, unsupported by any outward authority: a politician whose success rests not upon craft nor the mastery of technical devices, but simply on the convincing power of his personality, a victorious fighter who has always scorned the use of force, a man of wisdom and humility, armed with resolve and inflexible consistency, who has devoted all his strength to the uplifting of his people and the betterment of their lot, a man who has confronted the brutality of Europe with the dignity of the simple human being, and thus at all times risen superior.”

4.4. Judaism

In his youth, Einstein did not feel a sense of belonging to the Jewish community, possibly because his family, with the exception of one of his uncles, were not practicing Jews. Having been educated at a Catholic school, his religious interest was channelled elsewhere. It was only after establishing

himself as a lecturer in Prague, at the age of 32, that he saw at first hand the conditions under which many Jews were forced to live on the fringes of society. From then on, he increasingly accepted that he was a Jew and that he wanted to be one, identifying with the Zionist movement which was demanding an Israeli homeland in Palestine. Much of Einstein's fame from the 1920s on, generated of course by his scientific contributions, was due to his work in various countries in support of the Zionist cause, and more specifically his participation at public events, sometimes before large crowds, to raise funds among the Jewish communities of the world to help build a Hebrew University in Jerusalem. There were times when Einstein doubted whether the Zionist movement would live up to his expectations of peaceful integration with the Palestinian people – and indeed, we are reminded of this failure in the news every day– and he even doubted whether the effort he had put into the creation of the university was really worthwhile: he feared that it might become not more than a Jewish theological seminary.

He devoted much of his time not only to making public declarations, but also to publishing articles and manifestos in an attempt to arouse a sense of identification among the Jewish people, who in many cases for fear of disdain, alienation and persecution sought to conceal their true identity. He Looked for the signs of Jewish identity which he saw in “the democratic ideal of social justice, coupled with the ideal of mutual aid and tolerance among all men” and "the high regard in which it holds every form of intellectual aspiration and spiritual effort”. It was these aspects—which Einstein considered to be essential to the Jewish tradition—that allowed him "to regard my belonging to it as a gift of great fortune”, he wrote in an article entitled “Why Do They Hate The Jews?” (*Collier’s Magazine*, New York, 1938).

Basing himself on studies by renowned anthropologists, Einstein maintained that the Jewish people was not a race per se, however much it was considered as such by the political propaganda which had resulted in its persecution and diaspora. It was the Jewish people's signs of identity, Einstein felt, and the fact that in small groups they were, ultimately, the settlers of the entire world, and could be considered as a threat if they joined forces in a combined and widespread action, that was “the essential cause for the savage hatred of Jews raging in present-day Germany”.

Anti-Semitism was so obtuse, so blinding and so radical that Philipp Lenard, winner of the 1905 Nobel prize for physics for his work on cathode rays, who had taken an interest in the photoelectric effect before Einstein discovered the

quantum law that governed it, and had even lectured Mileva, and who for all of these reasons was held in high regard by Einstein, attacked relativity and Einstein to whom he referred as a ”pure-blooded Jew” and railed against “Jewish science”, ignoring his own debt to Hertz, another Jew, to whom Lenard owed much of his scientific success.

Such was Lenard's intolerance and aggression that he once said “it is evident that the Jew lacks an understanding for truth, unlike the Aryan research scientist in his serious, painstaking search for the truth... Science, like any other human product, is racial and is conditioned by blood”.

4.5. Pacifism

Einstein’s rejection of all things military (he saw parades as ridiculous and grotesque and renounced his German nationality when he was 17 in order to avoid doing military service) and his aversion to the arms race were constants in his life, as evidenced in his writings and in his membership of pacifist societies. He became ever more radical in his stance, calling on people to conscientiously object in order to oppose governments that chose war as a way of “achieving peace”. However, with the persecution and extermination of the Jews by the Nazis, he toned down his opposition to participation in the war. In 1944, he rewrote his 1905 article on relativity by hand and auctioned it to raise funds for the allied war effort. It made six million dollars.

The fatal outcome of the war, with the dropping of two atomic bombs, led him once again to position himself radically against arms production, insisting again and again in that the solution did not lie in international treaties which at critical moments nobody observed or in international organisations (from which he always ended up resigning, because they never addressed the heart of the problems).

Einstein's last pro-pacifist action was his agreement to head the "Russell-Einstein Manifesto" of 1955. Presenting the manifesto in London, Russell told how he and Einstein had agreed on the first steps. When Einstein's letter arrived subscribing to the manuscript, he had already been dead a week. His call for world peace was summarised in the final paragraph of the manifesto:

> “In view of the fact that in any future world war nuclear weapons will certainly be employed, and that such weapons threaten the continued existence of mankind, we urge the governments of the world to realize, and to acknowledge publicly, that their

purpose cannot be furthered by a world war, and we urge them, consequently, to find peaceful means for the settlement of all matters of dispute between them."

Joseph Rotblat was a member of the Manhattan project team which built the first atom bomb in America, but resigned before production concluded and was consequently accused of being a Russian spy. He is the only surviving signatory of the manifesto. In an article in *El Mundo* (14/4/2005), he spoke about how the manifesto was first developed in Great Britain at Russell's initiative, with collaboration from Rotblat. They wanted to bring the most prestigious scientists on board; There were eleven signatories, but undoubtedly the most internationally renowned was Einstein. Rotblat writes:

"He was a scientist but a realist and aware of what was going on in the world. He was quite the opposite of people's concept of a scientist —absent-minded, naive and immersed in their work. He was fully aware and trying to get something done. I admire him not only as a great man of science but also as a great human being. I think if he were still alive, he would still be working on his theories. But he would be working towards peace."

The Russell-Einstein Manifesto led to the Pugwash Conferences on Science and World Affairs, awarded the 1995 Nobel Peace Prize.

4.6. Literature

One of the tasks that they young Habicht, Solovine and Einstein set themselves at their "Olympia Academy" in Berne was to read and make literary commentaries. Their favourite readings were the classics, including Sophocles, Racine and Cervantes. Writing in 1952, Einstein says of classical literature:

"Somebody who only reads newspapers and at best books of contemporary authors looks to me like an extremely near-sighted person who scorns eyeglasses. He is completely dependent on the prejudices and fashions of his times, since he never gets to see or hear anything else. And what a person thinks on his own without being stimulated by the thoughts and experiences of other people is even in the best case rather paltry and monotonous.

There are only a few enlightened people with a lucid mind and style and with good taste within a century. What has been preserved of their work belongs among the most precious possessions of mankind. We owe it to a few writers of antiquity (Plato, Aristotle, etc.) that the people in the Middle Ages could slowly extricate themselves from the superstitions and ignorance that had darkened life for more than half a

millennium.

Nothing is more needed to overcome the modernist's snobbishness."

Amongst contemporary literature, Einstein was attracted by the worldview of H. G. Wells and Bernard Shaw. At a talk on *The Jewish Community* given at the Savoy Hotel in London in 1934, which was attended by the two writers, Einstein turned to Shaw, whom he called a "doctor of the soul" on account of the moral principles contained in his works and said:

> "You, Mr. Shaw, have succeeded in winning the affection and joyous admiration of the world while pursuing a path that has led many others to a martyr's crown. You have not merely preached moral sermons to your fellows; you have actually mocked at things which many of them held sacred. You have done what only the born artist can do. [...] [Thus you] have relieved life of something of its earth-bound heaviness."

Einstein himself became a literary motif for some writers. During his time as a lecturer in Prague he met the writer Max Brod, the friend, biographer and publisher of Franz Kafka, who acknowledged that the character of Kepler in his novel *Tycho Brahes Weg zu Gott (1916, The Redemption of Tycho Brahe)*, was inspired by Albert Einstein. Other authors also used him as a model, including the Spaniards Juan Ramón Jiménez, Ramiro de Maeztu, Pedro Salinas, Ortega y Gasset, Jorge Guillén, Ramón Pérez de Ayala and Salvador de Madariaga

In Friedrich Dürrenmatt's black comedy *Die Physike (1962, The Physicists)*, Einstein and Newton are the names used by patients in a lunatic asylum in which the hero of the play, the nuclear physicist Möbius (discoverer of the formula for creating the atom bomb) takes refuge.

Just as Einstein himself was a select reader and a literary motif, his work, together with that of Planck and those who brought about the relativist and quantum revolutions of the twentieth century, is considered by some scholars of cultural movements to have wielded a considerable influence over literature and the visual arts, fields which during the first third of the twentieth century opened up to new movements which would be as revolutionary as those that had occurred in physics. Authors such as William Carlos Williams, Archibald MacLeish, Virginia Woolf, Vladimir Nabokov, Lawrence Durrell, William Faulkner and James Joyce, to name only the most outstanding of Einstein's contemporaries, found a language inspired by the new scientific concepts of the world. Alan J. Friedman and Carol C. Donley examine these influences

and particularly the impact on literature, in *Einstein as Myth and Muse* (1985). Gerald Holton in *Einstein, History and Other Passions* (1995) advises greater caution in assigning such influence: “The tempting task of finding the detailed culmination of hidden causal loops that relate capital works and the spirit of the times remains for future researchers”

4.7. Visual Arts

The same occurred with the plastic and visual arts as with literature. Relativity was particularly influential: of all Einstein's works, this is the one that really made its way onto the street and into popular culture, under the misguided slogan “everything is relative”. Schoenberg's music, Calder's mobiles and Picasso's cubism suggest that the new art and the new form of experimenting with images and sounds did not occur in isolation from other intellectual movements, especially Einsteinian relativity. Whether this really was the case or not remains to be seen, but Einstein himself certainly did not accept any such association. Holton cites this answer by Einstein to an art historian:

> “The essence of the theory of relativity has been incorrectly understood in [your article], granted that this error is suggested by the attempts at popularization of the theory. For the description of a given state of facts one uses almost always only one system of coordinates. The theory says only that the general laws are such that their form does not depend on the choice of the system of coordinates. This logical demand, however, has nothing to do with how the single, specific case is represented. A multiplicity of systems of coordinates is not needed for its representation. It is completely sufficient to describe the whole mathematically in relation to one system of coordinates.
>
> This is quite different in the case of Picasso’s painting, as I do not have to elaborate any further. Whether, in this case, the representation is felt as artistic unity depends, of course, upon the artistic antecedents of the viewer. This new artistic ‘language’ has nothing in common with the Theory of Relativity.”

These remarks by Einstein did not prevent painters, sculptors and architects from utilising their own concept of relativity in their works. Popular examples of these ideas include Escher's *Relativity* and the *Einstein Tower* in Potsdam designed by architect Erich Mendelsohn. A number of painters, too, sought to immortalise the figure of Albert Einstein, among them Andy Warhol.

Einstein's fame and popularity were also a tempting motif for the movie industry. In several films his name, his image, his relativity... even his eyes

(Spielberg used him as a model in designing ET's eyes) are used more or less felicitously. Of all the films in which he appears, perhaps the most striking was *Virtual Obsession*, made in 1998. Einstein is a virtual scientist, a "post-biological" man as the film puts it, who sometimes escapes from the limits of the digital screen to incorporate himself into everyday life as an intangible but decisive being because of his creative capacity and his morality. He is a figure for eternity who can be turned to in our hour of need, as his assistant in the real world does. In love with the Einstein system, she integrates herself with him and dies of "virtual aneurysm". Einstein, in real life, died of a burst aortic aneurysm in his abdominal aorta.
Despite Einstein's refusal to accept what others saw as the influence of his relativist theories on other areas of human activity, in terms of artistic creation, Einstein not only took pleasure in contemplating and performing works of art (especially music), he even considered that scientific activity contained a major artistic component. Those who worked with him tell how he valued the beauty of physical theories, especially when they attained a degree of simplicity and clarity. This was the case with the Newtonian and Maxwellian syntheses, achievements that were outstanding for their simplicity in getting their ideas across.

According to Einstein, like the artist, the scientist must have an intuitive capacity to "see" harmony and the scientific structure on which nature is sustained. In this creative undertaking, the scientist, he said, must "feel free to play with the concepts". A good illustration of this link between science and art is to be found in the book by Arthur I. Miller,
Einstein, Picasso. Space, Time, and the Beauty That Causes Havoc
(New York, 2001).

4.8. Music

Einstein was influenced by his mother's musical gifts At the age of six he had already mastered the violin and it was to remain his favourite musical instrument for the rest of his life. Music and science were his two great passions. When he travelled he would take his violin ("Lina") with him, in the hope that there might be a chance to play something by his favourite composers, alone or in company. He seized any opportunity to immerse himself in music, playing with fellow scientists, people from his neighbourhood or anyone who offered him the chance. He took part in public and private concerts, played the organ at synagogues and on more than one

occasion contributed with his music to raising funds for the Zionist cause.

His favourite composers were Mozart, Bach, Schubert, Vivaldi, Corelli and Scarlatti. He was not so keen on Beethoven, whom he considered to be too dramatic and personal. He had varying opinions on other composers, but the one he most opposed was Wagner, although he did appreciate his contribution to the new forms of opera.

After work he would relax, sometimes playing in the kitchen so as not to bother the neighbours:

> "First I improvise and if that doesn't help, I seek consolation in Mozart; but when I am improvising and I feel I am achieving something, I need the clear constructions of Bach to get to the end."

In 1950, his doctor ordered him to stop playing the violin and he turned to the piano instead—an upright Bechstein. On occasions passers-by would listen in with pleasure. His violin was inherited by his grandson Bernhard Caesar, son of Hans Albert.

Einstein was on good terms with the Spanish cellist Pau Casals (18761973). As well as their music, they were united by their opposition to tyranny against nations. Casals, who had rebelled against the Franco dictatorship of which he himself was a victim, said to Einstein: "The only weapons I have are the conductor's baton and the cello: they are not lethal, but I have no other. With them I protest against anything I consider ignominious for mankind". It was an attitude which earned Einstein's praise: "What I most admire in him is his firm stance, not only against the oppressors of his people, but also against all the opportunists who are ever ready to make a pact with the devil. I see clearly that the world is threatened not so much by the wrongdoers themselves, but more by those who condone evil and allow it to be done". It should be remembered that Einstein had come out in favour of the Spanish Republic, unconcerned that he might cast a bad light on the policies of the British, French and American governments, who maintained an arms embargo against the republican army for fear of losing Catholic votes in their respective countries.

As one might expect, has also inspired music: there are groups that bear his name, he is quoted in a number of songs and in 1975 Philip Glass wrote the opera *Einstein on the Beach* where the most important musical instrument is

the violin, with the violinist appearing characterised as Einstein.

4.9. Philosophy

Einstein considered that his scientific work formed part of the philosophical contributions made throughout history to understanding the mysteries of nature. In a book written by Einstein and his assistant Leopold Infeld (*The Evolution of Physics, from Early Concepts to Relativity and Quanta* (New York, 1938)), speaking about the reciprocity between physics and philosophy, in the section "The philosophical background", he wrote:

> "The findings of scientific research often determine profound changes in the philosophical conception of problems whose breadth escapes the restricted domain of science. What is the purpose of science? What requirements must by met by a theory that seeks to describe nature? These questions, even when they exceed the remit of physics, are closely associated with it, since they have their origin in science. Philosophic generalisations must be based on scientific conclusions. But, when the former are broadly established and accepted, they in turn influence the subsequent development of scientific thought, indicating one of the many paths to be taken. One consequence of a fortunate rebellion against that which accepted is that it leads to generally unexpected developments which bring with them new philosophical conceptions. These observations will appear vague and insubstantial if they are not illustrated by examples from the history of physics."

However, like everything else in his life, Einstein's attitude to knowledge was peculiar, and not without its contradictions. Whereas at the beginning of his career he was influenced by positivist philosophers such as Ernst Mach and the mathematician Poincaré, in his later years he abandoned positivism, even going so far as to call Mach as "a bad philosopher", increasingly convinced as he was that the formulation of scientific theories did not need to be associated with the experience of observation. From his encounters with Einstein, Karl Popper reached this conclusion: "It is our inventiveness, our imagination, our intellect and especially the use of our critical faculties to argue and compare our theories which makes it possible for our knowledge to be developed". Einstein summarised this notion in a few words: "Here there is no goal, only the opportunity to give oneself over to the pleasant task of thinking". Speaking of his personal impression of Einstein, Popper wrote:

> "It is difficult to convey the impression that Einstein's personality made on me and on my wife. One simply had to trust him, one had to surrender unconditionally to his kindness, his goodness, his wisdom, to his sincerity and his almost childlike simplicity.

> It says a lot in favour of our world and in favour of America that a man who is so distant from the world not only can survive in it, but that he is appreciated and respected in it."

As regards to his way of working and acting, some notion can be gleaned from the conversations with Einstein's son, Hans Albert, and a large group of Einstein's collaborators from throughout his life, broadcast by the BBC in 1966, and published by G. J. Whitrow in *Einstein: The Man And His Achievement* (Mexico, 1961). These are some of the ideas taken from Banesh Hoffmann's piece on the period from 1937 when he and Leopold Infeld worked under Einstein's supervision, having dared to introduce themselves to the great scientist and ask him to advise them on a subject for research:

> "I had the good fortune to work with Einstein. Anyone would have seen it as a wonderful opportunity to see how his mind worked and learn how to become a great scientist oneself. Unfortunately, those revelations did not occur. Genius cannot be reduced to a series of simple rules that anyone can follows.
>
> When we reached an impasse, we would all pause and Einstein would stand up quietly and say in his quaint English "I will a little think" So saying, he would pace up and down and walk around in circles, all the time twirling a lock of his long grey hair around his forefinger. At those dramatic moments, Infeld and I would stay completely quiet, not daring to move or make the least sound, so as not to interrupt the course of his thought... He had a dreamy, distant and yet inward-looking look on his face. He did not have an appearance of intense concentration. A minute would pass, and then another and suddenly, Einstein would visibly relax and his countenance would light up with a smile... he seemed to return to reality and become aware of our presence again. Then he would give us the solution to the problem and the solution nearly always worked."

4.10. Religion

On the centenary of Einstein's birth, Pope John Paul II, addressing the Pontifical Academy of Sciences, praised him "for the eminent contribution he made to the progress of science, that is, to knowledge of the truth present in the mystery of the universe...a truth inscribed in creation by the finger of God". Einstein – "the deeply religious non believer" – did not share the same God as the Pope's:

> "I believe in Spinoza's God who reveals himself in the orderly harmony of what exists, not in a God who concerns himself with fates and actions of human beings."

More than as a belief, Einstein valued religion as an attitude to the world. Adolf Keller, the Zurich theologian who had met Einstein in his younger years, went to visit his old acquaintance when he was attending a theology seminar in Princeton in 1941. He gave an account of the meeting to Einstein's biographer, Carl Seelig, who remembers some of Keller's impressions:

> "For Einstein, freedom is the greatest good of mankind. In our conversation he became very passionate talking about Germany under Hitler; he had renounced even scientific freedom, and with that he had prostituted himself to power. Speaking about this he said something which really stuck in my memory: 'I always hoped the German universities would launch the struggle for freedom. But I was wrong. However—he went on to say—even when the universities did nothing, at least the churches fought for freedom, both the Catholic and the Protestant church. As a Jew I want to acknowledge that. And that struggle must never be forgotten'. I am all the happier that Einstein recognised that because he always said he was a supporter of the spirit, not of any church."

Einstein considers that the "insurmountable conflict" between science and religion, which had gone on for centuries, lacked any consistent foundation. For him "science without religion is lame, and religion without science is blind". He even said once that science is to some extent a form of religion:

> "Among all the most profound scientific talents, you would be hard put to find a single one that does not have its own religious sentiment. But it is something different to the religiosity of the layperson. For the layperson, God is a being from whose care one hopes to benefit and whose punishment one fears... But the scientist is imbued with the feeling of universal causality. For him, the future is something as inevitable and as determined as the past. In morals there is nothing divine; it is a purely human matter."

From his perspective on religion and civic education, he argued "the need for an ethical culture" promoted by the school to improve coexistence:

> "The desire to fight for an ethic-moral structuring of our community life is of the greatest importance. In this aspect no science can save us. I really believe that the excessive emphasis on the purely intellectual (which tends to be directed towards effectiveness and towards the practical) in our education, has led to a weakening in ethical values."

4.11. Einstein on himself

Einstein, aged 22, was described as follows in his Swiss military book, where he was declared unfit for military service:

Height: 171.5 cm

Breadth of chest: 87 cm
Arm: 28 cm
Illnesses or handicaps: varicose veins,
flat feet, and excessive perspiration of feet.

Self-portrait

Of what significance is one's existence, one is basically unaware and it should certainly not concern our neighbour. What does a fish know about the water in which he swims all his life?

The bitter and the sweet come from outside. The hard from within, from one's own efforts. For the most part I do what my own nature drives me to do. It is embarrassing to earn such respect and love for it. Arrows of hate have been shot at me too; but they never hit me, because somehow they belonged to another world, with which I have no connection whatsoever.

I live in that solitude which is painful in youth, but delicious in the years of maturity.

On his everyday life (in answer to a reporter from *ABC* during his stay in Spain in 1923):

Well then; I shall satisfy your curiosity. My life is very irregular. Sometimes, when I am concerned with a problem, I do not work for days on end; I go for walks, I pace up and down at home, I smoke, I dream and I think. On the contrary, there are weeks when I don't stop working. But, in general, I go to bed at eleven and get up at eight. As you see, my body and my brain need a long repairing sleep. I rarely go out at night; social life irritates me.

Disillusionment at the mistrust and persecution suffered by some scientists in the United States in the 1950s, Einstein among them:

If I would be a young man again and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find that modest degree of independence still available under present circumstances.

To Elisabeth Ley, Stuttgart

September 30, 1920 Dear Miss Ley,

Elsa tells me that you are unhappy because you didn't get to see your Uncle Einstein. Therefore I will tell you what I look like: pale face, long hair, and a modest paunch. In addition, an awkward gait, a cigar—if I happen to have one—in the mouth, and a pen in the pocket or hand. But this uncle doesn't have bowed legs or warts, and is therefore quite handsome; and neither does he have hair on his hands, as ugly men often do. So indeed it is a pity that you didn't get to see me.

With warm greetings from your Uncle Einstein

This is how he saw himself throughout his life

"The physicists say that I am a mathematician, and the mathematicians say that I am a physicist.

I am a completely isolated man and though everybody knows me, there are very few people who really know me."