Reflections

That One Year !

1905 must stand out as the year of wonders in Einsteins life, *annus mirabilis*. The only parallel that comes to mind is Newton's two plague years 1666–1667, spent in the peace and quiet of his native Woolsthorpe. By Newton's own account, the seeds of all his great mathematical and physical discoveries – relating to calculus, universal gravitation and optics – were sown in that period.

Let us take a brief look at four scientific papers which Einstein submitted to the prestigious journal, *Annalen der Physik*, in the months of March, May, June, and September 1905. The March paper has the title 'On a heuristic point of view concerning the generation and conversion of light'. Its subject was nothing less than the true nature of radiation, today, every schoolboy has heard of the word 'quantum' and the name of Max Planck who took the first step toward this idea. But it was really Einstein who first clearly stated that radiation energy itself came in these fundamental units, which we call photons today. Einstein went further and used his light quantum hypothesis to explain one of the leading puzzles in physics at that time. This was the photoelectric effect, in which electrons are emitted from a metal on which light falls. As such, there was no surprise in the transfer of energy from a beam of radiation to electrons. But the experiments showed that the frequency of light played a vital role – if it was below a certain value, there was no emission even for a strong beam, while if it was above the critical value, even a weak beam could cause emission of electrons. Once it was accepted that the energy came in quanta and a single unit was responsible for emission of a single electron, this mystery was solved. But the price was that nearly half a century of physics based on the notion of electromagnetic radiation in the form of continuous waves had to be reviewed. Einstein was fully aware of it, hence the cautious words in the title 'heuristic point of view' (meaning point of view which may be useful in making further progress). It needed many more contributions – Einstein himself in 1917, Bose in 1924, and Dirac in 1927, before the picture was complete. But the first step had been taken in Einstein's March 1905 paper. It won him the Nobel Prize for Physics in 1921.

By May 11th, Einstein had completed and sent off another fundamental piece of work. This time the title was *'On the motion required by the molecular kinetic theory of heat of particles suspended in fluids at rest*.' This was on the subject of colloids (of which milk is an example) in which particles big enough to be seen individually are suspended in a fluid. The motivation for this study was another long standing mystery, the phenomenon of Brownian motion, originally noted by the botanist Brown for pollen grains in water. Einstein developed a full theory of the diffusion (spreading out from the point of origin) of such particles, their mobility under the action of external forces, and indeed deduced the value of the Avogadro number (e.g., the number of hydrogen atoms in a gram) in fair agreement with what he had himself

derived from the study of radiation. He proposed precise tests of his theory which were later carried out by J Perrin and which removed all doubts of the reality of molecules and their thermal motion.

Pretty good going for a twenty seven year old patent clerk working essentially alone and far away from any of the great scientific centres of the day? Well, more was to come to the *Annalen der Physik* in the month of June. This was a paper entitled 'On the electrodynamics of moving bodies'. This paper created the special theory of relativity, destroyed the concepts of absolute time and simultaneity, introduced the notions of length contraction and time dilatation. Problems which the best minds of the day, Lorentz and Poincaré, were struggling with for a decade were solved by this rank newcomer to the scene. The other authors were close to a mathematical solution but only Einstein had the courage and clear vision to accept the physical implications wholesale.

Of course, the short times between papers on very different subjects is misleading. Einstein had been thinking about all these problems for many years. But there is no doubt that many things must have crystallised in his mind in these magic six months. Perhaps we can therefore forgive him for missing something else for a whole three months. It emerged in September, as a shorter paper, also in the area of special relativity. Its title asked the question 'Does the inertia of a body depend on its energy content?' The answer was given in the form of an equation, $m = E/c^2$. Slightly rearranged, it becomes the equivalence and interconvertibility of mass and energy $E = mc^2$ – one of the most famous physical concepts of our times. And also one of the most infamous, since it formed the basis for measuring the energy content of nuclei, for predicting which reactions between them would lead to a large energy release, viz, fission of heavy nuclei and fusion of light ones. In other words, the September 1905 paper was the starting point on the long road that led to the uranium and hydrogen bombs.

Looking back, such a burst of creativity from a single mind in a single year is probably unparalled in our times. The 1905 volume of *Annalen der Physik* stands to tell us that all this really happened.

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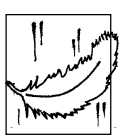


Why does this magnificent applied science, which saves work and makes life easier, bring us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it.

Albert Einstein

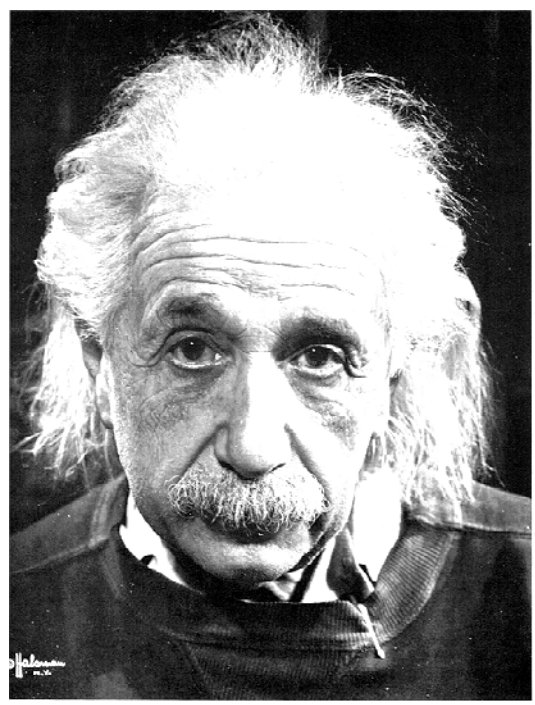
Albert Einstein – The Man Behind the Myths [1]

John Stachel

"*In the last analysis, fame is only the epitome of all the misunderstandings which gather about a new name*." – Rainer Maria Rilke

These words of Rilke were first cited with reference to Einstein in 1930 by his son-in-law Rudolf Kayser. The years between have made them seem even more apt. Few modern figures, and certainly no other scientist, have become centers of attraction around which have accreted such an ever-growing number of myths and misconceptions. We only know great figures of the past, such as Buddha, Lao Tse and Jesus, through the myths and legends that have come down to us. But in the case of Einstein we have the rare opportunity to watch the mythic process in operation, to see a legend taking form. I am surprised that social psychologists have in the main neglected this opportunity, and recommend the topic for further study.

Not because I suspect anyone in this audience is a victim of such myths, but just to recall them, let me mention a few of the better known ones. Perhaps the most widespread is that Einstein was created old. The mere name 'Einstein' calls to mind, a white-haired saintly figure, well advanced in years. It takes an effort to remember that he was born at a more tender age, passing through a childhood, adolescence and young manhood that were in many ways quite stressful. He always recalled with distaste the drill-sergeant atmosphere in his German primary school, and dropped out of high school to spend a half-year as what today we might call a hippie, wandering about Italy – a period he looked back on as one of the happiest of his life. His father's repeated business failures left him unable to go to the University without financial help from better off



[1] Text of Frontier Lecture given on December 5, 1997 at Indian Institute of Science, Bangalore.

relatives; and his own failure to get an academic job upon graduation – when all other members of his class did so – left him on the brink of financial disaster. When he did get a steady job, it was not the teaching post for which he had prepared, but as a third-class technical expert in the Swiss Patent Office. He married, despite the opposition of his parents, and before the marriage had a child whose fate is still unknown. After seven years in the Patent Office, he finally started an academic career, rising rapidly to a full Professorship, as a result of the growing recognition of his genius. A few years later came the offer of a full-time research position in Berlin. But 1914, the year he assumed this post, brought two major blows: separation from his first wife, who left Berlin forever with their two sons to whom he remained deeply attached; and the outbreak of the First World War, which left him in the center of German militarism (which he despised) as a wave of national chauvinism swept over most of his colleagues. And in 1914 Einstein was just 35 years old! There was a long and complex lifetime leading to the saintly white-haired figure of the myth.

Associated with the myth of his creation at age seventy goes another myth: Einstein was loved by all humanity. How could anyone help loving that saintly image? Many did manage to. No one can ever be sure, of course, but it is possible that Einstein was as much hated as he was loved during his lifetime. He was hated as a Jew, a pacifist, a democrat and civil libertarian, a radical and in later years a socialist, to list some of the reasons. And this was true not only during his years in Germany, where his life was threatened many times in the 1920's, and which he renounced forever when the Nazis assumed power in 1933; but also in the United States, where his efforts on behalf of Jewish and other anti-fascist refugees earned him the hatred of 'American chauvinists' from his earliest days in the United States. It is amusing – if you have a wry sense of humor – to compare the laudatory tributes to Einstein published after his death and ever since, with what those same sources (*The New York Times*, for example) had to say about him during the early 1950's, when Einstein stood like a bastion in defense of the Bill of Rights while so many other intellectuals were collapsing under the onslaught of McCarthyism and the anti-communist hysteria in the United States. Much influenced by Gandhi's example, Einstein advocated civil disobedience on many occasions. In June 1953, for example after Einstein advised a teacher not to cooperate with the House Un-American Activities Committee, the New York Times chided: "To empty the unnatural and illegal forces of civil disobedience, as Professor Einstein advises, is, in this case, to replace one evil with another."

Now let me mention some myths about Einstein the scientist – or should I say mathematician, because he was the world's greatest mathematician, wasn't he? Actually, as a young man

he never felt at ease with mathematics, and was only driven by the problems he had to deal with in physics to feel the need for more and more abstract mathematics. Indeed, when he did need assistance in his work, at a crucial point in the development of general relativity, it was usually from mathematicians. In the later years of his life, he had young assistants to help him with his research, and he chose them primarily from the ranks of mathematicians, precisely because that was the field where he felt the weakest.

Another myth is that Einstein created air-tight, perfect physical theories that will endure forever. Could anyone ever challenge the theory of relativity? Of course, this is a complete misconception of the nature of science – a misconception that Einstein never shared. He was quite aware that his approach, his way of trying to understand the physical universe, had grown out of a long history of previous attempts. He had to criticize these earlier attempts in order to go beyond them. But, as early as 1917, just after he had completed the general theory of relativity, he wrote that he was quite sure that, just as his theory of gravitation had gone beyond Newton's, sooner or later in ways that could not be foreseen, someone would have to go beyond his theories. He conceived of the evolution of physics as a constant attempt to solve new problems; an attempt he compared with a detective novel, except that in science we can never turn to the last page and find out 'who did it.'

Another myth is that Einstein was completely impractical, a purely abstract thinker. That is perhaps the opposite of the case: he was really most at home with concrete imagery. There are different styles of thought, which is not to say one is better or worse than the other, of course. When I think of a highly abstract style of thought, a well-known mathematician-friend comes to mind. He does not even dream in images, but in words – a voice tells him what is happening. He could not, with the help of a ruler and compass, draw a straight line or a circle well. He is really a highly abstract thinker and went into mathematical logic, which was perfect for him. This was not Einstein's style. Einstein grasped the world in concrete images, and his problem was to translate those images afterwards into words and equations that could be shared with other people. Let me quote Einstein:

> *The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The physical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined.*
>
> *The above-mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary*

stage, when the mentioned associative play is sufficiently established and can be reproduced at will.

Elsewhere he says:

Direct observation of facts has always had for me a kind of magical attraction.

Again, quite the opposite reaction to that of the savant who likes raw facts pre-digested into abstract concepts before starting to work on them.

As I mentioned previously, Einstein's first steady job was at the Swiss Patent Office. A streak of independence (perhaps even overdone?) in his nature, which he had demonstrated to his professors at the Swiss Technical University, as well as his being a Jew, probably explain his being passed over when assistantships at the University were offered to his fellow students. All other academic avenues were also blocked for him. Through the kindness of one of his school friends – and the connections of the friend's father – he got the Patent Office post, in 1902. By the time he left it, he had published over two dozen papers, at least four of which were profoundly significant. One might think: what torture it must have been for a genius like Einstein, his mind brimming over with new ideas, to devote himself to the daily drudgery of Patent Office routine for seven long years. On the contrary, Einstein looked back on it as one of the happiest periods of his life:

The work on satisfactory formulation of technical patents was a true blessing for me. It compelled me to be many-sided in thought, and also offered important stimulation for thought about physics. Following a practical profession is a blessing for people of my type. Because the academic career puts a young person in a sort of compulsory situation to produce scientific papers in impressive quantity [publish or perish we call it today]*, a temptation to superficiality arises that only strong characters are able to resist.*

At any rate, Einstein maintained his interest in practical inventions throughout his life. He was promoted before he left the Patent Office, whose tough-minded Director was sorry to lose him. He was called in as a patent expert in various legal cases long after he had won the Nobel Prize for physics; and himself held numerous patents on inventions from gyroscopes to refrigerators made alone or jointly with colleagues, at least one of which brought modest royalties. Of course, it is true that financial matters were of relatively little importance to him, so people to whom practicality equals wealth might well consider him impractical.

He did have one problem at the patent office, as his son-in-law Rudolf Kayser tells it:

Albert's work, though it was not too trying, was still a strain. He was not used to sitting eight hours over official duties which he could discharge with the same degree of faithfulness in three or four. He was much too young and too high-strung to perform his duties as slowly as the others. He soon discovered that he could find time to devote to his own scientific studies if he did his work in less time. But discretion was necessary, for though authorities may find slow work satisfactory, the saving of time for personal pursuits is officially forbidden. Worried, Einstein saw to it that the small sheets of paper on which he wrote and figured vanished into his desk-drawer as soon as he heard footsteps approaching behind his door.

This anecdote illustrates another side of Einstein's character: Again, contrary to legend, he was no plaster saint. Although a profoundly moral person, he was not above fiddling with the official regulations if no one was hurt thereby. It was during this time at the Patent Office that he wrote his formula for success – the only formula I shall quote:

A (Success) = X (Work) + Y (Play) + Z (Keep your mouth shut).

Not a bad recipe even today for success in any bureaucracy.

Another characteristic of Einstein's style of work was extraordinary tenacity. He could carry on his train of thought under almost any circumstances, interrupt it, and go right back to it. He said to a student:

I am always available to speak to you. If you have a question come to me without worrying. You will never disturb me because I can always break off my work at any moment and resume it immediately after the interruption.

Lest you think this self-description exaggerated, here is the scene another student came upon when he went to visit Einstein at home, shortly after Einstein got his first academic job:

He was sitting in his study in front of a heap of papers covered with mathematical formulae. Writing with his right hand and holding his younger son in his left, he kept replying to questions from his elder son Albert who was playing with his bricks. With the words, "Wait a minute, I am nearly finished," he gave me the children to look after for a few moments and went on working. It gave me a glimpse of his immense powers of concentration.

Of course it always happens that way in the films: somebody sits in a cafe and writes a symphony or discovers radium, but outside of a handful of geniuses like Mozart or Einstein,

few people can actually work under such conditions.

I cannot attempt here to give any real idea of the content of his scientific work, but I would like to say something about what motivated Einstein in this work. Most people starting out in science begin to work on problems other people are already working on, that is with what Einstein called an external motive. When asked about his own motivation, Einstein said:

> *In theoretical science the external motive of discovery always lies in the current state of empirical and theoretical knowledge. In my own work I cannot indicate anything which could be designated as an* external *motive for my theories.*

He then listed three key questions he had posed for himself in the course of his study of physics, which came to assume such basic importance that in retrospect he characterized them as the motivation for his 'proper life's work.'

> *The first question was: how does the representation of a light ray depend on the state of motion of the co-ordinate system with respect to which it is referred?*

Those who have read Einstein's autobiographical reminiscences may see here references to a question he started to think about at age 16. He began to wonder: what would happen if you were to chase a light ray, running faster and faster? Could you catch up with it, and if you did, what would it look like? Well, I suppose many a precocious adolescent might think about such a question for 5 or 10 minutes, or even half an hour. Einstein thought about this question, and the deeper problems that grew out of it, for ten years. Looking back with the hindsight born of success, he saw in this question the beginning of his work on the special theory of relativity, completed in 1905 at the age of 26, a theory in which the speed of light is the ultimate, unattainable speed. Einstein was capable of thinking about problems such as this, developing and elaborating his ideas over a decade; and then coming up with a profound new physical theory to resolve the problem. His tremendous tenacity was combined with the ability to focus it on questions that not only troubled him, but were really vital for the advance of physics.

The second key question which he mentions is:

> *What is the basis for the equality of the inertial and gravitational masses of bodies?*

If you know a little bit about the history of physics, you will recognize a consequence of this equality known for 300 years, since Galileo and his famous Leaning Tower experiment: all

bodies fall with the same acceleration when dropped. Einstein saw here not just a fact but a deep puzzle. He started thinking about this problem shortly after he completed the special theory of relativity, and continued thinking about it, and the complex of other problems that grew out of it, for about eight years, until he completed the general theory of relativity at the end of 1915. This was Einstein's theory of gravitation, still the best theory of gravitation we have. As I noted earlier one cannot say it is the final, ultimate theory (one should not think in such terms about science); but no one has yet succeeded in probing more deeply into the nature of gravitation. There have been many attempts at such alternate theories, but so far Einstein's has withstood all tests.

The third of the questions he said characterized his most important scientific work was:

> *Can the gravitational field and the electromagnetic field be theoretically grasped in a unified manner?*

It seemed artificial to Einstein that the two basic natural forces then known, gravitation and electromagnetism, should be explained by completely different theories. He started to think about this question shortly after he developed the general theory of relativity, about 1918, and he continued to think about it until the end of his life in 1955. So it occupied his mind for almost forty years, but he never arrived at a solution that was ultimately satisfactory to himself – let alone to the rest of the physics community. Yet for Einstein, success was *not* the most important thing. He had posed a deep problem he felt required an answer. So he felt justified in devoting the major part of his efforts for decades to looking for that answer. If he did not succeed, well, so much the worse for him; he was sure there was an answer. Einstein once remarked that, if a carpenter had to bore a hole in a piece of wood, he would not think very much of him if he looked for a thin spot and made the hole there.
For a long time the search for such a unified theory of all the basic physical forces was out of fashion among physicists. But in recent years it has come back into fashion, although in ways rather different from those Einstein worked on (several new forces have been discovered).
Einstein concluded:

> *These three questions characterize my own proper life's work. Whatever else I occupied my mind with was more occasional work related to the current problems of physics.*

Let me remind you that this "whatever else" includes all his work on quantum theory, and statistical mechanics, work the importance of which someone once suggested by the following story: if you ask most physicists today who is the greatest physicist of our century, they would

say Einstein for his work in relativity theory. If you ask them who is the *second* greatest physicist of our century, quite a reasonable answer would be Einstein for his work outside of relativity. This is the work that Einstein dismissed as his occasional work, which anybody could presumably have done!

What motivated him in attempting to solve what he considered the really important questions?

> *It is always the striving for a logically simple interpretation of empirically known connections – supported by the conviction of the existence of a logically simple interpretation. Psychologically, the state of mind is comparable to the state of mind of a person who wants to solve a riddle or chess problem about which he is indeed convinced the solution certainly exists because the person who made up the riddle possesses it.*

There have been many myths about Einstein's religious views. The statement I just quoted contains the key to what Einstein meant by cosmic religion. For him it was the guarantee that there is a solution to the puzzle, that the universe is lawful. This feeling of certainty that the universe is rational is what enabled Einstein to work for ten years on special relativity, almost a decade on general relativity and then to work the rest of his life on the unified field theory problem. If he could not find the solution to such a problem, it was not the fault of the universe!

Einstein's religiosity thus has little or nothing to do with religion in the conventional sense. He wrote:

> *I do not believe in the immortality of the individual, and I consider ethics to be an exclusively human concern with no superhuman authority behind it.*

This did not mean he undervalued morality:

> *...people of our type see in morality a purely human matter, albeit the most important in the human sphere.*

I shall return to some of his moral judgements later.

Another myth about Einstein is that he was a poor teacher, or at least did not like to teach. I think it is true that he was soon tired of teaching the same basic courses over and over, but this is not uncommon even among good pedagogues. It is clear from accounts by former students that he was not the conventional 'Herr Professor' of the German academic tradition but this was certainly not held against him by the students. It is also clear from the reminiscences of

Einstein as a lecturer that he loved to expound his ideas, and that he was very successful at it. Let me quote from one such account:

> *Einstein's delivery in his lectures was quite unrhetorical, anything but brilliant. With expressively opened eyes, the chalk in his slightly raised right hand – he stood at the board often looking off into the distance. He spoke rather softly. He was at that moment no more but also no less than that which he was thinking about out loud – like a spotlight guided from without which in vivid perspective lit up ever new portions of a landscape – itself remaining modestly in the darkness background ...*
>
> *Also characteristic was his frequent recourse to sensory impressions, which materially eased the listener's task in following him. Not only spatial means of representation stemming from sight, but also muscular sensations, for example in mechanical problems, played an important part.*

Note that this account by a student agrees perfectly with Einstein's own comments, quoted earlier, about the nature of his thought processes.

In 1914, after a conventional academic career of only five years, Einstein was called to Berlin to fill a post especially tailored to his talents. He could devote as much time to research as he wanted; he had the right to teach at the University of Berlin if he desired, but no fixed teaching obligations. He gave several courses of lectures at Berlin and elsewhere before he left Europe for good in 1933. Thereafter, he only gave occasional individual lectures, at Princeton or elsewhere in the United States. His university experiences left him rather cynical, yet not unappreciative:

> *In truth the university taken as a whole is a machine with a very poor efficiency, and yet irreplaceable, and indeed also not essentially capable of improvement. Here the public must assume the standpoint that the biblical God took toward Sodom and Gomorrah: for the sake of a few, the whole effort must be made. And it is worth it.*

(He is playing here on the meaning of the term 'efficiency' in mechanics: output over input.)

Einstein always took a great interest in educational issues, from primary school to university level. He wrote a very large number of highly interesting comments on the subject, which unfortunately have not yet been collected. I can only give one sample:

> *... I want to oppose the idea that the school has to teach directly that special knowledge and those accomplishments which one has to use later directly in life. The demands of life*

are much too manifold to let such a specialized training in school appear possible. Apart from that, it seems to me, moreover, objectionable to treat the individual like a dead tool. The school should always have as its aim that the young person leave it as a harmonious personality, not as a specialist. This in my opinion is true in a certain sense even for technical schools, whose students will devote themselves to a quite definite profession. The development of general ability for independent thinking and judgement should always be placed foremost, not the acquisition of special knowledge. If a person masters the fundamentals of his subject and has learned to think and work independently, he will surely find his way and besides will be better able to adapt himself to progress and changes than the person whose training principally consists in the acquiring of detailed knowledge.

I think one can detect here echoes of Einstein's reaction to his own schooling, which (aside from a final year of High School in the Swiss Cantonal School at Aarau) he did not remember fondly.

Turning to Einstein's social and political views, one encounters another crop of myths. Going with the myth of the ancient sage is that of Einstein the bleeding heart: the naive sufferer for all humanity who would support any cause if it were presented to him in sufficiently pathetic terms. This myth completely misses a central element in Einstein's emotional makeup at least in his later years, which he once described as follows:

My passionate sense of social justice and social responsibility has always contrasted oddly with my pronounced lack of need for direct contact with other human beings and human communities. I am truly a "lone traveler" and have never belonged to my country, my home, my friends or even my immediate family with my whole heart; in the face of all these ties, I have never lost a sense of distance and a need for solitude – feelings which increase with the years. One becomes sharply aware, but without regret, of the limits of mutual understanding and consonance with other people. No doubt, such a person loses some of his innocence and unconcern; on the other hand, he is largely independent of the opinions, habits, and judgements of his fellows and avoids the temptation to build his inner equilibrium upon such insecure foundations.

To understand Einstein one must understand that he built his 'inner equilibrium', not upon the foundation of personal relationships, but upon the foundation of his scientific quest for cosmic order.

Although in later years he spent a large part of his time responding to the many requests for his help in various personal and scientific matters as well as in social and political causes, he

maintained a certain inner distance. As a collaborator of his once told me, he still slept well every night. He also chose his issues carefully. He was well aware that his celebrity (I shall return later to his fame) gave him a vast audience for his views; but he also realized that he had to use this instrument sparingly if it was to remain effective. So he refused many times to speak out on an issue. If he disagreed with the cause, naturally he refused; but he also refused to endorse appeals for causes which he favored, if he was skeptical about the good faith of the sponsors or if he thought his voice would not add significantly to the impact of what had already been said.

There is no evidence that Einstein was politically active in any way before the First World War broke out. It was the impact of that war, particularly the response of most intellectuals in the warring states – by and large it was the same as the way everyone else responded, they fell victims to jingoistic, chauvinistic passions – which stirred him into action. His first political action was connected with the pacifist movement in Germany. He was a Swiss citizen at that time – but even so such actions were a bit risky in wartime Germany: his name appears as number 9 on a list of notable pacifists prepared for the Berlin police chief. This was the beginning of a lifelong association with pacifist movements.

His pacifism later gave rise to much controversy. At the beginning of the thirties he urged young men to refuse military service, provoking the hostility of nationalists in many countries, including my own. However, after Hitler came to power, he felt this was no longer a viable tactic, and urged the rearmament of the democratic states in the face of the fascist peril, provoking cries of betrayal from many former pacifist colleagues. Einstein felt that changed circumstances called for changed tactics: since advocacy of disarmament and refusal of service were impossible in fascist states, their advocacy in democratic countries played into the hands of the dictators. He never regarded his actions as a renunciation of pacifism.

In this connection one meets another myth: Einstein the father of the atomic bomb. Everyone knows that Einstein proved $E = mc^2$ (sorry another formula has slipped in), even if he or she does not know exactly what E, m, c and squared mean; and everyone knows it has something to do with the A-bomb. Actually, the work leading to the discovery of nuclear fission and production of the A-bomb could have taken place just as well even if Einstein had not derived that formula from his special theory of relativity. After all, fires were lit long before a theory of chemical combustion existed. But Einstein wrote a famous letter to President Roosevelt, didn't he; and didn't that trigger the production of the A-bomb? Einstein certainly signed the letter, written by others, but the role it played in the development of the American A-bomb project has often been greatly exaggerated. Einstein never worked in nuclear physics

and played no role in the actual bomb project:

> *My part in producing the atomic bomb consisted in a single act: I signed a letter to President Roosevelt pressing the need for experiments on a large scale in order to explore the possibilities for the production of an atomic bomb. I was fully aware of the terrible danger to mankind in case this attempt succeeded. But the likelihood that the Germans were working on the same problem with the chance of succeeding forced me to this step.*
>
> *I could do nothing else, although I have always been a convinced pacifist. To my mind, to kill in war is not a whit better than to commit ordinary murder. As long, however, as nations are not resolved to abolish war through common actions and to solve their conflicts and protect their interests by peaceful decisions on a legal basis, they feel compelled to prepare for war. They feel obliged to prepare all possible means, even the most detestable ones, so as not to be left behind in the general armament race.*

He wrote this at the time the H-Bomb was being developed, so he continued with a great sense of urgency:

> *The road [of an armaments race] necessarily leads to war, a war which under the present conditions means universal destruction. Under these circumstances the fight against means has no chance of success. Only the radical abolition of wars and of the threat of war can help. That is what one has to work for. One has to be resolved not to let himself be forced to actions that run counter to this goal. This is a severe demand on an individual who is conscious of his dependence on society. But it is not an impossible demand.*

Einstein was most concerned about the social and moral responsibility of the scientific community to try to end the arms race.

> *We scientists whose tragic destiny it has been to help make the methods of annihilation ever more gruesome and more effective, must consider it our solemn and transcendent duty to do all in our power to prevent these weapons from being used for the brutal purpose for which they were invented. What task could possibly be more important for us? What social aim could be closer to our hearts?*

It was also after World War I that Einstein first started to emphasize his identity as a Jew. He had been brought up in a rather secular Jewish home and never identified closely with the Jewish community. It was witnessing the post-war growth of anti – Semitism as it flared up in Germany, particularly, that led him to identify with that community, and decide to

support the work of the Zionist movement. Some people have seen a paradox here. Einstein always pronounced himself a confirmed internationalist; in the last years of his life he was an advocate of world government. How could he square his internationalism with his activities on behalf of the Jewish people and their attempt to build a homeland in Palestine? He answered that question in 1926:

> *Generally speaking, it does not accord with my ideal that communities bound together by the bond of race or tradition should make special efforts to cultivate and emphasize their separateness. In so far, however, as a given community is attacked as such, it is bound to defend itself as such in order that its individual members may be able to maintain their material and spiritual interests. Corporate action is needed to save the individual from those spiritual dangers which isolation necessarily entails. Whoever understands this clearly must approve of united action by all Jews for a corporate purpose, be he never so unsympathetic in principle to nationalism.*

Along with his support of the Zionist movement went a deep awareness of the problem of the existence of two peoples in Palestine. He was active in trying to find some means of cooperation, some modus vivendi, between the Jewish and the Arab communities in Palestine. Here is one of his many statements on that topic (1930):

> *I believe that the Arab renaissance in the vast expanse of territory now occupied by the Arabs stands only to gain from Jewish sympathy. I should welcome the creation of an opportunity for absolutely free and frank discussion of these possibilities, for I believe the two great Semitic peoples, each of which has in its way contributed something of lasting value to the civilization of the West, may have a great future in common, and that instead of facing each other with barren enmity and mutual distrust, they should support each other's national and cultural endeavors and should seek the possibility of sympathetic cooperation. think that those who are not actively engaged in politics should above all contribute to the creation of this atmosphere of confidence.*

In so far as he could, he worked towards that goal to the end of his life.

When Einstein came to the United States, he immediately saw a parallel between the position of Jews in Germany and the position of Blacks in that country. he came to the US in 1933 and by 1934 he was already speaking out in favour of the struggle of Black people for their rights. In this context, he said:

> *...The tragedy of such a fate lies not merely in the unfair treatment to which these minorities*

are automatically subjected in social and economic matters, but also in the fact that under the suggestive influence of the majority most of the victims themselves succumb to the same prejudice and regard their kind as inferior beings. This second and greater part of the evil can be overcome by closer association and by deliberate education of the minority, whose spiritual liberation can thus be accomplished. The resolute efforts of the American Negroes in this direction deserve approval and assistance.

Einstein's concern with economic and social inequities growing out of the organization of our society ultimately led him to the conclusion that only a socialist reorganization could provide the framework for a solution to such problems:

... the essence of the crisis of our time... concerns the relationship of the individual to society. The individual has become more conscious than ever of his dependence upon society. But he does not experience this dependence as a positive asset, as an organic tie, as a protective force, but rather as a threat to his natural rights, or even to his existence. Moreover his position in society is such that the egotistical drives of his makeup are constantly being accentuated, while his social drives, which are by nature weaker, progressively deteriorate. All human beings,whatever their position in society, are suffering from this process of deterioration. Unknowingly prisoners of their own egotism, they feel insecure, lonely, and deprived of the naive, simple and unsophisticated enjoyment of life. Man can find meaning in life, short and perilous as it is, only through devoting himself to society.

And he pinpointed the cause of this crisis:

The economic anarchy of capitalist society as it exists today is, in my opinion, the real source of the evil. We see before us a huge community of producers the members of which are unceasingly striving to deprive each other of the fruits of their collective labor – or by force, but on the whole by faithful compliance with legally established rules.

He was not naive, however, about what constituted socialism. He certainly did not think that just having a planned economy would solve all problems, being well aware of what had happened in the Soviet Union:

Nevertheless, it is necessary to remember that a planned economy is not yet socialism. A planned economy as such may be accompanied by the complete enslavement of the individual. The achievement of socialism requires the solution of some extremely difficult socio-political problems: how is it possible, in view of the far-reaching centralization of

political and economic power, to prevent bureaucracy from becoming all-powerful and overweening? How can the rights of the individual be protected and therewith a democratic counterweight to the power of bureaucracy be assured?

I hope you can see, even from my brief and unsystematic account, that unfortunately Einstein's views on such issues as education, war and peace, discrimination against minorities, planning and freedom are far from irrelevant to our current situation. In many ways he is still our contemporary, whom we would be well-advised to praise less and read more.

I promised to return to the subject of Einstein's fame. It came to him in November 1919, as a result of the publicity given to the results of the English eclipse expeditions in that year, which confirmed Einstein's prediction of the so-called deflection of starlight by the sun's gravitational field. I say 'so-called' because the point of Einstein's theory is that the starlight is travelling on the straightest possible path through space and time – it is the latter which are warped by the sun's gravitational effect. Einstein could never understand why the theory of relativity, with its elaborate conceptual but tiny empirical refinements of the Newtonian theory of gravitation, gripped the popular imagination so vividly and for such a long period of time. And indeed here is another unsolved puzzle for the social psychologists.

Why did the results of the eclipse expedition have such an extraordinary impact on the general public, why did the theory of relativity 'catch on' as a subject of popular attention, why did Einstein's person become and remain a center of attraction – gravitational or otherwise – for so many stories, books, myths? I once compiled a list of about a dozen reasons that have been offered, but none of them by itself seems an adequate explanation.

At any rate, overnight Einstein became a celebrity, what today we might call a superstar. What was his reaction? What did fame mean to him – and for him? At Christmas 1919 he wrote to a close friend:

I get more and more stupid with fame, which is quite a common occurrence. The disproportion is really too great between what one is and what others think, or at least, say that one is. One must however bear it with humor.

In January 1920 he wrote to the same friend:

A cult has grown up around me since the announcement of the light deflection so I appear

to myself like an idol. But, with God's help, this too will pass away.

By February 1920 a tone of desperation had crept into his comments. He wrote to a former collaborator who invited him to give a talk:

Saying no has truly never been my strong point. But in this misery in which I find myself I am slowly learning how. Since the flood of newspaper articles, I am so fearfully deluged with requests, invitations, demands that I dream at night that I am roasting in Hell, and the mailman is the devil who yells at me continually as he throws a new pack of letters at my head because I still have not answered the old ones.

By the late twenties a cynical note appears:

For the amusement of the multitude everyone must be prepared to suffer, even the wise man. It is up to him to bear it with resignation and a cheerful expression.

When he came to the United States his difficulties intensified. While European reserve protected him to some extent, in America people would think nothing of coming up to him in the street and starting a conversation, just because they recognized him. He would respond cheerfully enough, but his feelings are reflected in a comment he is reported to have made after one such encounter: "*Well, the elephant has gone through his paces again*." He once expressed a desire to ride on the New York subways, but had to get off after one stop because he was mobbed.

He took comfort of a sort:

Such massive and shameless lies and free inventions of reporters have appeared about me that I would long ago have been under the ground if I had allowed myself to take them to heart. One must console himself with this: that time has a sieve through which most of the trifles run off into the sea of oblivion and what remains after this weeding out is often still insipid and worthless.

When he was seventy Einstein summed up his feelings about fame in a letter to a relative:

It is a curious thing to see how one appears from the perspective of others. It was my fate that my accomplishments had been over-valued beyond all bounds for incomprehensible reasons. Humanity needs a few romantic idols as spots of light in the drab field of earthly existence. I have been turned into such a spot of light. The particular choice of person

is inexplicable and unimportant.

Here I must dissent. Considering some of the individuals idolized in recent times, I take some comfort for the future of humanity from the fact that a man like Einstein even in mythical garb has become an enduring symbol of human aspirations.

As a consequence, in the first place so many press around me that I have to live like a prisoner who can never dare to venture forth because it kicks up a stir and brings unforeseeable complications. In addition there is the bad conscience that I cannot read or hardly answer the numberless manuscripts and letters and requests that incessantly pour down on me, an inability that only grows with the years.

At this time, there had been a lot of publicity in connection with his latest attempt at a unified field theory, which was to be his last. The press, as usual, sensationalized his effort: "*Seventy-year old sage unlocks secrets of the universe*" might have been the headline.

Just don't believe what the irresponsible newspaper writers say. After years and years of ceaseless efforts I have rounded off the relativity theory. But on account of enormous mathematical difficulties, I am not myself in a position to judge if the completion of the theory has hit the correct mark. The contemporary generation of my colleagues does not believe in it, so that I stand rather isolated in my viewpoint on fundamentals, without being certain that I have taken the right path. Anyway, the arguments are good and the remainder of my days is well employed, even if my powers bear no relation to the magnitude of the task…I enjoy my later days, preserve my good humor and do not take myself nor others seriously.

He closes with some advice:

Be glad of your calm days and do not let yourself be deceived by the appearance of external circumstances. Take pleasure that only a few care about you and believe me, it has its good side. Better to be an understanding spectator that an electrically illuminated actor.

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