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Einstein and Oppenheimer: Interactions and Intersections

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Argument

The paper is an exploration of the interactions between Einstein and Oppenheimer. It highlights the sharp differences in Einstein's and Oppenheimer's approach to physics, in their presentation of self as iconic figures, and in their relation to the communities they considered themselves part of. To understand their differing approaches to physics it briefly reviews the kinds of unifications that took place in physics during the first two-thirds of the twentieth century and points to the 1961 MIT centennial celebration to demonstrate the potency of Einstein's vision that there might be a fundamental theory from which all known theories could be derived. It also briefly reviews various aspects of the development of theoretical physics and of general relativity in the first two-thirds of the twentieth century, to better understand the context of the sharp, negative remarks that Oppenheimer made about Einstein and about his theory of general relativity in 1965 on the occasion of the tenth anniversary of Einstein's death. To answer the question: "Why the antagonism on Oppenheimer's part?" it looks at Oppenheimer's and Einstein's relation to their Jewish roots, their stance regarding nationalism, and their philosophical commitments.

Introduction

Both Albert Einstein and Robert Oppenheimer became iconic figures at a certain stage of their lives. In 1919, after the successful verification of one of the predictions of general relativity – the bending of the light from distant stars in its passage near the sun –, Einstein was hailed in the public sphere as a genius, one of the most intelligent human beings that ever lived, "the greatest scientist of the world," and "the most revolutionary innovator in physics" since Newton, a "universe maker" (Berlin 2001). Oppenheimer, in a public address on the occasion of Einstein's sixtieth birthday in 1939, could state that "[Einstein's] name is perhaps more widely known than that of any other living scientist; to many millions of people it has come to stand for science itself, and for all we admire in the way of life and thought of the scientist" (Oppenheimer 1939, 335).

As time went on, in addition to his scientific stature, Einstein became acclaimed for his humanity, his humility, and his lack of pretension. He was also admired for his political stance during the Weimar period in Germany, for his fight against fascism during the 1930s, and after World War II for his stand against McCarthyism, for his campaigning for peace, and for his efforts to eliminate nuclear weapons. He came to be seen not only as a courageous guardian of democracy and an outspoken foe of

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militarism, but as the embodiment of sanity, of reason, and of ethical behavior. In addition, his concerns with morality and with religion found a certain resonance in the wider public.[1]

Oppenheimer, for his part, was the "boy-wonder" of the American physics community during the 1930s. Having overseen the making of weaponry that terminated World War II and changed the balance of power as well as the conception of terror on the planet, after 1945 he became identified in the public mind not only with the awesome instrumental power of science, but also as a man who understood better than any one else the nature and gravity of the crisis the world faces by virtue of the existence of atomic weapons, who had a clearer idea of how difficult it will be to control their proliferation, and who had thought more deeply about the transformations necessary in the world in order to integrate these developments into human life. As Isador Rabi noted in his eulogy for Oppenheimer, with the end of the World War II and the retirement of the older statesmen of science whose leadership had been generally accepted by the physicists, by the press, and by the public at large, by 1946,

> this mantle naturally fell on the shoulders of Robert Oppenheimer. Although other eminent scientists exerted strong influences, ... Oppenheimer's leadership was recognized more universally, both at home and abroad, even though he held no high position and was not the recipient of extraordinary scientific honors. . . . Oppenheimer after Einstein, emerged as the great charismatic figure of the scientific world. (Rabi et al. 1969)

Yet there is a paradoxical element with Einstein and Oppenheimer as iconic members of the scientific community, since after they acquired this position they were for the most part outside it. Einstein did not accept the revolutionary vistas, challenges, and opportunities opened by the advent of quantum mechanics in 1925. And after 1946 Oppenheimer was no longer a practicing physicist. He became a scientific statesman, the director of the Institute of Advanced Study at Princeton, and the head of the very active school of physics there. But he did not set its intellectual agenda nor that of the wider theoretical physics community. Thus both were iconic and idiosyncratic at the same time, representatives of the community, yet outsiders.[2]

It is of course clear why the physics community should wish to accept Einstein as an iconic figure: Einstein's accomplishments in physics prior to 1927 were so extraordinary that his influence within physics and in many areas of the cultural scene has extended into the twenty-first century.[3] There were good reasons for Oppenheimer's acceptance

[1] Needless to say, there were also those who vehemently opposed his views on pacifism, nationalism, racial equality, and socialism. J. Edgar Hoover saw him as a security threat (see Jerome 2002).

[2] I thank one of the referees of the paper for insightfully stating the case thus, and for urging me to restructure the paper to partially address this phenomenon.

[3] The numerous conferences and exhibits that were organized in 2005 to celebrate the centennial of Einstein's *annus mirabilis* are certainly proof of this, e.g., the conferences organized by the Einstein Forum in Berlin, by the

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as well: he had been a first rate theorist during the 1930s, the person responsible for creating at Berkeley the outstanding school of theoretical physics in the United States during that decade. His leadership at Los Alamos had enabled scientists, and physicists in particular, to design and assemble a weapon that transformed the world. In that new world physicists acquired unusual importance, status, and influence, had new responsibilities thrust upon them, and gained some measure of power.[4]

These observations are the point of departure of my paper, which is an exploration of the interactions between these two remarkable individuals and of the role played by their membership in various collectivities. I shall look at some of the communities Einstein and Oppenheimer belonged to, and analyze some of their interactions in the light of their membership in them. I shall highlight the sharp differences between Einstein's and Oppenheimer's approach to physics, in their presentation of self as iconic figures, and in their relation to the communities they considered themselves part of. Doing so permits a somewhat different perspective on these two individuals and draws attention to the role played by philosophical commitments, the situatedness of these commitments, and underscores context-dependence more generally.

There were striking differences in the character of these two individuals. There was no element of ostentation in Einstein's presentation of self, whereas Oppenheimer always seemed to be playing a role and thrived on being oracular and "deep." But there were also similarities. Neither one was particularly successful in his personal relationship with his wife or as a parent. And there was an element of tragedy in both their lives. The revocation of his security clearance and the outcome of his "trial" in 1954 were traumas from which Oppenheimer never recovered. To many of his fellow physicists and to liberal intellectuals,[5] he came to be seen as a tragic figure, a fallen hero, at times compared to Galileo and to Dreyfus. It has been suggested that one aspect of the tragic figure is that he discovers himself to be an enigma, without any fixed point of attachment.[6] It seems that Oppenheimer never came to a full understanding

Israel Academy of Sciences and Humanities in Jerusalem, and the Einstein exhibit mounted by Jürgen Renn and the Deutsches Museum in Berlin.

[4] It is clear that in the public mind Einstein's status as a global iconic figure is secure. Thus *Time* magazine in 2000 selected him as "Person of the Century." Frederic Golden in his article on Albert Einstein in that issue noted: "He was the pre-eminent scientist in a century dominated by science. The touchstones of the era – the Bomb, the Big Bang, quantum physics and electronics – all bear his imprint. He was the embodiment of pure intellect, the bumbling professor with the German accent, a comic cliché in a thousand films. Instantly recognizable, like Charlie Chaplin's Little Tramp, Albert Einstein's shaggy-haired visage was as familiar to ordinary people as to the matrons who fluttered about him in salons from Berlin to Hollywood. Yet he was unfathomably profound – the genius among geniuses who discovered, merely by thinking about it, that the universe was not as it seemed." On the other hand, Oppenheimer's status is less clear cut. Several excellent recent biographies have been written about him attesting to the important role he played in the history of the United States during the twentieth century. He is still a widely respected figure among older physicists. However, at the present time he is not a well known figure among young scientists outside the United States.

[5] Diana Trilling spoke of him as "a culture hero for American intellectuals, especially for literary intellectuals" and commended him for his political stand during the 1930s.

[6] Crease has insightfully analyzed the tragic element in Oppenheimer (Crease 2005).

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of himself nor did he ever achieve a stable sense of identity. Einstein was very different and on several occasions stated clearly who he was. He had been deeply influenced by his early readings of Schopenhauer and had taken to heart what Schopenhauer had said about finding happiness in "what one is":

> . . . what a person is for himself, what abides with him in his loneliness and isolation, and what no one can give or take away from him, this is obviously more essential for him than everything that he possesses or what he may be in the eyes of others . . . for one's happiness in this life, that which one is, one's personality is absolutely the first and most essential thing. (Schopenhauer 1851, vol. 1, 348–49; quoted in Howard 1997)

If Einstein achieved some measure of personal happiness by being what he was for himself, there was nonetheless a tragic element in his life. In the last twenty-five years of his life, Einstein stopped questioning the validity of his goal and of his approach in the unification of gravitation and electromagnetism at the classical level, and thus lost his connection to the physics community.

Einstein (1879–1955) and Oppenheimer (1904–1967) belonged to two different generations, with the advent of quantum mechanics delineating the boundary. By 1925 the division of labor between experimental and theoretical physics had become a fact, and it became the exception for a physicist to be both. The mid-1920s also marked the ascendancy of American physics. By the outbreak of World War II the United States harbored the fastest growing physics community in the world, and had become recognized as the leader in experimental nuclear physics and several other areas of physics.[7] Thus, the stage upon which Einstein had acted, and Oppenheimer was acting, the freedom and constraints under which they operated made for their different presentation of self. Most theoretical physicists of Oppenheimer's generation thought that Einstein was wrongheaded in his approach that attempted to fuse gravitation and electromagnetism at the classical level. Nonetheless the vision of unification, which had its roots in nineteenth-century German Romanticism, was nurtured by his efforts.

In section 1 of this paper, I briefly review the kinds of unifications that took place in physics during the first two-thirds of the twentieth century, and point to the 1961 MIT centennial celebration to demonstrate the potency of Einstein's vision that there might be a fundamental theory from which all known theories could be derived. This celebration took place at a time when the understanding of the workings of nature was described in terms of four separate and distinct forces: gravity, electromagnetism, the weak interactions, and the strong interactions. The views expressed by Ronald Peierls, Chen Ning Yang, and Richard Feynman on the subject of unification and "final" theories at the MIT colloquium still merit attention. They were statements by leading members of the community who were actively engaged in research, influential in setting the agenda of the community, and thus represented the community. As we

[7] See for example, Kragh 1999, chap. 17, and references therein.

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shall see, Oppenheimer viewed the enterprise of high energy physics differently from them.

Similarly, section 2 briefly reviews various aspects of the development of theoretical physics and of general relativity in the first two-thirds of the twentieth century, to better understand the context of the sharp, negative remarks that Oppenheimer made about Einstein and about his theory of general relativity in 1965 on the occasion of the tenth anniversary of Einstein's death. In his eulogy, Oppenheimer was saying in public things that many physicists had been saying for years about Einstein in private, yet many of these same physicists expressed indignation upon reading Oppenheimer's remarks.

In section 3, I give an account of some of the Oppenheimer-Einstein interactions. Oppenheimer, though deeply admiring of Einstein, was also at times highly critical of him publicly. Einstein, for his part, had a high regard for Oppenheimer and had only respectful things to say about him in public. If he knew of some of Oppenheimer's less admirable qualities and some of his deplorable deeds he would probably have said in a Spinozian spirit "I cannot hate him because he must do what he does," or quote Schopenhauer's saying, "A man can do what he wants, but not want what he wants," the aphorism Einstein considered his "unfailing well-spring of tolerance" throughout his life (Einstein 1954, 8–9).

In section 4, I address the question: "Why the antagonism on Oppenheimer's part?" and attempt to give some answers by looking at Oppenheimer's and Einstein's relation to their Jewish roots, their stance regarding nationalism, and their philosophical commitments. I also briefly compare their differing views of the metaphysics of physics. A short conclusion brings the article to a close. The sectioning of the article is as follows: 1. Unification. 2. A bird's eye view of general relativity: 1915–1960. 3. The Einstein-Oppenheimer interaction. 3a. At the Institute for Advanced Study (IAS). 3b. Oppenheimer's eulogies. 4. Roots and tradition. 5. Conclusion.

1. Unification

Eugene Wigner, one of the leading contributors to the quantum theory, made an insightful comment regarding the development of quantum mechanics in a lecture he delivered in the early 1980s at an international school of subnuclear physics:

> . . . while I was studying chemical engineering [during the early 1920s] and visited the Berlin University's physics colloquium each week, I gained the impression that many of the participants had doubts whether the human mind is strong enough to extend physics to the microscopic domain. . . . The first change in this pessimistic attitude came with Heisenberg's paper, modest as the aim of that was. . . . An equally large change came with Schrödinger's paper. . . . [But] we were. . . modest, we accepted and worked with a theory which we knew to be incomplete, the limitations of which we recognized. We were both proud and surprised when we could extend it to new sets of phenomena. (Wigner 1983)

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Two sets of phenomena were addressed. One was the extension of quantum mechanics towards the macroscopic realm – i.e., explaining the binding and structure of molecules, the nature of chemical bonding, the structure of solids, the electrical and thermal properties of metals, the cohesion of solids – and the success in dealing with these problems resulted in the belief "that we possess the basic information from which all chemistry could be deduced" (Wigner 1983, 769).

And indeed, quantum mechanics resulted in the unification of physics and chemistry. The other extension was toward the subatomic realm. The confidence gained from the mastery of the atomic and molecular realm, and later during the 1930s of the nuclear domain, cannot be overestimated. The success of the quantum mechanical explanations in these realms – the collective accomplishment by the physics community – together with Einstein's formulation of his general relativity theory – an outstanding exemplar of individual creativity, but nonetheless one that drew from the communal resources of the mathematical and physics community – cast aside doubts "whether the human mind is strong enough to extend physics to the microscopic domain" (Wigner 1983).

The state of affairs in "elementary particle" physics after World War II was summarized by John Archibald Wheeler (born 1911) in an important address delivered at a joint meeting of the National Academy of Sciences and the American Philosophical Society in the fall of 1945. Wheeler observed that the experimental and theoretical research of the 1930s had made it possible to identify four fundamental interactions: a) gravitation, b) electromagnetism, c) nuclear (strong) forces, d) weak–decay interactions. The belief that these were four independent realms governed by distinct forces was prevalent until the early 1960s – the period of relevance to our story.

Except for a brief period after the advent of general relativity stretching from 1915 till roughly 1926–27, the physics community was primarily concerned with the elucidation and representation of these separate realms. After the advent of quantum mechanics, Einstein was one of the few physicists who attempted to give a unified description of the forces of nature – in his case a unified description of gravitation and electromagnetism, and this at the classical level. There were exceptions: Oskar Klein in the late 1930s,[8] and after World War II, Julian Schwinger, who on several occasions attempted to give a unified quantum field theoretic formulation of the strong and the electromagnetic interactions using spin 1 gauge bosons. He reported on these efforts in the 1964 issue of the *Reviews of Modern Physics* dedicated to Oppenheimer on the occasion of his sixtieth birthday.

The program of unification traces its origins to Newton and his realization of the universality of gravitation. Different aspects of the program were anchored during the nineteenth century. Oersted and Faraday gave credibility to the quest by providing the first experimental indication that the program of unification had validity. Thereafter, Maxwell constructed a model for a unified theory of electricity and magnetism

[8] See Klein's contribution to the 1938 Warsaw conference. For an insightful and informative exposition of Einstein's views on unification and the tradition out of which it emerges, see Cassidy 1995.

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and provided a mathematical formulation that was able to explain much of the observed phenomena and to make predictions of new ones. Fraunhofer, Kirchoff, and others demonstrated that the laws of physics discovered here on earth also apply to stellar objects. With Einstein the vision became all-encompassing. His "search for a foundation of the whole of physics" was always present, even during his student days at the Eidgenössische Technische Hochschule (ETH), the Swiss Polytechnical Institute in Zurich. In an essay written in 1940 he indicated that he had always attempted to find a unifying theoretical basis for all of physics, a basis from which all the concepts and relationships of the sub-branches of physics might be derived by logical process. "The confident belief that this ultimate goal may be reached [was] the chief source of the passionate devotion which always animated [him] as a researcher" (Einstein 1954, 324). Einstein came to advocate unification coupled to a radical form of theory reductionism. In 1918, in his address celebrating Max Planck's sixtieth birthday, he stated: "The supreme test of the physicist is to arrive at those universal elementary laws from which the cosmos can be built up by pure deduction" (Einstein 1918). And in his 1949 "Autobiographical Notes" Einstein was even more explicit:

> I would like to state a principle, which cannot be based upon anything more than a faith in the simplicity, i.e., intelligibility, of nature; that is to say, nature is so constituted that it is possible logically to lay down such strongly determined laws that within these laws only rationally, completely determined constants occur (not constants, therefore, whose numerical values could be changed without destroying the theory). (Einstein 1949)

After the formulation of the electroweak theory by Steven Weinberg and Abdus Salam in the late 1960s, reduction and unification have been two tenets that have dominated fundamental theoretical physics.[9] But this was not the case between 1945 and 1965. Yet the hope of unification, to which Einstein had devoted the last twenty-five years of his life, always loomed in the background. Let me briefly consider the 1961 MIT Centennial Celebration as proof of this assertion. In April 1961, the Massachusetts Institute of Technology celebrated its hundredth anniversary with a week-long conference on scientific and engineering education. The morning session of the last day of the gathering was devoted to a panel discussion on "The Future of the Physical Sciences."[10] Francis Low, a professor at the Institute, chaired the session, and the speakers – in the order of their presentations – were John Cockcroft, Rudolf Peierls, Chen Ning Yang, and Richard Feynman. All five were physicists, and except for Cockcroft, theorists. The absence of any other kind of physical scientist on the

[9] For a helpful and perceptive synopsis of views of unification at the end of the twentieth century, see Cat 1998.
[10] The session took place in the MIT armory on April 8, 1961. The records of the conference are available in the M.I.T. Archives. I thank the archivist of the M.I.T. Library for permission to quote from the transcripts of the session and Carl and Michelle Feynman for permission to quote from Richard Feynman's presentation at this session.

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panel is indicative of the status that physicists then enjoyed, and the preponderance of theorists similarly reflected their standing within the scientific community.

Peierls, who at the time was professor of mathematical physics at Birmingham University, felt that there had to be "some new kind of connection which interprets the many fields and couplings [of the then known elementary particles] as different aspects of some common principle." But he thought that "we should not expect, as we expected at one time [during the 1930s], that the unification will come with one go. . . . There will be many stages of partial clarification before everything fits together, and, of course, . . . the last stage may never be reached" (MIT centennial celebration, 1961, MIT Archives).

Yang, who had recently won the Nobel Prize with Tsung Dao Lee for their work that had led to the demonstration that parity is not conserved in the weak interactions of the elementary particles, and was then a professor at the Institute of Advanced Study in Princeton, began his presentation by asking what made physics so unique an intellectual endeavor. The answer, he believed, lay in the fact that it offered "the possibility of formulation of concepts out of which, in the words of Einstein, "a comprehensive workable system of theoretical physics can be constructed. Such a system embodies elementary laws from which the cosmos can be built by pure deduction" (Einstein 1918; Yang [1983] 2005, 319). He noted that the three great conceptual revolutions of the twentieth century – special relativity, general relativity, and quantum mechanics – which unified much of physics, gave hope for the possibility of further unification, and in particular the hope for "integration of the weak, the electromagnetic and the strong interactions." But he also interjected a discordant note and warned his audience that although he believed that "new levels of penetration" would be achieved, the task of unraveling and understanding the new levels would become harder. Even though it is very natural in the day-to-day work of a physicist "to implicitly believe that the power of the human intellect is limitless and the depth of natural phenomena finite," for this faith gives courage, nonetheless Yang asserted that "the belief that the depth of natural phenomenon is finite is inconsistent, and the faith that the power of the human intellect is limitless is false" (MIT centennial celebration, 1961, MIT Archives; see also Yang [1983] 2005, 319).

It was Feynman who made the most provocative statements. Although he concurred with "almost everything" that Peierls and Yang had said regarding the near term prospects, he did not agree with "Professor Yang's idea that the thing is getting too difficult for us. I still have courage. . . I think it looked difficult at any stage." But he shared some of Yang's pessimism about the long term. What, Feynman asked, would likely happen to fundamental physics if, "though it may seem ridiculous, we suppose a society somewhat like our own continuing for a thousand years." One possibility, Feynman conjectured, is that "a final solution" would be found. In contrast to Yang, who believed that "it was self evident that [this] is impossible," Feynman thought this was potentially possible. What Feynman meant by a "final solution" is that every new experiment would only result in checking the fundamental laws.

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Under those conditions he thought that it would get "more and more boring as we find that time after time . . . nothing new is discovered that disagrees with the fundamental principles." What if on the other hand, as Yang wished, there are an infinite number of layers? Feynman believed that if that is the case "It will become boring, [to discern] . . . that things change always when you look deeper." And therefore Feynman did not believe that fundamental physics could last a thousand years of investigation. Feynman concluded that under those circumstances the enterprise "will slow up, [and] the questions will become more difficult." Far fewer experimental results would become available, new discoveries would be made ever more slowly, the problems would become harder and harder and "more and more people [would] find it a relatively uninteresting subject, and so it [would] be left in an incomplete state with a few working [on understanding some lower level]." But Feynman alluded to another possibility: Physics may expand "into the studies of astronomical history and cosmology." Feynman characterized the situation in physics at that time as follows:

> There is no historical question being studied in physics at the present time [i.e. in 1961]. We do not have a question, "Here are the laws of physics, how did they get that way?" We do not imagine, at the moment, that the laws of physics are somehow changing with time, that they are different in the past than they are at present. Of course, they may be, and the moment we find they are, the historical question of physics will be wrapped up with the rest of the history of the universe, and then the physicist will be talking about the same problems of astronomers, geologists, and biologists.[11]

In closing his presentation, Feynman reiterated his belief that: "We live in a heroic, a unique and a wonderful age of excitement. It is going to be looked at with great jealousy in ages to come" and summarized what he had said by stating that he believed "that fundamental physics has a finite lifetime." Feynman could speak of living in "a heroic, a unique and a wonderful age of excitement" even though at that particular time – the early 1960s – particle physics was in the midst of a crisis. He could characterize as "unique and wonderful" what was happening in high energy physics because it was being propelled by a constant stream of new empirical discoveries stemming from the plethora of high energy accelerators and detectors that had just been built, and were being built. And indeed the end of the decade saw major theoretical advances culminating in the Glashow-Weinberg-Salam model unifying electromagnetism and the weak interactions, and shortly thereafter the establishment of the standard model, giving a unified description of the electroweak and the strong interactions. Feynman was also prescient. Physics did become more concerned with historical questions and did become "enwrapped in the cosmological problem."

Each of the speakers at the MIT celebration had addressed the ultimate goals and the future of physics. In 1964, in an effort to gain support for a "superhigh energy

[11] I am here quoting Feynman's statement as he formulated it in Feynman 1963, 3–9.

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accelerator in the energy region of multi-hundred BeV" the high energy community issued a little volume containing the views of the leading theorists – all "active in the field of high energy physics, . . . to whom collectively, the theoretical progress of the [post World War II period] . . . is largely to be attributed" – indicating the "Purposes of High Energy Physics" (Yuan 1965, 2).[12] Oppenheimer wrote its foreword. His being asked to write the foreword exemplifies his paradoxical standing as icon and as outsider. What is striking in Oppenheimer's remarks is that he did not claim, as did most of the other contributors, that, (to quote Robert Sachs, for example), "High energy physics is the essence of today's science of physics. . . and is the domain [in which] the fundamental laws of nature are now being discovered." The consensus – expressed in the words of Hans Bethe – was that high energy physics was "indeed the most basic field of knowledge in the physical world. . . no other field will give us such deep understanding. . . . [P]article physics deserves the greatest support among all the branches of our science because it gives the most fundamental insights." It provided, so Henry Primakoff in turn put it, "in some sense the fundamental building blocks. . . out of which the material universe is constructed." Although Oppenheimer certainly agreed that seeking to understand the structure of matter had been astoundingly intellectually fruitful in the past, he refrained from giving his assent to Abraham Pais's conviction that the very goal of high energy physics was to find a fundamental, unitary theory of the interactions between elementary particles. To Pais's mind, on the contrary, an "interruption of the pursuit toward high energy machines would be disastrous" for just that reason, as "[w]e may be stranded without their synthesis. . . . We may stop short of . . . integrating such disjointed forces into a new unification."

Though clearly supportive of the aims of the enterprise, for Oppenheimer its justification was not the further elucidation of the nature of matter. Rather for him it was to make sure of the continuance of the Enlightenment project:

> . . . the last centuries of science have been marked by an unabating struggle to describe and comprehend the nature of matter, its regularities, its laws, and the language that makes it intelligible. The successes in this struggle. . . have inspired the whole scientific enterprise, and lighted the world of technology, and the whole of man's life. They have informed the education and devotion of young people. . . . We are now, despite tempting and brilliant successes, deep in the agony of this struggle. . . . *[W]ithout further penetration into the realm of the very small, the agony this time may not end in a triumph of human reason. That is what is at stake;* . . . (Oppenheimer in Yuan 1965, 5; my emphasis)

To the best of my knowledge, Oppenheimer never publicly stated his views regarding the possibility of a "final theory." It is likely, given his Sanskrit and Eastern predilections, that there would have been some resonance with the views Yang expressed at the 1961

[12] The American high energy community had "sensed the apparent existence of some misunderstanding of the objectives of high energy physics, not only among the general public but also among the scientific community as a whole" (Yuan 1965, Preface).

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MIT celebration. He did not believe – and so stated – that one could reconstruct the world from the knowledge of a foundational theory in physics. Chemistry, biology, psychology, . . . are different realms of nature.

It is beyond the scope of this paper to give a detailed analysis of the differing views of Einstein and Oppenheimer regarding unification. They were committed to different metaphysics. Einstein by virtue of education and intellectual milieu had to address Kant and his legacy – and disagreed with many of the Kantian concepts. On various occasions he indicated his affinity with Leibnitz's notions of a pre-established harmony, and expressed his admiration of Spinoza's views of determinism and the deity (see Cassidy 1995).[13] Oppenheimer by virtue of education and intellectual milieu, was drawn to pragmatism, operationalism, and to Bohr's positivism. In the 1930s, like Bohr, Oppenheimer believed that the resolution of the difficulties encountered in relativistic quantum field theory needed a conceptual revolution of the same magnitude as quantum mechanics. But by the 1950s, with the successes of the renormalization program and the plethora of new particles that cosmic rays and the new accelerators were revealing, he viewed the issues differently. It was clear to him that the insights of quantum mechanics and of quantum field theory into the dynamics of the atomic and subatomic world – uncertainty principles, vacuum fluctuations, relations between energy scales and distance scales, new symmetries and ontologies, . . . – were such that the next unification had to be expressed within a quantum mechanical framework. Einstein, on the other hand, believed that the non-linearity of the general theory of relativity would yield solutions that corresponded to localized energy-momentum distributions in space-time, i.e. particle-like solutions, and that the interactions between such "particles" would be determined by the gravitational field equations. He likewise hoped that the unification of electromagnetism and gravitation would similarly yield particle-like solutions endowed with electric charge. And he even believed that this approach might yield the quantum mechanical description, with its statistical feature emerging from of an "averaging" of the space-time description. For Oppenheimer, their contrasting views were irreconcilable. This because of all the new empirical data that had been obtained from cosmic rays experiments and high energy accelerators. The chasm went even deeper – for Oppenheimer was not convinced that Einstein's formulation of general relativity was necessarily the correct theory of gravitation. In the early 1960s he thought that Carl Brans and Robert Dicke's extension on general relativity might be a better theory. It is to this issue that I turn next.

2. A bird's eye view of theoretical physics and of general relativity: 1915–1965

The reception and reaction to general relativity can be better understood in terms of the following rough periodization of twentieth-century theoretical physics: a) the period

[13] I return to these themes in section 4.

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from 1900 till 1927, during which the subdiscipline of theoretical physics became established. This "glorious period" witnessed three great revolutions: special relativity, general relativity, and quantum mechanics; b) a second period from 1927 till 1940 – which saw the development of quantum chemistry, nuclear physics, and of quantum field theory, and its vicissitudes; c) a third period that extends from 1945 till the mid-1970s and culminated with the establishment of relativistic quantum field theory as the foundational formalism for the representation of the microscopic and submicroscopic world. Its end points are marked by the formulation of the standard model, the solution of the phase transition problem, Wilson's renormalization group methods, the reinterpretation of the renormalization procedures developed by Feynman, Schwinger, and Dyson in the late 1940s, and Anderson's challenge to reductionism with his landmark article "More is different" of 1970.[14]

The generations trained or coming of age during the above enumerated periods reflected their differing context. The generation of Bohr, Born, Einstein, Ehrenfest, Langevin, Sommerfeld, ... was the generation that matured during the first period. These physicists put theoretical physics on the map. Einstein is of course the towering – Mozart like – theorist of that generation.

The second period was dominated by the generation that included Pauli, Dirac, Heisenberg, Jordan, ... and by the theorists who were trained just slightly before or slightly after the advent of Quantum Mechanics (QM): Bloch, Bethe, Gamov, Oppenheimer, Landau, Peierls, Rosenfeld, Solomon, Tamm, Tomonaga, Weisskopf, Wentzel, Wigner, Yukawa, ... The leading theorists of that period had a mastery of all of physics. Oppenheimer can be taken as a paradigmatic figure for this second period. By virtue of his close association with Ernest Lawrence's Radiation Laboratory in Berkeley, and with the experimental nuclear physics research group and the astronomers at Cal Tech, Oppenheimer worked principally on problems in nuclear physics, cosmic ray physics, and astrophysics, and on the foundational theories that sought to explain the phenomena encountered in these fields: relativistic quantum electrodynamics and meson theory. During the 1930s Oppenheimer was one of the leading theoretical physicists working on these problems, then the frontiers of the discipline. He represented a new type of theoretical physicist who by virtue of his mastery of the novel features that emerged from the synthesis of quantum mechanics and special relativity could not only account for some of the puzzling experimental data generated by the newly built accelerators and by cosmic ray experiments – but could also predict new ontologies: positrons and mesotrons.

[14] The increase in the size of the community and the ever expanding areas of interests to theorists makes the list of the principal contributors to the advances during this period much larger. The names Schwinger, Feynman, Dyson, Gell-Mann, Salam, Landau, T. D. Lee, Yang, Ward, Chew, Low, Weinberg, Glashow, Coleman, Goldstone, Nambu, Veltman, Wilson (in high energy), Abrikosov, Anderson, Kohn, Landau, Luttinger, Martin, de Gennes, Schrieffer, Fisher, Kadanoff, Wilson (in condensed matter) are names that come immediately to mind.

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Oppenheimer personified some of the accomplishments of that generation as well as its frustrations. With his postdoctoral student, Wendell Furry, Oppenheimer formulated a relativistic invariant quantum field theory of the electron-positron field. His analysis of cosmic ray shower phenomena helped establish the existence of the particle we now call the μ-meson. He worked on the problem of energy generation in stars, but its solution was found by Hans Bethe. A long lasting, outstanding contribution to quantum field theory eluded him, although his students contributed importantly to the concept of mass and charge renormalization. Nonetheless, during the 1930s Oppenheimer embodied the power that quantum mechanics and special relativity had given physicists by virtue of their understanding, control, and mastery of the atomic and nuclear realms. World War II demonstrated how that knowledge could be translated into the design and construction of macroscopic gadgets.

One of Oppenheimer's most creative research projects during the 1930s was the work he did with his students Michael Volkoff and Hartland Snyder on the evolution of massive stars that did not become white dwarfs after they had exhausted their thermonuclear sources of energy. Under those conditions gravitation would induce a collapse of the star to dimensions and densities where general relativistic effects become pronounced. They found that, as seen by a distant observer, general relativity predicted that the star would asymptotically shrink to its Schwarzschild radius as it closed itself off from the rest of the universe except for its intense gravitational field (Oppenheimer and Volkoff 1939; Oppenheimer and Snyder 1939; Hufbauer 2005). They had in effect discovered what John Archibald Wheeler later would call black holes. But the importance of their work was not recognized at the time, neither by them nor by the astrophysical community at large, because it could not be observationally corroborated. Also, with the outbreak of World War II other problems became the primary concern of physicists. It is now known that black holes exist ranging in size from a few solar masses to a few billion and play an important role in the economy of the universe.

It is not clear whether Oppenheimer ever communicated his results to Einstein at the time. This episode points to a characteristic of the chronicle of general relativity from 1915 to 1965. In terms of the periodization given above general relativity thrived during period a), was dormant during period b) except for some important work by Einstein and Infeld on the equations of motion of point masses in general relativity, and acquired new vigor and importance during period c).

The decade from 1915 till about 1925 demarcates the first phase of research activities in (classical) general relativity (GR) on the part of physicists and mathematicians after Einstein's papers had appeared. Its high point is of course the Dyson-Eddington observation of the bending of light by the sun. The publication of Pauli's "Relativitätstheorie" article (Pauli 1904–1922, vol. 5, chap. 19, 621) in the *Encyclopedie der Mathematische Wissenschaften*, Herman Weyl's magisterial *Raum, Zeit, Materie,* and Eddington's *The Mathematical Theory of Relativity* established general relativity as a sub-discipline of theoretical physics. However, the number of people actively working in the field never exceeded a few dozen, or so.

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The advent of quantum mechanics, its applications to solid state physics, chemical physics, and nuclear physics, and in its field theoretic extension, its applications to cosmic ray phenomena shifted the interest away from GR during the 1930s. The absence of further experimental tests, beyond the three classic ones Einstein had initially formulated, and the paucity of accurate new data were also factors in the lack of further attention devoted to GR. The reawakening of interest in the field can be dated to the July 11–16, 1955, Bern meeting which celebrated the fiftieth anniversary of the creation of special relativity and was concerned exclusively with topics in special and general relativity. Pauli was the chair of the organizing committee,[15] and André Mercier its secretary. Mercier communicated to Einstein the plans for the meeting and hoped he might be able to attend. Replying to Mercier, Einstein expressed his joy and gratitude for what appeared to him to be a very promising conference, adding "It will demonstrate, that the expectations, that were bound to the general principle of relativity, were extraordinarily varied. This is good, because among us researchers the philosophical saying that 'War is the father of all things' [did not entail] the fatal smack [Beigeschmack], that usually sticks to it" (Mercier and Kervaire 1956, 10). Einstein died in April of 1955 and the meeting thus became a gathering at which to come to terms with the fact "that Einstein is no longer with us" and an occasion to bid "farewell to the man" (Pauli, "Opening Talk," in ibid., 27).

More than 80 people from 22 countries attended the conference. Two years later the first of the General Relativity Conferences was held in Chapel Hill organized by Bryce de Witt.[16] Its theme was "The Role of Gravitation in Physics." By the end of the decade one could point to several "schools" of general relativity: John Archibald Wheeler at Princeton University;[17] Peter Bergmann at Syracuse University;[18] Leopold Infeld in Warsaw;[19] Bryce de Witt at North Carolina University, as well as various individual workers such as Bondi, Ehlers, Fock, Lichnerowitz, Møller, Papapetrou, Pirani, Penrose, Tonnelat, etc. There thus came into being a community of researchers in general relativity addressing a common set of problems. The end of the decade was marked by new insights – by Martin Kruskall, George Szekeres, Tulio Regge – into the Schwarzschild solution of the GR equations which paved the way to the modern version of black hole theory. The early 1960s also saw new experimental developments which promised feasible new tests of general relativity and thus stimulated greatly increased activities and new research directions for GR. The research activities of

[15] The committee consisted of all the senior theorists holding professorial positions in the various Swiss universities at the time: A. Mercier, K. Bleuler, M. Fierz, W. Heitler, A. Houriet, F.G. Houtermans, R. Jost, D. Rivier, E.C.G. Stueckelberg, W. Scherrer, M. Schüber..

[16] See his opening remarks in de Witt 1957, 351.

[17] Komar, Misner, Regge, R. F. Baierlein, D. H. Sharp are Wheeler students who worked on GR for their Ph.D. thesis.

[18] R. Penfield, R. Schiller, H. Zatzkis, and J. L. Anderson were among Bergmann's students doing their Ph.D. with him during the 1950s.

[19] Trautman inherited Infeld's mantle.

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Robert Dicke in particular should be singled out. Dicke was a leading experimenter and theorist at Princeton University who not only had undertaken new experiments to determine the validity of some of general relativity's claims but who, with one of his graduate students, Carl Brans, had also formulated a version of general relativity that introduced a new scalar field that simulated possible variations of the (inverse of the) gravitational constant with position and time. For a few years after its introduction in 1961 the Brans-Dicke theory was considered as a possible challenge to general relativity (Brans and Dicke 1961; see Kaiser 2006). The proposed experiments by Dicke and Oldenberg to measure the oblateness of the sun were designed to discriminate between the Brans-Dicke predictions and those of GR for the deflection of light in its passage near the sun.

In addition to these developments the problems connected with developing a consistent formulation of quantum gravity were also receiving attention from some of the leading physicists of the day: Wigner 1957, Schwinger 1962 and 1963, Feynman 1964, Wheeler, and by some of their students: de Witt, Arnowitt, Deser, and Misner.[20] The fact that Feynman offered a lecture course on GR and its quantized version at the California Institute of Technology during 1962–63, helped make GR and quantum gravity respectable fields of investigations for graduate students elsewhere. In connection with his course, Feynman had studied the quantization of the Yang-Mills field theory and the difficulties that were encountered in quantized GR. He wrote a paper on the subject which proved to be very influential, for it focused on the particular problems that arose in quantizing gauge theories such as Yang-Mills theory and general relativity. Ryoyu Utiyama, who was a visiting member of the Institute for Advanced Study during the academic year 1955-56, had written an important paper while there which clarified both the Yang-Mills theory and general relativity as gauge theories (Utiyama 1956).[21]

It is certainly the case that Oppenheimer was aware of all these developments, for activities at Princeton University and at the Institute were central to the resurgence of interest in GR. That by the early 1960s general relativity was abuzz with activity and acquired a new status within the physics community can be gauged by the fact that in 1964 the first half of the Brandeis Summer School in Theoretical Physics was

[20] De Witt, Arnowitt, and Deser were students of Schwinger; Misner of Wheeler. See DeWitt 1957 and the other articles in that issue of the *Reviews of Modern Physics,* e.g., Deser 1957 and Misner 1957.

[21] In his paper Utiyama considered field systems that are invariant under a certain group of transformations depending on n parameters, and formulated a general rule for introducing a new field that possessed a definite type of interaction with the original fields by postulating the invariance of the enlarged system under a wider group derived by replacing the parameters of the original group by a set of arbitrary functions. The transformation properties of this new field under the wider group were determined from the invariance postulate. Utiyama then derived the equations the new fields obeyed, as well as the conservation laws that were a consequence of the invariance. Utiyama illustrated this approach with the electromagnetic, the gravitational, and the Yang-Mills fields as examples.

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devoted exclusively to General Relativity and was attended by over 100 graduate and post-doctoral students (see Deser and Ford 1965).

We are now ready to consider the interactions between Oppenheimer and Einstein.

3. The Einstein-Oppenheimer interaction

Oppenheimer first met Einstein in January 1932 when Einstein visited Cal Tech during his round-the-world trip of 1931-32.[22] In January 1935, Oppenheimer went East to attend a meeting of the American Physical Society. While in New York he took the opportunity to go to Princeton to visit the Institute to which he had been invited to spend a year as a visiting member. He conveyed his reaction to Fine Hall – the building where both the mathematics department of Princeton University and, until 1938, the Institute for Advanced Study were located – in a letter to his brother Frank: "Princeton is a madhouse: its solipsistic luminaries shining in separate & helpless desolation. Einstein is completely cuckoo. . . . I could be of absolutely no use at such a place, but it took a lot of conversation & arm waving to get Weyl to take a no" (Smith and Weiner 1980, 190).

Undoubtedly Oppenheimer's strong reaction was due to the contrast between his and Einstein's working style, their sharply differing attitudes to quantum mechanics, and their conflicting views of what constituted the important contemporary problems in physics. Though readily conceding its extraordinary success, Einstein never accepted quantum mechanics as the theory demarcating the path to a more fundamental understanding of the physical world. Thus in an interview in 1945 he stated: "The quantum theory is without a doubt a useful theory, but it does not reach to the bottom of things. I never believed that it constitutes the true conception of nature" (Stern 1945).

Einstein's working style is well known. After he came to Princeton, in his personal life as well as in his scientific activities, he became very much the loner. If as he claimed this had been the case in his personal life before coming to the Institute,[23] this was not so in scientific matters. As a student at ETH, he had developed close friendships with fellow students Marcel Grossman, Michele Besso, and Mileva Marić, whom he later married. Working at the patent office in Bern, there had been intense interactions with Maurice Solovine and Conrad Habitch in what they called the Akademie Olympia, at whose meetings philosophical issues were thrashed out (Feuer

[22] Oppenheimer's father, Julius, who was staying with Robert after his wife's death in October 1931, commented in a letter to Robert's brother Frank that "he [Robert] is always busy and has had two short talks with Einstein" (Smith and Weiner 1980, 153).

[23] Einstein in his 1931 essay entitled "The World as I See It" said of himself: "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 the sense of distance and a need for solitude – feelings which increase with the years. 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 judgments of his fellows and avoids the temptation to build his inner equilibrium upon such insecure foundations" (Einstein 1954, 9).

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1974; Fölsing 1997, 99–100). And during the annus mirabilis of 1905 Einstein had lengthy discussions with Michele Besso, then his colleague at the patent office, about the problems he was tackling. His collaborations with Marcel Grossman and later with Jakob Grommer – working on the mathematical representations of his insights into the relation between gravitation, general covariance, and geometry – were marked by their length. Similarly, his visits to Göttingen and his discussions with David Hilbert were consequential. After Einstein came to Berlin there were meetings with Paul Ehrenfest and his students in Leyden. After World War I, there were extended discussions with the bright young men who had come to Berlin during the 1920s to be where the action in physics was – Szilard and Wigner. However, he lectured only intermittently, created no school, and had but one Ph.D. student.[24] There were of course the often extremely stimulating sessions of the Prussian Academy that Einstein faithfully attended, as well as the various meetings of the Solvay Congress in which he participated until the early 1930s. Most such interactions ceased after Einstein came to the United States. He attended the University and Institute physics seminars and colloquia but rarely, and became intellectually isolated from the physics community.[25] After he came to the Institute his research was primarily carried out with his assistants: Banesh Hoffman and Leopold Infeld on the relation of the equations of motion of point particles to the field equations in general relativity elaborating earlier results; with Peter Bergmann, Valia Bargmann, and Bruria Kaufman, on unified field theory, and with Boris Podolski and Nathan Rosen on quantum mechanism and realism (see Pais 1982, chap. 29).

This is in contrast to Oppenheimer, who in the 1930s while at Berkeley created the most important school of theoretical physics in the United States. His graduate lecture courses – particularly those on quantum mechanics and on electromagnetic theory – were models of clarity. They emphasized utility, but also conveyed to the students the beauty of the subject matter. In his eulogy for Oppenheimer Bethe noted that "Probably the most important ingredient [Oppenheimer] brought to his teaching was his exquisite taste. He always knew what were the important problems, as shown by his choice of subjects. He truly lived with these problems, struggling for a solution, and he communicated his problems to his group" (Bethe 1967). Furthermore, Oppenheimer was not only the center of his students' intellectual world, he was also at the center of their social world.

At a memorial service for Oppenheimer in 1967, Serber described Oppenheimer's interaction with his students:

> He met the group [which in the mid thirties consisted of a dozen graduate students and about half a dozen postdoctoral fellows] once a day in his office. A little before

[24] As Oppenheimer was to put it in his UNESCO speech of 1965.

[25] Although his primary research interest was the unification of electromagnetism and gravitation he was aware of other developments. Thus in 1951 after Yang and Lee had written their classic papers on the statistical mechanical theory of equations of state and phase transitions, Einstein asked Yang to come see him to discuss the papers (see Yang 2005, 15).

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> the appointed time the members straggled in and disposed themselves on the tables and about the walls. Oppie came in and discussed with one after another the status of the student's research problem while others listened and offered comments. All were exposed to a broad range of topics. Oppenheimer was interested in everything; one subject after another was introduced and coexisted with all the others. In an afternoon they might discuss electrodynamics, cosmic rays, astrophysics, and nuclear physics. (Serber, in Rabi 1969, 18)

This form of cooperative investigation that made use of the collective knowledge of the group became the characteristic mode of distributed inquiry in research groups – but only much later. Oppenheimer had recognized the transformation that had taken place in theoretical physics, and in physics more generally, since the advent of quantum mechanics: physics had become a much more cooperative enterprise between theorists and experimentalists. He and his students functioned in part as "house theorists" to the Rad Lab at Berkeley and the experimentalists at Cal Tech. Also the community had become much larger.

The differences in Einstein's and his own working style was made explicit in Oppenheimer's radio address on the occasion of Einstein's sixtieth birthday in 1939. He began with laudatory remarks:

> Most of us who are concerned with research in one or another branch of scientific work, are proud to have in Einstein a popular symbol of what we are doing and trying to do. Few men have contributed so much to our understanding of the Physical World, to our ability to predict and follow and control its behavior. And we see in Einstein, especially those who have come to know him a little, all those personal qualities that are the counterpart of great work: selflessness, humor, and a deep kindness.

and went on to declare

> But if few scientific workers would quarrel with the fact that Einstein is in many ways a perfect symbol of their work, there are many who would feel that there is something a little false and fabulous in the way that he is thought of . . . [T]here is . . . a general impression, supported in part by his eminence, that his work has been qualitatively different from that of his fellow workers; that it is abstruse, and remote, and useless. This seems to me a very strange ground for admiration. And of course it is not true; and the truth is much better than the false. All discoveries in science grow from the work, patient and brilliant, of many workers. They would not be possible without this collaboration; they would not be possible without the constant technological developments that are necessary to new experiments and new scientific experience. One may even doubt whether in the end they can be possible except in a world which encourages scientific work, and treasures the knowledge and power which are its fruits.[26]

[26] Interestingly, Oppenheimer went on to remark that one of the most "spectacular project[s] of contemporary atomic physics was to tap the sources of the sun's energy – a project made possible by Einstein's early work on

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For Einstein, however, creativity rested in individuals, not in the collective. But he was of course aware of the role that the community played in educating the new generations of practitioners, in recording and transmitting the past achievements, in preserving tools and thus helping shape new ones, in setting standards and conventions, in maintaining values and in forming consensus.[27]

As noted above, in an interesting coincidence, Einstein and Oppenheimer came into their closest proximity in questions of physics in 1939. Although Oppenheimer's focus had been principally quantum mechanics and quantum field theory, his contacts with the astronomers at Cal Tech brought him closer to Einstein's concerns. Through general relativity, each became enwrapped in his own way in what Feynman had called "the historical question of physics" (Feynman 1963, chap. 3, 9). In the late 1930s Oppenheimer concerned himself – if not with the cosmological problem, though deeply interested in it – with a historical question: namely, what happens to heavy stars when they exhaust their nuclear fuel? And with his students, George Volkoff and Hartland Snyder, he had discovered that general relativity predicted the existence of strange dense objects: black holes. Einstein was hostile to the idea of black holes, as he did not believe that any solution of the general relativistic field equations that contained a singularity was physically acceptable. Nor did he ever contemplate the physical possibility of black holes. According to Freeman Dyson, Oppenheimer too in later life was uninterested in black holes – although Dyson thought that, in retrospect, they were his most important contribution to science (Dyson 1995).

3a. At the Institute for Advanced Study

In the fall of 1947 Oppenheimer became the director of the Institute of Advanced Study and a professor of physics there. He and Einstein thus became colleagues.

the theory of relativity. He then noted that in this as in every case one would find that the development of Einstein's discovery was "so closely interwoven with the work of countless other scientists and technicians . . . that we would come away [from an analysis of the development] with a deepened conviction of the cooperative and interrelated character of scientific achievement (J. R. Oppenheimer. Special Radio Program celebrating the sixtieth birthday of Albert Einstein, March 16, 1939, reported in Oppenheimer 1939). In 1960 Oppenheimer attributed the spectacular success of the scientific tradition to "the methods and cooperative character of the undertaking . . . [which have] have proven to be golden, one of the great events of human history" (Oppenheimer [1959] 1960, 8).

[27] Howard (2004) claims that this position of Einstein is also reflected in his views regarding physical theories. According to Howard, Einstein was committed to a Duhemian viewpoint of holism and underdetermination of theories. If one is so committed, then the following questions arise: "If theories are in fact underdetermined, why is it that in practice physicists are unaware of this underdetermination of theory in their day-to-day practice, and why is it that at any one time there is one prevalent theory among all the possible choices?" Though Einstein never said so explicitly, Howard suggests that the implication from his letters to Schlick and others seems to be that he believed that the apparent determination in theory choice is a consequence of physicists all being similarly socialized when becoming members of their common scientific community. What it means to be a member of such a community is being committed to making one's *initial* theoretical choices in accord with the criteria and values the community holds in common.

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Their interactions became colored by two separate considerations, one intellectual, the other political. After his own brief excursion into the field, Oppenheimer did not believe that either general relativity itself – because of lack of observational data – or quantized versions thereof – because of conceptual and technical difficulties – were areas of physics that would reward theorists' efforts. He went so far as to discourage, if not forbid people from taking up these problems while at the Institute.[28] He likewise discouraged Institute members to have contact with Einstein.[29] Their interactions were also polarized by the difficulties Oppenheimer was having with the House Un-American Activities Committee and potentially even greater ones with Joseph McCarthy's Senate committee. Oppenheimer felt under great pressure not only to dissociate himself from persons who might be considered fellow travelers, but also to insulate the Institute from charges that it was harboring such individuals. Oppenheimer thus distanced himself from Einstein, who had made his political stand and his commitment to the protection of civil liberties clear.[30]

Oppenheimer did not contribute an article to the July 1949 *Reviews of Modern Physics* dedicated to Einstein's seventieth birthday. An insight into their relationship can be gained from the exchange of letters in 1954 between Oppenheimer and Abraham Tulin. Early in 1954 Oppenheimer had been elected a member of the Board of Governors of the Technion Institute of Technology in Haifa. In August of 1953 the Technion had decided to confer honorary degrees on Albert Einstein and James Frank, and the two of them had accepted. Since neither one was able to travel to Israel to receive the degree in person Tulin, the chairman of the convocation committee, asked Oppenheimer's advice as to where to hold the convocation and "begged" his active participation in the ceremony. Oppenheimer gave a "negative reply" to the request. Even though it was decided to hold the convocation in Princeton, Oppenheimer at the last minute refused to be present at the ceremony and informed the convocation committee that he had to be out of town the day the convocation was to take place.[31] It is the case that these were difficult times for Oppenheimer. The ceremony took place in October 1954, and Oppenheimer was still reeling from the blows he had received during his encounter with the Gray Board, and from the ruling by the Atomic Energy commissioners that denied him his security clearance. But his note to the gathering is revealing. Although the printed invitation indicated that honorary degrees were to be conferred to Dr. Albert Einstein and Professor James Frank – in that order – in his message to the convocation Oppenheimer wrote: "I send my greetings to this convocation. We honor today the great contributions to science and insight

[28] Stanley Deser, IAS fellow 1954-6, personal communication, February 2002..
[29] Laurie Brown, IAS fellow 1953, personal communication, June 2006.
[30] Einstein had made headlines in the *New York Times* for his defense of individuals who had been subpoenaed to appear before Senator McCarthy's and Senator Jenner's committee, and his advocacy of civil disobedience in these matters had been deemed questionable by a *New York Times* editorial.
[31] The convocation took place on October 3, 1954, at the Nassau Inn. On September 30th Oppenheimer called the secretary of the Technion Society in New York that he could not participate and would send a message.

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we owe to Dr. Frank and Dr. Einstein. We express as well the sense of community between institutions and scholars throughout the world dedicated to the advancement of knowledge."[32]

Earlier that year, in May 1954, during his security hearing, Oppenheimer had received a request from Sol Stein, the executive director of the American Committee for Cultural Freedom (ACCF), the American branch of the Congress for Cultural Freedom (CCF) of which Oppenheimer was a member, to persuade Einstein not to attend the meeting of the Emergency Civil Liberties Committee that was to honor him on his seventy-fifth birthday. The ACCF believed that the Emergency Civil Liberties Committee was a Communist front organization. In his letter, Sol Stein had informed Oppenheimer that he had received urgent telephone calls from leaders of the American Jewish community, "who are very concerned lest Dr. Einstein be sucked into another Communist-inspired occasion. Such an occasion will again tie up Judaism with Communism . . . [and] will help to spread the notion one hears so often nowadays about scientists being political-babes–in-the-woods."[33] Oppenheimer took time out from his appearance before the Gray Board to persuade Einstein not to participate in the gathering.

It is clear that from 1947 on, with the House Un-American Activities Committee investigating his former students, Peters, Weinberg, Lomanitz, and Bohm, and thereafter with the rise of Joseph McCarthy, Oppenheimer felt under great pressure to dissociate himself from his own "left-wing" past. Einstein, on the other hand, had made his political stand clear as a matter of principle. Thus he was prominently in the news protesting the "inquisitions" of the House Un-American Activities Committee, and those of Senator McCarthy and of Senator Jenner and the Senate Internal Security Sub-committee. In December 1953, Einstein had advised Al Shadowitz, an electrical engineer working on government contracts who had helped organize the Federation of Architects, Engineers, Chemists and Technicians (FAECT) at one of IT&T's laboratories. Shadowitz had been subpoenaed by Senator McCarthy to appear before his sub-committee. Shadowitz on the advice of Einstein, instead of pleading the fifth amendment as his defense for not answering questions posed to him, pleaded the first amendment. On December 16, 1953, the *New York Times* carried a front-page photo of Shadowitz, and an article with the headline: "Witness, on Einstein Advice, Refuses to Say if He Was Red." And a few months earlier, on June 12, 1953, Einstein had again made headlines in the *New York Times* for the advice he had given to William Frauenglass, a high-school English teacher, who had been called before the

[32] JROLoC Box 256, Folder "Einstein's honorary degree, Technion 3/10/54." It is the case that in his original letter dated February 18, 1954, Tulin stated that "Professor James Frank and Dr. Albert Einstein" were to be conferred degrees. But in all the subsequent correspondence the order was Dr. Einstein and Professor Frank. Incidentally, both Niels Bohr and Isidor Rabi attended the convocation and delivered addresses.

[33] Sol Stein to JRO, March 5, 1954. JROLoC Box 32. The letter is quoted in Thorpe 2005; see his endnote 24 for further details of the incident.

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Senate Internal Security Sub-committee, and had refused to be a cooperative witness even though it meant the loss of his job. Frauenglass had written Einstein for a letter of support. Einstein complied and agreed to have the letter sent to the *New York Times*. In his letter Einstein advised civil disobedience:

> What ought the minority of intellectuals do against this evil? Frankly, I can only see the revolutionary way of non-cooperation in the sense of Gandhi's. Every intellectual who is called before one of the committees ought to refuse to testify, i.e., he must be prepared for jail and economic ruin, in short for the sacrifice of his personal welfare in the interests of the cultural welfare of his country.[34]

And Einstein was clearly ready to follow this path.

3b. Oppenheimer's eulogies for Einstein

A few days after Einstein's death on April 18, 1955, Oppenheimer wrote a eulogy for the *Packet,* the local Princeton newspaper. In it he called Einstein

> one of the great of all time. We live today with physics that he first saw in the golden twenty years from 1905 to 1925. He helped bring into being the quantum theory. . . . He made the special Theory of Relativity [and in doing] so, he changed our understanding of measurements of space and time. . . . In the general Theory of relativity he created perhaps the single greatest theoretical synthesis in the whole of science, giving us a new understanding of the universality of gravitation and a new view of the cosmos itself. Unlike most discoveries in science, Einstein's general theory could well have lain undiscovered but for his genius. (Oppenheimer 1955b)[35]

He went on to say that those who had gotten to know him could confirm that the popular image of Einstein as a simple, kindly man, "with warm humor, . . . wholly without pretense" was accurate. Einstein was always ready to help those in trouble, persistently and relentlessly called attention to the plight of the oppressed and the unfortunate. All his life he protested the abuse of power and authority. And in concluding Oppenheimer noted that

> Even above his humanity and kindliness, even above his immense analytical power and depth he had a quality that made him unique. This was his faith that there exists in the natural world an order and a harmony and that this may be apprehended by the mind of man. He left us not only the greatest contribution in evidence of that faith, but the heritage of that faith itself. (Ibid.)

[34] *New York Times* 12 June 1953. Incidentally, in an editorial on June 13 the *Times* assailed the "forces of civil disobedience" as "illegal" and "unnatural" (see Jerome 2002, 241, 247–248).
[35] JROLoC Box 256, Folder "Einstein, Albert – Article for Princ. Packet."

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The eulogy in the *Packet* was meant for the citizenry of Princeton, Oppenheimer also wrote one for the physics community that appeared on page one of the January 1956 *Reviews of Modern Physics*. He there gave a thoughtful, tender, account of Einstein's life and accomplishments. He characterized succinctly and respectfully the last few decades of Einstein's life as follows:

> With single-mindedness, he turned his attention to the discovery of what for him would have been a basic and satisfying account of the atomic nature of matter. This was the program of the unified field. Here he sought to generalize the matter-free field equations of general relativity so that they might also account for electromagnetic phenomena. He sought equations whose solutions would correspond to local aggregations of mass and charge, and whose behavior would resemble the atomic world so well described by quantum theory. He was hard at work on this program until his death. (Oppenheimer 1956)

But in private, Oppenheimer made much less complimentary statements: that Einstein had no understanding of or interest in modern physics and that he had been wasting his time in trying to unify gravitation and electromagnetism. Furthermore, Oppenheimer complained that even though the Institute had supported Einstein for twenty-five years, he did not leave any of his papers to the Institute in his will – everything was to go to Israel.[36]

Given Oppenheimer's style and commitments at the time – not to mention his personality – it is not surprising that in his letter to his brother Frank in 1935 and in his 1939 address, that Oppenheimer was critical – and in the letter scoffing – of Einstein. If in his public radio address 1939 and in his public eulogies his criticism was subdued and respectful it was vocal and explicit in the talk Oppenheimer gave in 1965 to commemorate the tenth anniversary of the death of Einstein. He accepted an invitation from UNESCO to speak in Paris and went there for just twenty-four hours to give the lecture. Oppenheimer delivered his eulogy in the evening of the first day of the colloquium, December 13, 1965.[37] He justified giving it by noting that he had known Einstein for over 30 years and that after he became the director of the Institute

[36] Laurie Brown, who was a fellow at the Institute in 1953, invited Oppenheimer to Northwestern University in 1955 for a series of lectures. These took place shortly after Einstein's death. Brown recalls Oppenheimer making these statements at a meeting with graduate students after the final lecture (L. Brown, personal communication, May 20, 2006).

[37] There were two other speakers the day Oppenheimer spoke: Ferdinand Gonseth and Julian Huxley, with Giorgo de Santillana, Gerald Holton, Werner Heisenberg, B. Kedrov, and Jean Piveteau making presentations the next day. The presence of Julian Huxley and Jean Piveteau is explained by the fact that the colloquium was to commemorate not only the tenth anniversary of the death of Einstein and the fiftieth anniversary of the theory of the general relativity but also the tenth anniversary of the death of Teilhard de Chardin. The colloquium was entitled "Science et Synthèse. Pour une connaissance de l'homme et de l'univers." Huxley and Piveteau talked about de Chardin.

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of Advanced Study in 1947 they "were close colleagues and something of friends."[38] In his presentation Oppenheimer once again addressed the issue of the relationship between individual creativity and community and made explicit some of his critical attitude towards Einstein. Thus in his opening remarks[39] he indicated that he thought "it might be useful, because I am sure it is not too soon, and for our generation it is a little too late, to start to dispel the clouds of myth [that surround Einstein's genius] and to see the great mountain peak that these clouds hide. As always, the myth has its charm; but the truth is far more beautiful."

What was true of the myth, Oppenheimer was quick to call attention to, was Einstein's extraordinary originality. "Einstein was a physicist, a natural philosopher, the greatest truly of our time." He invented quanta and he drew the consequences of the fact that no signal could travel faster than the velocity of light. Although others would surely have come to formulate the meaning of the Lorentz invariance of Maxwell's equations in the way Einstein had done and would have understood the necessity of this viewpoint also for mechanics, but, "this simple, brilliant understanding of the physics could well have been slow in coming, and blurred had he [Einstein] not done it for us." He continued, clearly having the Brans-Dicke modification of general relativity in mind:

> The general theory of relativity, which even today, may very well prove wrong, no one but he would have done for a long time.[40] It is in fact only in the last decade, the last ten years, that one has seen how a pedestrian and hard-working physicist, or many of them, might reach that theory and understand this singular union of geometry and gravitation, and we can do that today only because some of the "a priori" open possibilities are limited by the confirmation of Einstein's discovery that light would be deflected by gravity.

Oppenheimer then pointed to another facet of Einstein's works: the deep elements of tradition that were embedded in them; and by studying his readings, his friendships, his correspondence, his research notes it is possible to discover how he came to them and how they became incorporated into his work. Oppenheimer enumerated three such elements, not necessarily the only ones. One was the statistical tradition going back to Maxwell and Boltzmann who indicated the connection between the laws of thermodynamics and the mechanics of large number of particles. It was this statistical tradition that had led Einstein to the laws governing the emission and absorption of light by atomic systems. It was this that enabled him to see the connections between

[38] JROLoC Box 235, Folder UNESCO (Paris) Einstein, 12/13/65 draft.

[39] In the following unless otherwise noted the quotations are from the original unedited transcription of Oppenheimer's talk. JROLoC Box 235, Folder UNESCO (Paris) Einstein, 12/13/65 draft.

[40] Upon receiving the transcription of his address, Oppenheimer edited the statement "may very well prove wrong, no one but he would have done it for a long time" to read "is not well proved experimentally, no one but he would have done it for a long, long time" which is what appears in the version published in the *New York Review of Books* (Oppenheimer 1966).

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photons, Wein's law and Planck's law and later on to see the relevance of the statistics of light quanta proposed by Bose.

The second was Einstein's "total love of the idea of a field and the following of physical phenomena in minute and infinitely sub-dividable detail in space and time. . . . It was this which made him see[41] that there had to be a field theory of gravitation, long before the clues to that theory were securely in his hand."

The third element was a philosophic one, which Oppenheimer characterized as a "form of the principle of sufficient reason." He pointed to Einstein asking for care when stating what we mean, asking for exactitude about what we can measure, and for clarity about what elements in physics are conventions. For it was Einstein who recognized and insisted that conventional elements could have no part in the real predictions of physics. Oppenheimer believed that this element followed from the long tradition of European philosophy

> starting with Descartes . . . leading through the British empiricists, and very clearly formulated, though probably without any influence in Europe, by Charles Peirce, a rather erratic American philosopher, that one had to ask how do we do it, what do we mean, is this just something that we can use to help ourselves in calculating, or is it something that we can actually study in nature by physical means? And the point is that the laws of nature not only describe the results of observations, but the laws of nature determine the scope of observations.

But, Oppenheimer went on, during the last twenty five years of Einstein's life, the years he spent at Princeton, in a certain sense his tradition failed him. "And this though a source of sorrow, should not be concealed. He had a right to that failure. [He] spent those years first in trying to prove that the quantum theory had inconsistencies in it" – and Oppenheimer continued "no one could have been more ingenious in thinking up devilish examples"[42] but the inconsistencies were not there – and eventually Einstein could only say that he didn't like the theory, that he didn't like the abandonment of continuity and of causality. "[T]o see them lost, even though he had put the dagger in the hand of the assassin by his own work, was very hard on him." He also struggled with an ambitious program to amalgamate the understanding of electromagnetism and gravitation in such a way as to explain "what he regarded as the semblance – the illusion – [43] of discreteness of particles in nature. . . ." But, Oppenheimer averred,

> I think that it was clear then, and believe it to be obviously clear today, that the things that this theory worked with were too meager, left out too much that was known to physicists but had not been known in Einstein's student days. Thus it looked like a

[41] Later edited to "it is this tradition which made him know that there had to be a field theory of gravitation. . ."
[42] Later edited to "no one could have been more ingenious in thinking up ingenious unexpected and clever examples."
[43] "– the illusion –" was added upon editing the transcription.

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> hopelessly limited and historically rather accidentally conditioned approach. Although Einstein commanded the affection, and that's not strong enough a word, the love of everyone for his determination to see through his programme, he lost contact with the profession of physics, because there were things that had been learned which came too late in life for him to learn them. (Oppenheimer 1966, 5)

Oppenheimer then commented that Einstein was in an important way "alone" and "lonely"[44] – though a deep and loyal friend,

> the stronger human affections played not a very deep or central role in his life taken as a whole. . . [H]e did not have in the technical jargon, a school. He did not have very many students who were his concern as apprentices and disciples. In later years, he had people working with him. They were typically called assistants. . . [and] did one thing which he lacked thoroughly in his young days. His early papers are paralyzingly beautiful but they are thoroughly corrupt with errors, and this has delayed the publication of his collected works for almost ten years. A man whose errors can take that long to correct is quite a man. (Oppenheimer 1966, 5)

Oppenheimer then elicited laughter in the hall when he commented that Einstein's fame gave him some very great pleasure, meeting people, but in particular of playing music not only with Queen Elizabeth of Belgium, "but what was more with Adolphe Busch, for he wasn't that good a violinist."

In the rest of his lecture, the tone changed. Oppenheimer extolled Einstein for his goodwill and humanity, for his ever present concern for not doing harm and described Einstein's attitude toward human problems by the Sanskrit word *Ahinsa*, meaning not to hurt, harmlessness. He commended him for his consequential stand against violence and cruelty wherever he saw it "and after the war he spoke with deep emotion and I believe with great weight about the supreme violence of . . . atomic weapons" and the need to "now make a world government."

Oppenheimer's concluding sentence – "In his last years, as I knew him, Einstein was a twentieth-century Ecclesiastes saying with unrelenting and indomitable cheerfulness 'Vanity of Vanities, all is Vanity'" – indicated, on the one hand, his empathy with Einstein who early on had come to appreciate "the nothingness of the hopes and strivings which chase most men restlessly through life." On the other hand, it reflected the fact that both of them had accomplished tasks at the limit of human capabilities and had received a commensurate degree of fame. And both had to confront their inability to match these heights thereafter, yet seeking what turned out to be futile ways to attempt to do so. As Einstein had once told Oppenheimer "You know, when it once has been given to a man to do something sensible, afterwards life is a little strange."

[44] Frank Jotterand, "Oppenheimer" in the *Gazette de Lausanne,* December 18–19, 1965, p. 25.

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Oppenheimer's talk had immediate repercussions. On the following day, the *New York Times* published a story headlined "Oppenheimer View of Einstein Warm But Not Uncritical." Although the article began with the statement that a warm and admiring but not uncritical portrait of Albert Einstein was drawn by Oppenheimer for an audience of about one thousand, the rest of it highlighted Oppenheimer's most critical statements: that "Einstein's early work was paralyzingly beautiful but full of errors" and that their correction had delayed the publication of Einstein's collected work by ten years: "A man whose errors take ten years to correct is quite a man"; that Einstein founded no school and that he did not have many students; that he did not play a vital role in the development of the atomic bomb; and that his letter to president Roosevelt in which he sought to make him aware of the possibility of a fission bomb "was not important."

Upon reading the *Times* article, Pais wrote him saying euphemistically that it made him "slightly uncomfortable."[45] In a note he sent to various friends, Oppenheimer attached a copy of the full text of his speech, and indicated that a number of his colleagues "suggested that I had been out of my mind" after reading the *Times*' coverage of his address.[46] Word that Helen Dukas was deeply upset by what she had read of Oppenheimer's talk in the *Times* must have reached him. He thereafter wrote her saying that "When I saw the story in the *New York Times* last month I shuddered for you." With his note he enclosed his edited version of the talk and added disingenuously, "I hope that this [the edited version], which is what I did say, will seem closer to the truth, and more welcome."[47]

The views that Oppenheimer had expressed in Paris were widely disseminated. The *Gazette de Lausanne* gave the story extensive coverage. The *Nouvel Observateur* translated Oppenheimer's speech verbatim and printed it in the 22 December issue. Gerard Bonnot a reporter for *L'Express* interviewed him after his lecture – while Oppenheimer was drinking some whisky – and *L'Express* devoted a page of its December 20–26 issue to their exchange. The views Oppenheimer expressed during the interview were even sharper than in the lecture:

> During all the end of his life, Einstein did no good [Einstein n'a rien fait de bon]. He worked all alone with an assistant who was there to correct his calculations. . . He turned his back on experiments, he even tried to rid himself of the facts that he himself had

[45] Abraham Pais to JRO, December 20, 1965. JROLoC Box 285, Folder "UNESCO-Einstein Correspondence."
[46] JROLoC Box 285, Folder "UNESCO (Paris) Einstein, 12/13/65 draft."
[47] JRO to Helen Dukas, December 20, 1965. JROLoC Box 285, Folder "UNESCO-Einstein Correspondence." The "edited" version was published in the March 17, 1966 issue of the *New York Review of Books (NYRB)*. The photographer, Philipe Halsmann, whom Einstein had helped escape from Germany in 1940, was furious upon reading Oppenheimer's article and wrote an angry letter to the *NYRB*. The toned down version, which was published in the May 26, 1966 issue, began with the statement "The beautifully phrased and delicate venom of Dr. Oppenheimer's 'tribute' to Professor Einstein [Mar. 1] distressed me deeply." See also C.N. Yang's Remarks at the dedication of the Einstein Stamp, March 14, 1966, and the Commentary thereupon in Yang 2005, 61–62.

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> contributed to establish . . . He wanted to realize the unity of knowledge. At all cost. In our days, this is impossible.

But interestingly, Oppenheimer stated that "he was convinced that still today, as in Einstein's time, a solitary researcher can effect a startling [foudroyante] discovery. He will only need more strength of character [force d'âme]." Bonnot concluded his interview by asking Oppenheimer whether he had any regrets? Any nostalgia? A smiling Oppenheimer, answered "Of course, I would have liked to be the young Einstein. This goes without saying."

4. Roots and tradition

Simone Weil perceptively noted that

> To be rooted is perhaps the most important and least recognized need for the human soul. It is one of the hardest to define. A human being has roots by virtue of his real, active and natural participation in the life of a community which preserves in living shape certain particular treasures of the past and certain particular expectations for the future. This participation is a natural one, in the sense that it is automatically brought about by place, condition of birth, profession and social surroundings. Every human being needs to have multiple roots. It is necessary for him to draw wellnigh the whole of his moral, intellectual and spiritual life by way of the environment of which he forms a natural part. (Weil 1952, 41)

In contrast to Einstein, for whom roots without the communal aspects became sufficient, the rootless Oppenheimer was always in need of a community.

Both Einstein and Oppenheimer were born into an emancipated, non-observant Jewish family. The nature of Einstein's ties to Judaism and to Jewish culture has often been told (Stachel 2002; Jammer 1999) and I need not repeat it here. However, I want to point to the interaction of the young Albert with Gustav Maier which I believe was deeply influential and which points to a commonality with experiences of Oppenheimer. Gustav Maier was a friend of the Einstein family in Ulm and an avuncular figure to the young Albert. He was the manager of the Ulm branch of the Deutsche Reichbank until 1881, at which time he moved to Frankfurt am Main to become the manager of Reichbank branch there. Before leaving Ulm he published a little pamphlet entitled "Mehr Licht! Ein Wort zur 'Judenfrage' an unsere christlische Mitbürger" in which he defended both Reform Judaism and socialism against the charges of hostility to Christianity. In 1886 he was one of the founders of the Frankfurt Peace Union. In 1891 he withdrew from the business world, moved to Switzerland, and devoted himself to writing on social and economic issues. By virtue of common political leanings and cultural interests he and Jost Winteler met and became good friends. Both of them helped found the Swiss Ethical Culture Society

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in 1896 and Maier became the editor of its publication until 1919. It was he who helped the young Albert, whom he considered a Wunderkind, obtain permission to take the ETH entrance examination required of applicants without a secondary-school certificate (see Einstein 1987-, 10–14). It was also he who arranged Albert's stay with the Winteler family in Aarhau for him to complete his high school education. Albert often visited Maier while he was a student at the ETH from 1896 till 1900. In 1898 Maier published a very influential book entitled *Soziale Bewegungen und Theorien bis zu modernen Arbeiterbewegung* that went through nine editions. This book is remarkable in that in nine chapters and a little less than 150 pages it gave a succinct account of communism, socialism, and anarchism, narrated the genesis and evolution of the Egyptian, Babylonian, Chinese, Japanese civilizations, described the platonic state, the Roman empire, the utopian vision of Thomas More, gave a historical overview of feudalism, the Reformation, the Peasant Wars, Luther, and from there to Colbert, mercantilism, and Turgot. The final three chapters covered the Industrial Revolution, the economic theories of Adam Smith, Ricardo, Malthus, the colonial, political and social policy of England, and presented the views and accomplishments of Lasalle, Friedrich List, and other socialists of the first half of the nineteenth century, paying special attention to Saint-Simon and the Saint-Simonians, Fourier, Cabet, and Robert Owen. The last chapter was devoted to Wilmhelm von Humboldt's views of the state, socialism, Proudhon, and Karl Marx and concluded with a "Ruckblick und Ausblick" in which he commended the communotarian form of socialism to which he was committed.

It was probably Maier and Winteler who planted the seeds of socialism in Einstein – and Einstein repeatedly made his own commitment to socialism well known.[48] Nor were his ties to Maier and Winteler, and theirs to the Ethical Culture Society forgotten as evidenced by the fact that he wrote a message to be read at the celebration of the 75th anniversary of the founding of the Ethical Cultural Society in January 1951.[49]

As is well known, Oppenheimer had been educated at the Ethical Cultural School. In many ways it was a parallel development to the Social Gospel movement of American Protestantism, a response to dismal conditions of the lower classes brought about by industrialization and urbanization in the last third of the nineteenth century. Walter Rauschenbush and the other theologians of that movement believed that the primary message of the Gospels was a call for social justice and that individual salvation was to be achieved through works for the good of society. Like these theologians, Felix Adler, founder of the Ethical Culture Society, supported and worked for the rights of workers to a decent wage, safe working conditions, and good schools for their children. Part of Oppenheimer's experience at the Ethical Culture School was attending school with the children of workers, and while in high school visiting and working in the settlement

[48] See, for example, his article "Why Socialism" (Einstein 1954, 151–158).

[49] Two years earlier Robert Oppenheimer had been the principal speaker at the installation of Richard Boyd Ballou as director of the Ethical Culture School in Riverdale.

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houses in lower Manhattan. However, in the United States the Ethical Culture Society, its support coming from emancipated middle- and upper-class Jews, never formed ties with socialism. And in contrast to the Germany of Bismarck in which Einstein grew up, to the Switzerland[50] he matured in, to the Austrio-Hungarian empire in which he got his first full professorial appointment, and to Weimar Germany, all harboring covert – and at times explicit – anti-Semitism, all of them maintaining barriers to the integration of Jews into the social and cultural life of the country, Oppenheimer grew up in the United States at a time when the notion of the melting pot had wide currency – at least for the Caucasian component of the population. Identifying as an American meant identifying with the aspirations of the most successful experiment in democracy until that time. It demanded solidarity with other Americans and a commitment to make the United States a better nation for everyone. The priority in how one identified oneself, whether first as an American and then as a Protestant of a given denomination, posed no problems for these citizens for they could think of the United States as a Christian nation. The situation was somewhat more difficult for Catholics, who were seen as owing some of their allegiance to the Vatican, and even more so for Jews. Oppenheimer in his professional life did overcome the discrimination against Jews that existed in the elite American universities – Harvard, Princeton, Yale, Cal Tech. However, for Oppenheimer to identify himself as an American Jew presented a conflict which he found difficult to resolve as a teenager, and which lingered on in adulthood. Recall that when the young Oppenheimer was recuperating from a severe case of dysentery his parents had asked Herbert Smith, his remarkable English teacher at the Ethical Culture School who became a sort of surrogate parent to Robert, to accompany him on a trip to the Southwest of the United States. Smith later told Alice Kimball Smith and Charles Weiner that he became aware of "how deeply Robert felt the fact of being Jewish when he asked to travel west as Smith's brother." And his close friend from the Ethical Culture School, Francis Fergusson, believed that for Robert going to New Mexico was partly to escape from "his Jewishness and his wealth, and his eastern connections" (Smith and Weiner 1980, 9). Oppenheimer did not escape from these tensions at Harvard, as indicated by the fact that Percy Bridgman, his thesis adviser, when writing a letter of recommendation for him to go work with Rutherford at the Cavendish, felt compelled to add a final paragraph referring to the candidate's

[50] Recall the statement of the faculty report recommending Einstein's appointment to the faculty of the University of Zurich in 1909: "[The] expressions of our colleague Kleiner, based on several years of personal contact, were all the more valuable for the committee as well as for the faculty as a whole since Herr Dr. Einstein is an Israelite and precisely to the Israelites among scholars are ascribed (in numerous cases not entirely without cause) all kinds of unpleasant peculiarities of character, such as intrusiveness, impudence, and a shopkeeper's mentality in the perception of their academic position. It should be said, however, that also among the Israelites there exist men who do not exhibit a trace of these disagreeable qualities and that it is not proper therefore, to disqualify a man only because he happens to be a Jew. . . . Therefore neither the committee nor the faculty as a whole considered it compatible with its dignity to adopt anti-Semitism as a matter of policy. . ." (quoted in Pais 1982, 185–6).

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Jewish background: "As appears from his name, Oppenheimer is a Jew, but entirely without the usual qualifications of the race. He is a tall, well set-up young man, with a rather engaging diffidence of manner, and I think you need have no hesitation whatever for any reason of this sort in considering his application" (ibid., 77).

Nor was the atmosphere at Berkeley and at Cal Tech free from anti-Jewish prejudice. Even after the war, when Oppenheimer was intent on leaving Berkeley and was considering going to Cal Tech full-time he could write to Charles Lauritsen

> I proposed twice getting Rabi to the [Cal Tech] institute thinking a good thing generally, and for us in particular a great source of strength. Has this fallen through? If so, is it lack of money, is it reluctance to add another jew to the faculty, is it a general feeling that he would not fit in? (Ibid., 299)

Had the Oppenheimers lived in Germany or Austria they might have converted and thus open the channels of upward mobility to their sons. This is what the Peierls, the Weisskopfs and other liberal, emancipated Jews, had done. But Oppenheimer was born in the United States where conversion was a less frequently traveled road; one, had he taken it, that would presumably have been painful to his parents. In any case, Ethical Culture was to provide an outlet for these inner tensions, but it clearly did not do so for the young Robert.

Identification as a member of the Ethical Culture Society proved not to be an escape from being identified as a Jew. Moreover, Oppenheimer had found its ethical messages somewhat shallow. When he was seventeen, he wrote a jingle for his father's birthday, teasing him for having "swallowed Dr. Adler like morality compressed." After Oppenheimer left the Ethical Culture School and went to Harvard (1922–25), he began seeking a more satisfying approach to religious thought in the Hindu classics, albeit in English translation. When Isador Rabi met him in Germany him in 1929, it seemed to Rabi that Oppenheimer was more interested in those literary works than in physics.

It should be mentioned that Einstein too had an affinity to Hindu thought with which he first became acquainted through his readings of Schopenhauer.[51] I will here only indicate one of its manifestations: the striking way that Einstein holds his thumb and index finger together in his pose at the 1911 Solvay Congress (fig. 1) and later in a photograph taken in 1942 (fig. 2). It is the way that Vishnu, and later the Buddha, are represented in many of the sculptures of them: their thumb and forefinger are joined, in what is called the vitarka gesture, the sign for compassionate teaching. In a later Buddhist tradition, the joining of the thumb and forefinger also symbolizes the uniting of method and wisdom.

[51] See Howard 1997 for a convincing presentation of the Schopenhauer's extensive influence on Einstein.

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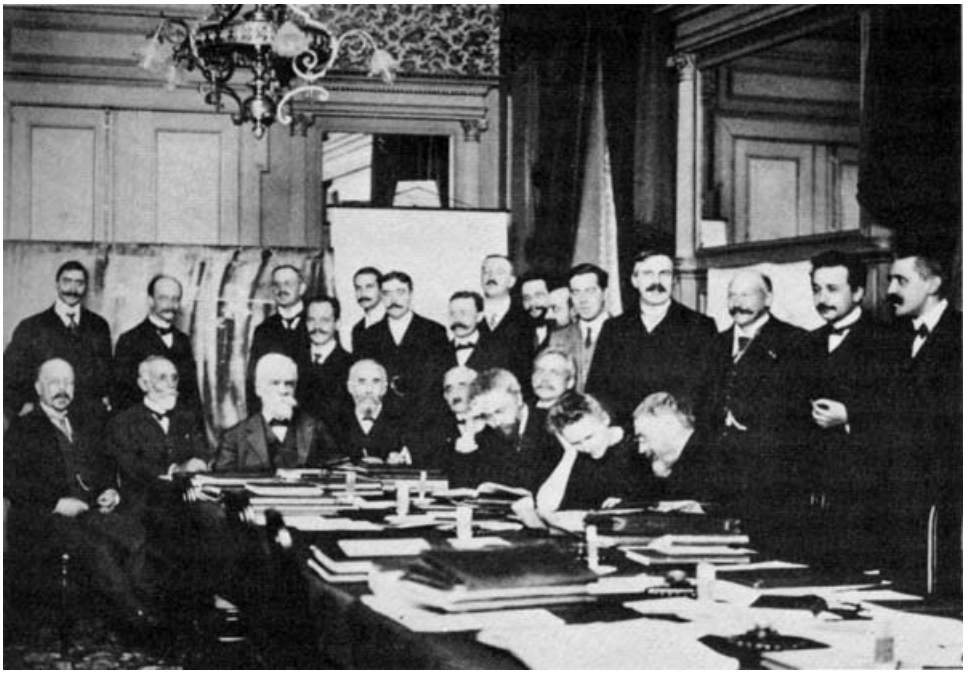


Fig. 1. Photograph of participants taken at the 1911 Solvay Congress. Courtesy the Jerusalem Einstein Archives.

Oppenheimer had acquired a deep knowledge of the *Bhagavad-Gita*[52] in 1933 when, as a young professor of physics at Berkeley with interests ranging far beyond his academic specialty, he studied Sanskrit with Arthur W. Ryder. The *Gita*, Oppenheimer excitedly wrote to his brother, was "very easy and quite marvelous." This is the earliest direct evidence of the impression the book made on Oppenheimer, and it was a lasting impression. Later he called the Gita "the most beautiful philosophical song existing in any known tongue." He kept a well-worn copy of it conveniently on hand on the bookshelf closest to his desk and often gave the book (in translation) to friends as a gift. He continued to browse in it while directing the bomb laboratory. After President Franklin Roosevelt's death in April 1945, Oppenheimer spoke at a memorial service at Los Alamos and quoted a passage from the *Gita*. This ancient book was evidently on his mind as the atomic bomb neared completion, even before he saw the dazzling fireball from the Trinity test. In later years, too, he would look back on the *Gita* as one of the most important influences in his life. In 1963, the *Christian Century* magazine asked him to list the ten books that "did most to shape your vocational attitude and

[52] The *Bhagavad-Gita*, whose title can be translated as the "Song of the Lord," is a masterpiece and monument of Hinduism. One expert called it the most important single text for Hindu religion.

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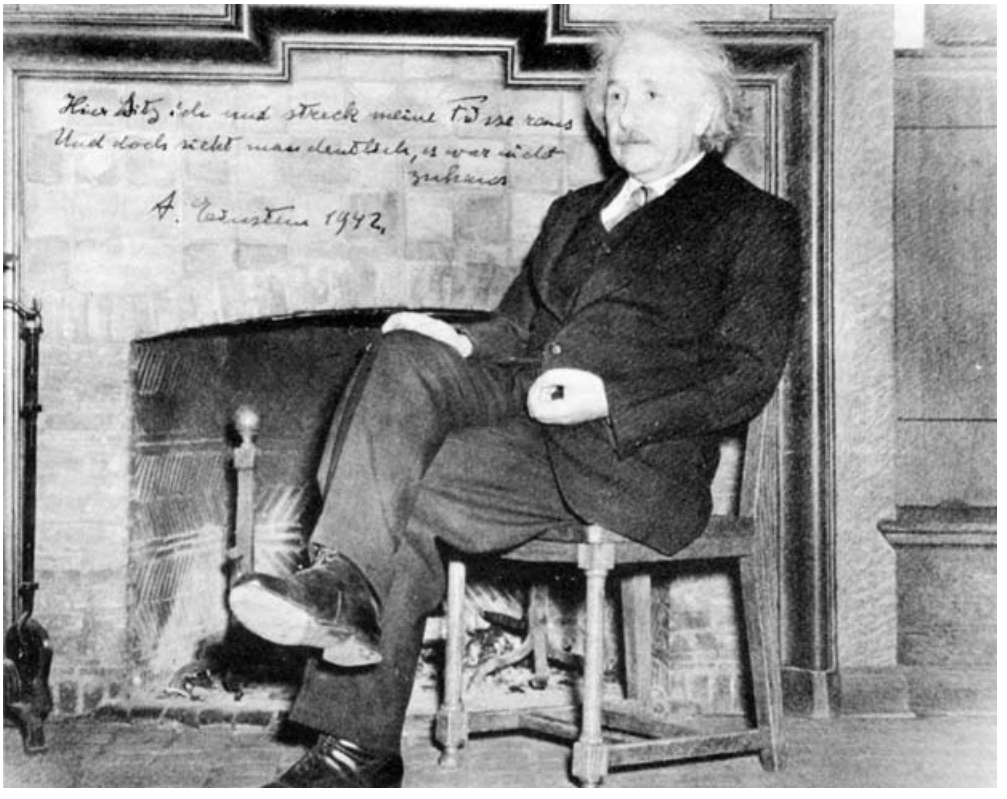


Fig. 2. Photograph of Einstein in 1942. Courtesy the Jerusalem Einstein Archives.

your philosophy of life." Along with Shakespeare's *Hamlet* and Eliot's *Waste Land*, Oppenheimer listed the *Gita*.[53] But it is not clear to what extent Sanskrit, the *Gita*, and other Hindu texts were also a mechanism to distance himself from his Jewish roots.

And in contrast to Einstein's relationship to Spinoza and Schopenhauer, whose *Ethics* and *Aphorisms* Einstein delighted in, and whose comportment in life became models for Einstein's own, I do not believe that after Los Alamos Oppenheimer found a similar anchor in the *Gita* and the actions of Arjuna. Einstein had first studied Spinoza's *Ethics* with his friends of the Olympia Academy, Besso and Solovine, while in Bern employed at the patent Office. On several occasions Einstein indicated that he had studied Hume's *Treatise of Human Nature* "with fervor and admiration shortly before the discovery of the theory of relativity" and added that "[I]t is very well possible that without these philosophical studies I would not have arrived at the special theory of relativity" (Seelig 1954, 67). We do not know whether it was Hume's, perhaps ironic,

[53] See Hijiya 2000 for a detailed exposition of the relation of Oppenheimer to the Gita.

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characterization of Spinoza's "doctrine of the simplicity of the universe, and the unity of its substance, in which he supposes both thought and matter inhere" and that it was a "hideous hypothesis" that made Einstein turn to Spinoza. In any case his first reading of Spinoza's *Ethics* dates from that time.[54] He evidently resumed these studies several years later (see Jammer 1999, 42 ff.). By 1920, the philosopher whom Einstein admired most was Spinoza.[55] Leo Szilard relates that he studied Spinoza's *Ethics* with Einstein in the early 1920s (Lanouette 1992). Jonathan Israel in his masterly *Radical Enlightenment* stresses "the unity, cohesion, and compelling power of Spinoza's system, surely a feature that Einstein would resonate with." Some have suggested that Einstein's radical reductionism has its origin in Spinoza's view that "there can be but one substance and therefore but one set of rules governing the whole of reality which surround us and of which we are part" (Israel 2001, 231), and similarly, that his commitment to strict determinism derives from Spinoza's Proposition XXIX of part I of the Ethics, that "in nature there is nothing contingent, but all things have been determined from the necessity of the divine nature to exist and produce an effect in a certain way." Moreover, "things could have been produced by God in no other way, and in no other order, than they have been proposed" [I, Prop. XXXIII].

The parallel between Einstein's comportment and way of life, particularly after 1930, with that of Spinoza has been commented upon in the past.[56] To this should be added the similarity of their political acuity. Recall for example, Spinoza's analysis of Cromwell's regime in the *Tractacus Theologico-Politicus* (Israel 2001, 167), and Einstein's analysis of militarism written shortly after the end of WWII. While giving up his religious affiliation with Judaism, Einstein, like Spinoza, nurtured his Jewish roots and identified as a Jew as a member of the cultural Jewish tradition, the tradition being the bond that held the community together. Oppenheimer too gave up his religious affiliation with Judaism, but in addition uprooted himself from the Jewish tradition. Perhaps he hoped to find with the *Gita* the possibility of planting new roots and to obtain some measure of solace in adopting aspects of the Hindu tradition.[57]

[54] See Israel 2001 for an outstanding account of Spinoza's philosophy as well as his role in shaping the Enlightenment.

[55] Incidentally, in 1920 Einstein composed a poem entitled "Zu Spinoza's Ethik" whose first stanza goes: "How do I love this man?/ More than I can express in words./ Nonetheless I fear that he remains alone/With his shining holy halo."

[56] See in particular Paty in Grene and Nails 1986, 267–302; Jammer 1999; and Holton 2004.

[57] It is interesting to note that both Spinoza and the *Gita* formulate a strictly deterministic system. James Hijiya has suggested that Oppenheimer was deeply influenced by three tenets of Hinduism: duty, fate, and faith. Hijiya believes that Oppenheimer thought that [at Los Alamos] he had a job to do; that he should do it because it was his job and not because he was intent on self-aggrandizement; and that following these principles would bring a measure of serenity into his tormented existence. In his Introduction to his translation of the *Gita* James W. Ryder summarized the song as follows: "The great epic relates the events of a mighty struggle between two families of princely cousins, reared and educated together. In manhood they quarrel over the royal inheritance, and their difference is sternly solved by war." As the epic opens, Prince Arjuna, whose courage and skill at archery had been displayed in previous battles, rides his chariot onto the battlefield and recognizes in the enemy

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I believe that Einstein's willingness to identify himself as a Jew, to be active in the support of Zionism, to readily and openly discuss his religious beliefs annoyed, if not exasperated, Oppenheimer. Oppenheimer's need for community manifested itself particularly strongly in his political activities during the 1930s. As Nathan Glazer has pointed out, by wholeheartedly committing himself to the activities of the left, Oppenheimer became a member of a community based on a faith in which everyone was equal. It allowed him to shed the limitations of his social world and to "join a fraternity that transcended the division of the world. This was the attraction of Communism for many Jews who no longer thought of themselves in any way as Jewish. And for many, faith remained stronger than interest." Perhaps Haakon Chevalier was right when he observed that

> The fervor that Opje displayed in all his political activity, the importance he attached to it, were, I think we all felt – those of us who were "on the inside" – a projection of an exceptional, almost anguished concern with the fate of man, both individually and in the large. . . . This was the "Hebrew prophet" side of his nature (which co-existed with, and never quite obliterated) the . . . sophisticated, worldly side. (Chevalier 1965)

The need to distance himself from being Jewish intensified Oppenheimer's nationalism. Identifying himself as an American was the one continuous, constant aspect of Oppenheimer's changing identities. Thus, making American physics on par and better than anywhere else was part of his mission when building his school of theoretical physics at Berkeley during the 1930s. As he was to say after the revocation of his clearance, what was so difficult for him was the fact that it was the country he loved so much that had done this to him.

Oppenheimer's nationalism sheds light on his comportment during World War II. In October 1941, after it had become clear through the work of Otto Frisch and Rudolf Peierls in England that atomic bombs could be assembled, Roosevelt gave the go-ahead to develop atomic bombs to Vannevar Bush and James Conant. On that occasion Bush and Conant signed an agreement that delegated all authority on atomic policy and the use of atomic bombs to the President or his delegated officers. Roosevelt named Secretary of Agriculture Henry Wallace, Secretary of War Henry Stimson, General George Marshall, and Bush and Conant as his delegates and they constituted the General Policy Group that was to make all the policy decisions. This transformed the up-to-then atomic bomb project from a civilian one that had been

ranks his own relatives, teachers and friends. Perplexed and distressed by the prospect of killing people close to him, he refuses to fight. But he is willing to take counsel from his charioteer, Krishna, an avatar of Vishnu, who has assumed the incarnation of a man. In their exchange, which takes up eighteen chapters, Krishna enlightens Arjuna as to why he should join the battle. Krishna tells Arjuna that since he is a soldier, it is his duty to fight. Furthermore, it will be Krishna, and not Arjuna, who will determine who lives and who dies, and Arjuna "should neither mourn nor rejoice over what fate has in store but should be unattached to such results. Finally, the most important thing is devotion to Krishna" (Hijiya 2000, 131).

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supported and controlled by the NRDC to a military weapons project under military command with a Military Policy Committee (composed of Bush and Conant and a representative from the army and one from the navy) empowered to issue orders to military commanders for the implementation of atomic weaponry policy.

Oppenheimer was always aware of this agreement and accepted its scope. De facto the Met Lab at Chicago, Los Alamos, Oak Ridge, and Hanford were military establishments – and Oppenheimer was ready to accommodate to this reality and don with relish the uniform of an Army officer. The scientists working at these installations were technicians. As General Leslie Groves was to assert at Oppenheimer's trial: "Dr. Oppenheimer was used by me as my adviser . . ., not to tell me what to do. . . . We [General Nichols and I] were responsible for the scientific decisions" (quoted in Oppenheimer 1956b, 164). Oppenheimer was always consistent in his assessment of the role he played as director of Los Alamos during the war. Thus the following exchange took place in 1964 following a lecture by Oppenheimer in Geneva:

> van Camp: If you had foreseen the present situation in the world, would you have dared start the researches that led to the atomic bomb?
>
> JRO: My role was very more modest. . . . My role was to preside over an effort, to make, as soon as possible, something practical. But I would do it again.
>
> . . .
>
> Weisskopf: I would like to address Mr. Oppenheimer in a different fashion. Given what has happened these past twenty years, would you in the position you were in 1942,would you again accept to develop the bomb?
>
> RJO: To this I have answered yes. . . An assistant: Even after Hiroshima? RJO: Yes. (Oppenheimer 1956a)

Whatever he did as an adviser to the government and as a public intellectual in the post World War II period were likewise imbued with a nationalistic feeling: he always meant to transform the potentialities the United States possessed by virtue of its wealth, its institutions, its know-how into realities for making this a safer and better world.

His identity as an "American" was manifested in many ways. His love of the grandeur of the New Mexico mesas, of horseback riding exploring the wilderness near his ranch, Pero Caliente, his cars and his reckless driving, and his dangerous sailing habits are all part of this fashioning of himself. But he was also an intellectual and like many earlier American intellectuals he distrusted the American city. Like Jefferson, one of his heroes, William James, John Dewey, to name but a few, he reacted critically to the American city (see White 1973). When in 1949 Ralph Lapp considered the planning of future decentralized population centers since atomic warfare was a real possibility he exemplified these with maps of a "satellite city," a "doughnut city," and a "rodlike

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city" (Lapp 1949, 162–4). Oppenheimer's metaphors always alluded to villages, never to cities.

5. Philosophy

I have indicated some of the factors that might have motivated Oppenheimer in making his critical public statements regarding Einstein, particularly at the UNESCO conference. But I believe there is an additional reason for the sharpness of some of his remarks. Einstein was not only a great physicist, but also an extremely influential philosopher of science. Oppenheimer had aspired to make a mark as a philosopher – but failed – and his philosophical stance was deeply at variance with Einstein's.

The drive towards "unity" was a constant in all that Einstein did, as though he had adopted the Heraclitean saying "What is wise is one" as a guiding principle. A much-cited letter to his friend Marcel Grossmann in 1900 when they both still were students at the ETH stated: "It is a glorious feeling to recognize the unity of a complex of phenomena, which appear to direct sense perceptions as quite distinct things" (quoted in Holton 1998a, xxxi). His philosophical commitment to unity extended beyond science. It was an integral part of his "cosmic religion" and according to Don Howard a manifestation of the influence that Buddhism and Schopenhauer had had on him (Howard 1997). Howard characterizes the heart of Schopenhauer's philosophy as the idea "that human individuality is a kind of illusion." The momentary overcoming of one's individuality, the recognition of "the futility of human desires and aims," the glimpse into the "sublimity and marvelous order which reveal themselves in nature and in the world of thought, the experience of the universe as a single significant whole" – all these are, for Schopenhauer, marks of "the way genius[58] apprehends the world" (ibid., 97). So in fact Einstein put it in a letter he wrote in 1950 to a grieving father who had lost a beloved son to illness:

> A human being is a part of the whole, called by us "Universe", a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest – a kind of optical delusion of his consciousness. The striving to free oneself from this delusion is the one issue of true religion. Not to nourish the delusion but to try to overcome it is the way to reach the attainable measure of peace of mind.[59]

[58] "Genius is the ability to leave entirely out of sight our own interest, our willing, and our aims, and consequently to discard entirely our own personality for a time, in order to remain *pure knowing subject,* the clear eye of the world; and this not merely for moments, but with the necessary continuity and conscious thought to enable us to repeat by deliberate art what has been apprehended, and what in wavering apparitions gleams fix in its place with thoughts that stand forever" (Schopenhauer, *Parerga und Paralipomena*, quoted in Howard 1997, 97).

[59] Einstein to Robert S Marcus, of the World Jewish Congress, dated February 12, 1950, AEA 60–424. Einstein's German draft is AEA 60–425.

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If unity, the search for a final theory that would fix all the constants of nature, and a deep awareness of what constituted his "self" were an integral aspect of Einstein's temperament and personality, Oppenheimer could never fashion a sense of self for himself. After 1947 three somewhat disparate personae coexisted in him: the scientific – as a professor of physics at the Institute; the intellectual – as the director of the Institute; the cultural and political – until 1954 as the most influential civilian adviser on military and political matters to the US government and after 1954 as a leading member of the Congress for Cultural Freedom (Thorpe 2005, 293–314).

Starting in the 1950s in his role as a public intellectual Oppenheimer decried the specialization that was occurring in the physical sciences, in the social sciences, in the arts and the humanities, and the consequent fragmentation of culture at large. For Oppenheimer, as for Einstein, communities were bastions that were to safeguard the sense of belonging and of interdependence. For Einstein, Bildung and tradition were to be the bonds that held them together (see Holton 1998b). But Oppenheimer was not as clear as Einstein as to what was to constitute the glue that held communities together. At the personal level, the physics community was special to Oppenheimer because his mastery of physics had been his anchor in integrity. Before 1954 he had had high hopes for the Institute for Advanced Study as a community. He had attempted to overcome the divide and the barriers between the different disciplines and the different intellectual communities that had a home there by trying to engage them in dialogue. He had hoped that dialogue would establish and cement bonds that would enable the institution to flourish as a collective.

After 1954 with the revocation of his clearance and the deep wounds of his "trial," for Oppenheimer communities became defensive enclaves against the onslaught of the growth of knowledge, and against the pervasive intrusion of mass media in all aspects of culture. Thus in the Columbia Centenary convocation in the fall of 1954 the picture of the world he adumbrated was bleak:

> This is a world in which each of us, knowing his limitations, knowing the evils of superficiality, will have to cling to what is close to him, to what he knows, to what he can do, to his friends and his tradition and his love, lest he be dissolved in a universal confusion and know nothing and love nothing. (Oppenheimer 1955a, 144)

And he would counsel his audience that

> If a man tells us that he sees differently than we, or that he finds beautiful what we find ugly, we may have to leave the room, from fatigue or trouble; but that is our weakness and our default. If we must live with a perpetual sense that the world and the men in it are greater than we and too much for us, let it be the measure of our virtue that we know this and seek no comfort. (Ibid.)

But in time he recovered some of his composure and attempted to take on more fully his role as a public intellectual. As he had done previously in his position regarding the interpretation of quantum mechanics and in his views regarding the control of atomic

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weapons he drew on Bohr's viewpoints. In some aspects Oppenheimer's philosophy could be characterized as more Bohrian than Niels Bohr himself – and thus very different from Einstein's. Like Bohr, he hoped that the notion of complementarity, when applied outside of physics, might reveal an underlying simplicity in areas where outward appearance revealed only complexity. In 1957 he had been invited to deliver the William James Lectures at Harvard, and he invested a great deal of time in their preparation. What he hoped to accomplish in them can best be understood as trying to make sense of, and come to terms with the constantly accelerated, seemingly exponential growth of knowledge, and finding meaning in this new world. The lectures were Oppenheimer's attempt to attain, he said, "as unified, consistent and complete an outlook" as was possible, given what he had learned from recent archeological and historical studies; from some of the social sciences and economics; from the psychology of perception and learning; from advances in logic, i.e., from Gödel's incompleteness theorem; and from physics when it had reconciled, on the basis of Bohr's complementarity principle, the seemingly contradictory aspects of the description of the atomic world.

In particular, Oppenheimer wanted to make clear our cognitive predicament that specialization and the pace of new knowledge creation had brought about. He described it as follows:

> the fact that there is a great deal to know; that it is not well ordered; that it does not follow from a few comprehensible principles; that it is offered to us in diverse tongues; that it is shared by rather small groups of very specialized people; that it is growing apace; and that we do not know very much of it.[60]

Oppenheimer did believe that there was an order, a unity to the world, but it is not a "closed, or global, or architectonic unity, but rather, [as William James had put it] that of a network, a reticular unity."[61] And he made explicit his high regard for James: "[I] admire James," he said, "because he fought against limitation and preconception; against the applicability of ideas from which specifics could be deduced; against certitude, against doctrine, against system."[62]

The fundamental point that Oppenheimer wanted to make, what he desired his lectures to accomplish, was something he had learned through his interactions with

[60] JRO, The William James Lectures Oppenheimer papers. Library of Congress. Box 259. A Xerox copy is available in the Harvard University Archives. These however do not include Oppenheimer's preparatory notes. Lecture 1: A pluralistic World.

[61] In his 1956 talk at a symposium on "Science and the Modern Mind" at the American Academy of Arts and Sciences, Oppenheimer had spoken of a "reticular unity" as well (see Oppenheimer 1958, 67–76). A few months later he came across the powerful passage in James's lectures on pragmatism: "Loosely speaking, and in general, it may be said that all things cohere and adhere to each other *somehow*, and that the universe exists practically in reticulated or concatenated forms which make of it a continuous or 'integrated' affair" (James [1907] 1981, 64).

[62] JRO, The William James Lectures. Lecture 1: A pluralistic World.

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Jerome Bruner, Ruth Tolman, and the other psychologists he had conferred with at the Institute:[63] "In order to know at all, man must act and choose; in doing that he loses the opportunity of other knowledge."[64] This, Oppenheimer believed to be a generalized formulation of the notion of complementarity that Bohr had introduced. It was to be the principle that would help unravel the cognitive chaos, and characterize and help understand the order and unity of the new open world that Oppenheimer was talking about.

This point came at the end of Oppenheimer's first lecture, which had lasted for over two hours – and was undoubtedly lost on the majority of the audience, held spellbound by his lyrical delivery. And those who understood the point probably thought that it was too inconsequential and superficial an instrument to resolve the difficult problems of the modern, open world. And yet Oppenheimer's closing words in his seventh and last lecture were normative and hortatory:

> We have, I think, a dual duty: a duty of faithfulness and firmness and steadfastness in the things which by accident in our own time, in our own place, are our knowledge, our skill, our arts; [and] we have a duty of great openness to others. . . , learning to welcome the strange and being glad to learn something that is new, and that we have not suspected, and that does not fit, that is different and in some sense alien. And both duties are part of any love of order and of truth that can exist today. Both are helped when we not only love other truth but each other who purvey it.[65]

Oppenheimer's James Lectures presented a viewpoint that was at variance with the views of his colleagues in physics, one held or defended, moreover, by but very few philosophers. The pragmatism of Dewey and James, and the neo-pragmatism that Oppenheimer was trying to elaborate, was considered soft and not rigorous. It was more concerned with issues having biological foundations – and largely ignored at the time. Nor was the Cold War conducive to endorsing uncertainty and fallibility.

Oppenheimer was more successful in later talks at making clear his views. In those later settings he made much more explicit, using simpler language, how history, contextual factors, and culture-specific values and motives play a role in making sense of one's world and one's moral horizon. He became much more forceful in expressing his distrust of any order which is hierarchical in the sense that "it says that some things are more important than others – that some things are so important that you can derive everything else from them" (Oppenheimer [1959] 1960, 39). And he would

[63] And more recently by reading the manuscript of Bruner et al. 1956: "No man ever notices more than a minute fraction of those things which are for him to notice; and that is the price for him noticing anything at all. . . . It means that the potential that may be known is very greater than what is really known. It means that the potential always transcends the real. . . . The things that are cut out are possibilities that are lost in order that one may perceive at all."

[64] JRO, The William James Lectures Reference 40. Lecture 1: A pluralistic World.

[65] JRO, The William James Lectures. Lecture 8: The hope for order.

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compellingly avow that as far as science was concerned, "No part of science follows, really, from any other in any usable form. I suppose nothing in chemistry or in biology is in any kind of contradiction with the laws of physics, but they are not branches of physics. One is dealing with a wholly different order of nature" (Oppenheimer [1960] 1984, 106).[66]

Surely, Oppenheimer must have felt that Einstein during the last twenty-five years of his life had shirked the second duty of the James Lectures, "learning to welcome the strange and being glad to learn something that is new, and that we have not suspected, and that does not fit." Oppenheimer's pragmatic stance was at odds with Einstein's search for a unitary theory. It also put his expectations at skew to those of many of his own colleagues who followed Einstein's vision of unity, if not Einstein's version of its realization.

Conclusion

It was at Los Alamos, building weapons of mass destruction, that Oppenheimer experienced to the fullest a sense of community and of communal living. As the director of the Institute for Advanced Study Oppenheimer expended enormous energy and effort to try to make it an intellectual community. In his 1954 report to the Board of Trustees Oppenheimer had commented, perhaps too optimistically and not very objectively, that the members of the Institute formed a community because "many members have . . . a ranging and wide understanding and interest, and some substantial knowledge outside their own field of specialization. They are a community because close friendships contribute to mutual understanding and common interest. The fact that most of the members of the Institute live in the same apartments, eat in the same restaurant, share the same common room and the same library helps to bring them together."[67]

But as time passed Kennan observed that Oppenheimer was often discouraged, and in the end deeply disillusioned by the fact that

> the members of the faculty of the Institute were often not able to bring to each other, as a concomitant of the respect they entertained for each other's scholarly attainments, the sort of affection, and almost reverence, which he himself thought these qualities ought naturally to command. His fondest dream had been [Kennan thought] one of a certain rich and harmonious fellowship of the mind. He had hoped to create this at the Institute

[66] In another lecture from this period he asserted: "There are no synapses, no gaps, no gulfs in the picture of the various orders and parts of nature; but they are not derivable from one another. They are branches, . . . each with its own order, each with its own concern, each with its own vocabulary" (Oppenheimer [1959] 1960, 15). "The metaphor of a tree is invoked," he said, "because it is a growing thing; it is a tree, not a temple" (ibid., 17).

[67] JROLoC Box 233, Institute for Advanced Study, Report of the Director 1954, 26.

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> for Advanced Study; and it did come into being, to a certain extent, within the individual disciplines. But very little could be created from discipline to discipline; and the fact that this was so – the fact that mathematicians and historians continued to seek their own tables in the cafeteria, and that he himself remained so largely alone in his ability to bridge in a single inner world those wholly disparate workings of the human intellect – this was for him [Kennan was sure] a source of profound bewilderment and disappointment. (Kennan 1972, 19)

The contrast between Kennan's assessment of Oppenheimer's communitarian views and those of Einstein as communicated in his message to the Italian Society for the Advancement of Science in 1950 is stark:

> [A]part from the knowledge which is offered by accumulated experience and from the rules of logical thinking, there exists in principle for the man in science no authority whose decision and statements could have in themselves a claim to "Truth." This leads to the paradoxical situation that a person who devotes all his strength to objective matters will develop, from a social point of view, into an extreme individualist who, at least in principle, has faith in nothing but his own judgment. It is quite possible to assert that intellectual individualism and scientific eras emerged simultaneously in history and have remained inseparable ever since. (Einstein 1954)

Einstein's message reaffirmed the chasm that existed between Oppenheimer's views regarding collective and individual creativity and Einstein's. When expounding his position, Einstein had in mind not only Galileo, Kepler, Newton, Maxwell and the like, but also himself and Bohr. That intellectual individualism is still a potent factor in theoretical physics is clear from the fact that even though all advances in the field grow – as Oppenheimer had said – "from the work, patient and brilliant, of many workers [and that] they would not be possible without this collaboration," very often the initial impetus comes from a single individual who thereafter has a dominant voice in setting the subsequent intellectual agenda of the community. This is a phenomenon that has continued to the present – think of Schwinger, Feynman, Gell-Mann, Chew, Glashow, Weinberg, Wilson, Witten, . . . as far as theoretical high energy physics is concerned. Their intellectual contributions, and the force of their personality, make understandable why these individuals were able to achieve that position. But only Einstein and Oppenheimer, and later Feynman, attained an iconic standing not only within the physics community as a whole, but with the public at large, and this globally. Bohr, who was as influential as Einstein in physics, philosophy, and politics, never realized this status, though the respect and high regard he commanded in Denmark reflected a deeper appreciation of his contributions to science, to education and to internationalism than was the case with Einstein worldwide.

One of the enabling conditions for achieving this iconic status is communicative skill. Science is also communication, communication with the scientific community and with the public at large. All three – Einstein, Oppenheimer, Feynman – were great communicators. It is interesting to note the differences between Einstein's,

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Oppenheimer's, and Feynman's attempts to communicate their science to the public at large. Einstein's popular expositions of his special and general theory of relativity and of the evolution of physics are remarkable in their straightforwardness, simplicity, insightfulness and conciseness and in the resulting profundity (Einstein 1920, 1938; see also his essays in *Ideas and Opinions*, Einstein 1954). The same is true for Feynman, whether in overviews of physics as a whole, as in his Messenger lectures (Feynman 1965), or when giving an exposition of his approach to quantum mechanics and quantum electrodynamics, as in his *QED* (Feynman 1985). By contrast, Oppenheimer could only speak of the contributions of other individuals and of the accomplishments of the community as a whole; and in doing so always strived for "depth" and displays of erudition. Furthermore, his mellifluous, mesmerizing style of poetic oral delivery did not transcribe well into written presentations – and most of his essays have their origin in such transcriptions. Part of Oppenheimer's appeal was his absolute control of language, his ability to deliver lengthy lectures without notes, his "weightiness" and the ambiguous, and at times obscure, quality of his messages. To Oppenheimer's "seriousness" contrast both Einstein's and Feynman's delight in being "on stage." Dyson in his eulogy of Feynman in 1989 in *Physics Today* called Feynman "half genius, half buffoon." Einstein similarly had an element of buffoonery in him. And this aspect of their character clearly resonated with the public at large: it made their genius human.

The necessary condition for Einstein and Feynman to become iconic figures within the scientific community, and thereafter for the public at large, was of course an extraordinary scientific contribution. Einstein did so with his theory of general relativity; Feynman with his novel approach to quantum mechanics and his mathematical reformulation of its formalism as integrals over alternative paths. Oppenheimer made no scientific contribution of this magnitude nor did he have the self-confidence that derives from such an accomplishment.[68] His exceptional contributions to the war effort were managerial and technical in character and were made possible by his impressive leadership and charismatic qualities and by his remarkable ability to assimilate and understand all the features of the project. But Los Alamos' technological success was the result of the collective efforts of the scientists working there.

Einstein did not need, nor did he seek, the approval of either the scientific community or that of the public at large. Oppenheimer did. Their interactions were affected by this, and by the fact that their intellectual, political, and cultural outlooks had been shaped in different times and under different conditions.

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[68] It should be noted that no one else during the 1930s made contributions of this magnitude.

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