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ROBERT EUGENE MARSHAK

1916—1992

A Biographical Memoir by

ERNEST M. HENLEY AND HARRY LUSTIG

Biographical Memoir

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R. E. Marshak

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ROBERT EUGENE MARSHAK

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BY ERNEST M. HENLEY AND HARRY LUSTIG

ROBERT MARSHAK WAS AN extraordinarily imaginative and productive physicist. After making important contributions to astrophysics, he turned to nuclear and elementary particle physics as his primary area of research. His and Hans Bethe's two-meson hypothesis and the proposal with George Sudarshan of the universal V – A weak interaction were milestones in the history of twentieth-century physics. Marshak was one of the great research guides of our time; his students and junior colleagues occupy important positions all over the world. Never a loner or one to limit his horizons, he became a leading statesman of world science and contributed enormously to strengthening communications and cooperation among scientists across borders and consequently to world peace and well-being. Throughout his life Marshak was driven not only by intellectual curiosity and brilliance, as well as a desire for personal recognition, but also by an unquenchable quest for social justice. This led him to make many contributions to the public good, most notably as president of the City College of New York during a period of wrenching change and renewal for that institution. He was a born leader and a practical dreamer whose work will live on for many years to come.

THE EARLY YEARS

Robert E. Marshak was born in 1916 in the Bronx, a borough of New York City, to poor immigrants from Minsk, Russia (now Belorus). In America his mother Rose became a seamstress and his father Harry worked as a garment cutter and seller of fruits and vegetables from a horse-drawn cart. Marshak's ability and ambition were recognized early and were strongly supported by his parents. (In later years Bob often was moved to tell the story of his father getting up at four in the morning to shine Bob's shoes, advising the son that his time was better spent in study than in cleaning shoes.)

He graduated from James Monroe High School at age fifteen, having won virtually every prize offered by the New York school system and having captained the school's math team to citywide victory. Like so many talented but poor New Yorkers, Marshak enrolled in the academically rigorous, tuition-free College of the City of New York (CCNY). After one semester he received a Pulitzer scholarship that provided full tuition and a stipend for study at Columbia University. Initially he majored in philosophy and mathematics and served as dance critic for the school newspaper. His first published article, in *Columbia Magazine*, was a critique of the dancer Martha Graham. (Bob Marshak maintained a love for and a commitment to the arts and humanities throughout his life. Almost five decades after Columbia, one of us [H.L.] attended a concert with him at CCNY's newly inaugurated Davis Center for the Performing Arts, in whose creation Bob had played a leading role. He told of his discovery of Schubert fairly late in life and he appeared moved to tears during the performance of that composer's Octet.) In his senior year Marshak switched to physics and came into contact with I. I. Rabi. Although

Rabi originally was skeptical of Marshak's commitment to physics, he later became a friend.

Marshak graduated from Columbia in 1936 and went on to graduate school at Cornell. There he studied with Hans Bethe, who at the time was working on problems pertaining to energy production in stars, work that later won him a Nobel Prize. Marshak wrote his dissertation on energy production in white dwarf stars, completing his Ph.D. degree in 1939 at the age of twenty-two. He concluded that white dwarfs could not contain hydrogen in their interior because it would immediately burn up at the high temperature. This conclusion is considered basic by astrophysicists who are expert on white dwarfs, and was confirmed by observation over the following half century. Never one to miss an opportunity, he persuaded Bethe to submit Bethe's paper on the carbon cycle as a source of stellar energy to the New York Academy of Sciences for the A. Cressy Morrison Prize. Bethe won that prize and gave Marshak a 10% finder's fee. When Marshak finished his thesis, it was also submitted to the Academy, and Marshak won the Morrison prize. With the money from it, he was able to buy his first car.

Jobs were hard to come by in the 1930s, especially for Jewish scientists. Marshak was nevertheless able to get a one-year position at the University of Rochester. It was "definitely for only one year," because it had been promised to another man who had gone off for advanced study with a famous physicist. But that other man did not return; so this tenure track position wisely was given to Marshak. At Rochester he met and worked with Victor Weisskopf. He remained at Rochester, with time off for the war effort and during later leaves, until 1970. In 1943 Marshak married Ruth Gup, a schoolteacher in Rochester. In 1950 they had a daughter, Ann, who is now professor of immunology in the Department of Microbiology at Boston University and five years

later a son, Stephen, who is professor of geology at the University of Illinois in Urbana-Champaign.

THE WAR YEARS

When the United States joined World War II in 1941, Marshak, like many other scientists, enlisted in the war effort. At first, he worked on developing radar at the MIT Radiation Laboratory. In 1943-44 he was at the Montreal Atomic Energy Laboratory (which later became the Chalk River Laboratory), where he worked for the British atomic bomb project on problems of neutron diffusion. In 1944 he joined the Manhattan Project, which was developing the American atomic bomb at Los Alamos, New Mexico. His position as deputy leader of a group in theoretical physics allowed him to be privy to the overall strategy of the creation of the atomic bomb. One of his contributions was an explanation of how shock waves work under conditions of extremely high temperatures during a nuclear explosion, when most of the energy is in radiation. These waves are now called Marshak waves. His explanation became the subject of renewed interest many years later when it helped to describe the consequences of a supernova explosion.

Both Robert and Ruth Marshak felt that Los Alamos was the most influential event in their lives. He worked among the most select group of physicists in the world, men like Bethe, Fermi, Bohr, Oppenheimer, and Feynman. With them he witnessed the explosion of the first atomic bomb, an event that affected him profoundly. The shock of the destruction of Hiroshima and Nagasaki led him to join in organizing the Federation of American Scientists, a group seeking to limit the proliferation of nuclear weapons and to ban the bomb. Marshak became chairman of the federation in 1947. In later years he was active in other organizations with similar goals, including the Pugwash Conference

and the Union of Concerned Scientists. Driven by a desire to help bring about world peace and prosperity and with an understanding of the unique role that science should play in achieving these goals, he was an effective world leader in the internationalization of science.

THREE DECADES AT ROCHESTER

After the war Marshak returned to the University of Rochester, where he moved quickly through the ranks to become a chaired professor and in 1950 the head of the physics department. During his fourteen-year chairmanship it became one of the top departments in the country and a recognized center for research. Many of the world's leading physicists passed through Rochester during those years and Ruth Marshak played an indispensable role as their hostess, as she did later as "First Lady" of City College. In spite of the growing prestige of the physics department, Rochester was not considered to be in the same league with institutions such as Princeton, Harvard, MIT, Caltech, or the University of California, Berkeley. To have students of high caliber in the department, Marshak sought out the best graduate students from overseas, notably from India, Pakistan, and Japan, and brought them to Rochester, a strategy that was soon copied by other departments on the move. Many of these students later became leaders in their countries' scientific communities.

During the Rochester years, Marshak's output was prodigious; it is recorded in 4 authored and 2 edited books, some 120 articles in refereed scientific journals and in more than 20 contributions to magazines. (Over the rest of his busy life, these numbers increased to 8 books, 180 scientific articles and close to 50 general articles.) He continued his work in astrophysics and published papers on solar models, on the internal temperature and opacities of white dwarfs,

and on the internal temperature-density distribution of main sequence stars. During this early period Bob was also interested in nuclear forces, nuclear binding energies, and beta-decay theory. The discovery of the muon (then thought to be the Yukawa meson) led to papers on the scattering of spin 1/2 mesons by nuclei. In 1947 Bethe and Marshak were among the first to realize that the weakly interacting muon could not be the Yukawa meson, and they proposed the two-meson hypothesis, thus suggesting that a second, strongly interacting, meson (now called the pion) remained to be found. Marshak continued to study the pion and muon and in particular the interaction of the former—its production, scattering, and absorption—with nuclei. With several colleagues he worked on charge independence in multiple pion production, X rays from pi-mesic atoms, and the meson theory of nuclear forces. With his students Peter Signell and Ronald Bryan he produced the Signell-Marshak potential, which, by virtue of including the spin-orbit contribution in the nuclear force, was one of the first to give quantitative agreement with experiment. In 1952 his book *Meson Physics* was the first to be published on that subject.

Marshak was the driving force for the construction of the 240-MeV Rochester cyclotron, built by Sidney Barnes. It was the first meson-producing cyclotron after the 184-inch cyclotron at Berkeley, and in 1948 it produced pions on nuclear targets that allowed researchers to determine the pion's spin and parity. Unfortunately, its energy was too low except for threshold pion production; the accelerator could not reach the energy of the delta resonance (1232 MeV) and the Rochester cyclotron was soon eclipsed by accelerators at the University of Chicago and Columbia University. In 1951 Marshak suggested that one could determine the spin of the positive pion experimentally by comparing the cross sections for the reactions $pp \rightarrow \pi^+d$ and $\pi^+d \rightarrow pp$ and

invoking the principle of detailed balance, which in turn is a result of the time reversal invariance of strong interactions. Immediately after Marshak made this proposal, experiments at Columbia and Rochester confirmed the spin to be zero. The Rochester cyclotron also was important in showing that protons could be polarized easily by scattering from a nucleus of zero spin, such as carbon.

Bob Marshak turned his attention to the strange particles when they were discovered in the late 1950s. He studied their expected properties: spins, magnetic moments, production, interactions, and decays. Together with S. Okubo and with his student Sudarshan, he showed for the first time that broken symmetries could account for the magnetic moments and masses of the sigma hyperons. As early as 1958, Marshak and Sudarshan studied chirality invariance and its effect on weak interactions. With Okubo, Sudarshan, W. Teutsch, and S. Weinberg, he investigated conserved currents and K-meson decays. During all these years he continued his interest in the nucleon-nucleon interaction, but after 1956, when parity violation was discovered in the weak interactions, his primary attention shifted to symmetries and the weak interaction. Two books recount the achievements of that period: *Elementary Particle Physics* (1961) by Marshak and Sudarshan and *Theory of Weak Interactions in Particle Physics* (1969), co-authored by Marshak, Riazzudin and C. P. Ryan.

Marshak's most significant scientific contribution arguably was the proposal in 1957 of the V – A theory of weak interactions in collaboration with George Sudarshan. The theory, which emphasized the importance of chiral invariance, was a starting point for the standard unified electroweak theory of Glashow, Salam, and Weinberg. Marshak and Sudarshan at that time published their theory only in the proceedings of a conference (the Padua-Venice International

Conference on Mesons and Recently Discovered Particles). Six months later a different derivation was published by Feynman and Gell-Mann in *Physical Review*. (An account of the rapid-fire developments in the origins of the universal V – A interaction appears in an article by Sudarshan and Marshak in the book *A Gift of Prophecy* mentioned in the penultimate paragraph of this memoir. Although the V – A concept was a seminal contribution to theoretical physics, a Nobel Prize was never awarded for it.

Not content with making his own major research contributions to physics, Marshak became an enthusiastic and indefatigable promoter—some have called him a prophet—of the field, even at an age when he was much too young to figure as an elder statesman. In 1950 Marshak felt that the successful conferences on present problems of physics, which had been held at Shelter Island (1947), the Poconos (1948), and Oldstone (1949), should be continued and that Rochester was the place to do so. The first of what was to become a series of annual Rochester conferences was held in December of 1950. It was attended by fewer than 100 people, who at that time constituted almost all of the U.S. theorists and experimentalists working in the field of high energy; the number also included a few from overseas. The meeting was expanded the following year and evolved later into the International Conference on High Energy Physics. This series of conferences rapidly became (and remain) the preeminent international gathering of high energy physicists. (It also served as a model for the establishment of international conferences in other fields.) Held in Rochester until 1957, the conferences then began to rotate among countries, returning to Rochester in 1960. They are amazingly vital gatherings, where new results are often announced for the first time. It was at one of the early Rochester confer-

ences that one of us [E.M.H.] first met Bob and was immediately impressed by his vitality.

Marshak made sure that all nations could be represented at the Rochester conference and worked very hard with the U.S. Department of State and with members of Congress to allow physicists from the Soviet Union and Eastern Europe to attend. In those years no one ever knew quite whom the Soviets would send to conferences and Bob Marshak had to insist that those who had been invited to talk would be among those permitted to come. During those days of the Cold War it was unusual to be able to discuss physics—much less politics—with Soviet scientists. Bob's initiative was not only an immense boon to physics but helped to lead the way to a rapprochement between the United States and the Soviet Union.

Marshak's intense interest in promoting international scientific cooperation and world peace manifested itself in many other activities. In 1956, after the death of Stalin, he was a member of the first delegation of six American scientists to visit the Soviet Union, where he met the leaders of the Soviet physics community, including Lev Landau. He made more trips to the Soviet Union in the late 1950s and became an acknowledged expert on Soviet science. As a result, he published articles about the subject in several magazines and was frequently interviewed by the news media. His outspoken views may have led to his being subjected to an interrogation during the McCarthy era. He was found to be a loyal American and allowed to retain his Q-clearance.

Over the years Marshak also made a large number of trips to other countries in Europe and to the Middle East, India, Pakistan, and Japan. In the 1960s he headed delegations of the National Academy of Sciences to negotiate exchange agreements with Poland and Yugoslavia. His trips

provided him with an opportunity to meet the scientific and occasionally the political leaders of many countries, including Prime Minister Jawaharlal Nehru of India. He became friends with physicists such as Hideki Yukawa, Abdus Salam, and others not as well known in the United States but who played major roles in the development of science in their countries. He was a founder of the International Centre for Theoretical Physics at Trieste and a member of its Science Council from 1965 to 1975 and again from 1984 until his death. He served as secretary of the Commission on High Energy Physics of the International Union of Pure and Applied Physics.

Not one to slight the promotion of science in the United States, Marshak was involved in lobbying to establish the National Science Foundation and in many issues that came before the U.S. Atomic Energy Commission. In addition to numerous academic visiting professorships he also had connections to industry, acting as a consultant to General Electric, Eastman Kodak, and the RAND Corporation. He served as editor of two major series of physics books, one for McGraw-Hill, the other for Wiley-Interscience.

In the late 1960s, as one of four Distinguished University Professors at the University of Rochester, as well as a distinguished physicist and by then elder statesman of science, Robert Marshak could have finished his career there in a secure and, from a professional viewpoint, an ideal position. However, in this era of the Vietnam War, conflicts between the conservative administration of Rochester President W. Allen Wallis and the more liberal faculty and students surfaced on a number of issues. The faculty elected Marshak as president of the Faculty Senate and what followed was effectively a battle between him and Wallis. After the faculty passed a vote of no confidence against Wallis

the two were never again on friendly terms. Rochester's turmoil became City College's opportunity.

PRESIDENT OF CITY COLLEGE (1970-79)

By 1969 the venerable CCNY of Bob Marshak's youth was in the throes of a revolution. For one thing, it had become a unit of a nineteen-campus bureaucratic system, the City University of New York. Its days as a leading and wholly disproportionate producer of undergraduates who would take their place among the country's leading physicists (as well as of a large number of intellectual leaders in most other fields of human endeavor) appeared to be over. Many bright young New Yorkers for whom CCNY would have been the only avenue to higher education and out of poverty now had the means and the opportunity to attend the Columbias and Harvards of the country. At the same time, Black and Hispanic New Yorkers, who could not meet the wholly meritocratic admissions criteria of City College, revolted against their "exclusion" and with their supporters occupied the campus. Their demands for admissions quotas that reflected their numbers in the high schools were answered with an "Open Admissions" policy for the City University. In 1970 this resulted not only in a doubling of freshman but, as public education and high-school graduation requirements in New York further deteriorated, in an influx of unprepared students and an increasing need to provide remedial education and new curricula for them.

Prior to open admissions another revolution had been launched, one that was much less noticed by the public. Led by a few "Young Turks," mostly from the physics department, which one of us [H.L.] then headed, CCNY was transforming itself from an essentially undergraduate college to a research institution with on-campus graduate programs in the sciences, engineering, and a few other fields.

Into this somewhat schizophrenic reality of CCNY Robert Marshak was recruited to serve. Those who knew of his extraordinary achievements and commitment to academic excellence, combined with his unusual dedication to social programs and equality, believed that he was the right person to replace the dismissed president of the college. As one of the faculty members of the search committee, I [H.L.] traveled to Rochester to recruit Bob to become City College's eighth president. Before speaking with him, I had the privilege of attending one of his legendary seminars. It became easy to convince the search committee and the Board of Trustees that here was an individual who was superior to all other candidates.

What Bob Marshak set out to do as soon as he became president was to take City College into the big leagues of the public and private universities of the seventies. He engaged a public relations firm and used pageantry to make friends and influence people. He launched an unprecedented $25 million fund-raising campaign. To help carry out his programs he liberally added deans, directors, and vice-presidents to the administration, and he summed up his vision in a master plan that he named "The Urban Educational Model."

To be sure, there were solid academic goals and achievements behind this structure and facade. Bob Marshak wanted to improve every department, whether it wanted to be improved or not, and he succeeded with about a dozen, physics most prominently among them. With the help of a major National Science Foundation development grant, the groundwork for the transformation of the physics department from a prodigiously successful undergraduate teaching operation to a research-active Ph.D. department had been laid before Bob's arrival. However, his presence at the helm and his strong if critical support made it possible to

bring in such scientists as Bob Alfano, Joe Birman, Mel Lax, Sam Lindenbaum, Rabi Mohapatra, Bunji Sakita, and Harry Swinney.

To much of the world, Bob's most visible and sometimes controversial achievements were evident in the new programs he created. Most of these were motivated, at least in part, by Bob's unshakable conviction and confidence that he had the obligation to do for the economically still poor (and socially and academically very different) students what the students and faculty previously had done for themselves. The new programs were often made possible and sometimes even shaped by the wishes and ambitions of donors. In rapid succession he created a major Center for the Performing Arts, an Urban Legal Studies Program, the Center for Biomedical Education, and several other new structures and programs.

The Center (later School) for Biomedical Education can serve as a paradigm of Bob's vision and determination, as well as of his occasionally less than completely realistic expectations. As he conceived it, the center was to serve all of the following purposes: 1) to retain and win back gifted students through an accelerated curriculum (they would obtain a medical degree in a total of six years, the first four at City College and the last two at prestigious medical schools with which Bob had negotiated transfers to the third year class); 2) to have 50% of this group composed of minority students; 3) to direct the students into primary health care (rather than into specialties) and practices in underserved areas; and 4) implicitly to show the medical establishment and the country that a medical education could be provided at a much lower cost than was (and is) the practice.

Experience soon showed, unsurprisingly, that these goals were somewhat incompatible. The program experienced difficulties and controversy, including a successful reverse

discrimination lawsuit, and had to be modified. It is a tribute to Bob Marshak's vision and determination that the program still exists twenty-five years after its creation and still makes a major contribution to the City College and to society.

During the City College period Marshak also vigorously pursued his lifelong commitment to international cooperation and to developing countries. Among other initiatives, he tried to set up a far-reaching exchange program with the University of Ife in Nigeria and he organized and chaired a workshop at CCNY on "Technological Development of Nigeria." On the domestic front he organized and co-chaired with Hans Bethe a conference on "American Energy Choices Before the Year 2000." At City College itself, Bob Marshak, motivated by his social conscience and sympathies, was extraordinarily responsive to all demands. He created not two (as had originally been demanded) but four ethnic studies departments: Black, Puerto Rican, Asian, and Jewish. He worked hard to establish ties with the Harlem community.

All of these acts of creation were initiated in the face of a rapidly deteriorating economic and political situation for CCNY, largely caused by the impending bankruptcy of New York City. This led to the abandonment after 128 years of free tuition and to severe budget cuts (which became even more traumatic in the eighties and nineties). Marshak's acts of creation were also carried out against a background of ethnic strife and agitation that was manifestly much worse than what Bob had expected when he took the job. Indeed it hardly should be called a background, because it consumed so much of Bob's time and effort; unfortunately, it also took a toll on his health. He suffered a stroke during a confrontation with a student group. It affected his physical balance for the remainder of his life, but it did not stop the intensity of his commitments and his work habits.

Not surprisingly, during his extraordinarily demanding presidency, Marshak heroically tried to keep up with physics and, stealing away to his little hideout in the physics department on as many Friday afternoons as he could, he worked with Mohapatra and others to make new contributions. His papers in *Physical Review* and in *Physical Review Letters* were mostly on CP violation and the strange particles. In the end, the deprivation of not being at the center of science, as well as the accumulated frustrations of life at City College, got to him, and at the age of sixty-three he again became a full-time physicist, at the Virginia Polytechnic Institute and State University.

THE BLACKSBURG YEARS

Robert Marshak joined the Virginia Polytechnic Institute and State University in 1979 as a University Distinguished Professor; the announcement of his appointment was made by the governor of Virginia. He continued to work in the area of quark-lepton symmetry and the construction of grand unification schemes with his former student at Rochester and colleague at CCNY, R. N. (Rabi) Mohapatra, who had moved to Virginia Tech, and with others. The failure to detect proton decays predicted by the SU(5) theory had increased interest in experimental tests of alternative options. Bob proposed tests of the SU(10) grand unification theory by studying neutron-antineutron oscillations in the nucleus, and by looking for finite mass Majorana neutrinos. With students and research associates, Marshak worked on models of quarks and leptons. He recognized the importance of anomaly cancellations as a necessary condition in the construction of a new theory. He authored several papers on chiral gauge anomalies and on the relations between the perturbative and non-perturbative ones.

Continuing a lifelong practice of good citizenship and

service in his local and the wider national and international community, Bob Marshak organized several memorable physics meetings at VPI and was active in numerous scientific organizations. Among his contributions were service on the National Academy of Sciences' Commission on Human Resources and the Committee on Scientific Exchanges with the People's Republic of China; the vice-chairmanship of the United States National Committee for the International Union of Pure and Applied Physics; membership on the Governing Board of the American Institute of Physics; the chairmanship of an Advisory Committee of the U.S. Agency for International Development; and the organization of the 1984 Trieste conference on physics and development. He was elected president of University Research Associates, but he had to relinquish that responsibility because of a heart bypass operation.

A most important, if not the principal, beneficiary in the early eighties of Bob's intellect and energy was the American Physical Society (APS) and its programs and influence. After serving on its council from 1965 to 1969 and as chairman of its Division of Particles and Fields in 1969-70, he allowed himself to be nominated as vice-president after his retirement from CCNY. This led to the presidency in 1983. The recollections of his colleagues and a perusal of council minutes, as well as newspaper reports, attest that his term was very eventful and effective. Bob Marshak did not leave strong activism and controversy behind when he left City College. An example is his use of the weight of the APS to debate the Reagan Administration on the issue of placing an anti-ballistic missile system in space, a program popularly know as Star Wars. One result was an unprecedented statement on nuclear arms control that the council issued on January 23, 1983, under Bob's energetic leadership, which evoked an extraordinary negative response from George

Keyworth, President Reagan's science advisor. Another perhaps more influential outcome was the production by the APS some years later of an objective scientific study of the feasibility of directed energy weapons. A second major Marshak creation was the approval and initiation of the China Program ("Chinese-American Cooperative Basic Research Program in Atomic, Molecular, and Condensed Matter Physics" of the American Physical Society, 1983-1991.) It is now seen as one of the great contributions of the APS. This program passed the council also on January 23, 1983, by a vote of thirteen members in favor, eleven opposed, and three abstaining. Bob Marshak did not require unanimity to forge ahead; he and his convictions often constituted a strong working majority.

Marshak retired officially from his chair at Virginia Tech in 1992 at the age of seventy-five. During the four years before that and for the remaining months of his life, he worked intensely on his last book *Conceptual Foundations of Modern Particle Physics* (1993). He finished the final corrections on December 22, 1992. When he dropped the manuscript in the mailbox, he turned to his wife and said jokingly: "It's done; now I can die." The last communication I [H.L] had from Bob Marshak was also dated December 22, 1992. It is a note proudly telling us that he had been selected as the first recipient of the American Association for the Advancement of Science's Award for International Scientific Cooperation, for which I had nominated him on behalf of the APS. The next day, December 23, 1992, the Marshak family gathered in Cancun to celebrate Bob and Ruth's fiftieth wedding anniversary. Minutes after their arrival Bob took the grandchildren to the beach. While they played, he stepped into the warm water of the Gulf of Mexico. The undertow was unexpectedly strong, and he apparently lost his balance—the final manifestation of his stroke. He

fell into the water, could not stand up, and drowned a few feet from shore.

ENVOI

Beginning early in his life and lasting throughout his career, Robert Marshak received wide recognition and a plenitude of honors. He was elected to the National Academy of Sciences in 1958 and to the American Academy of Arts and Sciences in 1962. He was an Alexander von Humboldt awardee, three times a Guggenheim fellow, a Sigma Xi national lecturer, a Phi Beta Kappa scholar, and a Nobel lecturer. He held distinguished visiting appointments at some twenty foreign and domestic institutions. He received three honorary degrees. On his retirement from CCNY the science building was named in his honor, in defiance of a policy he had established during his presidency of selling the names of buildings to donors. And his students and colleagues honored him with no fewer than three Festschriften, one on his retirement from Rochester in 1970 ("R. E. Marshak: The Rochester Years"); the second, in observation of his sixtieth birthday at City College ("International Symposium on Five Decades of Weak Interactions," proceedings published in *Ann. N. Y. Acad. Sci.*, vol. 294, ed. N. P. Chang, 1977); and, upon his death, with the book *A Gift of Prophecy-Essays in Celebration of the Life of Robert Eugene Marshak* (ed. E. C. G. Sudarshan, World Scientific, 1994).

Bob Marshak was manifestly not a prophet without honor in his own country or abroad. Scores of colleagues have testified to his seminal contributions to science. The work on the V – A interaction has been described by a disinterested colleague as "a crucial turning point in twentieth century physics." Others have spoken eloquently about the many other results of Bob's "deep physical intuition" and of their admiration for him as a "deep and creative theoretical physi-

cist." His leadership in the world scientific community has evoked equally strong expressions of tribute. His successful pursuit of the presidency of City College has been hailed as "an act of great courage and human compassion."

In spite of these tributes and Bob Marshak's immense achievements, his life was sometimes punctuated by disappointment and controversy. Although Marshak was anything but self-effacing or reluctant to claim credit for his accomplishments, he was not always satisfied with himself or with the recognition he received. He was extraordinarily persistent but not always patient in pursuing his ambitious goals in science and society. He did not suffer fools (or for that matter wise men and women who disagreed with him) gladly, and he occasionally exasperated colleagues and persons in high places as much as they must have exasperated him. His interaction with people was anything but weak.

At the same time he was a most generous friend and mentor, particularly to students and junior colleagues. Many have testified about his graciousness, his approachability, and the unexpected amount of time that he took to discuss their problems. A severe workaholic, he had an enormous sense of duty to deliver, fully and promptly, on everything he promised. George Sudarshan reports that "any manuscript or notes handed to him were returned with detailed comments within forty-eight hours, irrespective of how busy he was." Although physics usually took precedence over other duties (and his commitments as a statesman of science over personal concerns), he was involved in everything and he enriched the lives of more people than he or the public ever knew.

FORTUNATELY, THE LIFE and achievements of Robert E. Marshak have been well documented by himself and by others. In addition to items cited in the Selected Bibliography and other material, includ-

ing personal reminiscences, we have found the following documents particularly useful: 1) *Robert E. Marshak: A Brief Biography.* Special Collections Department, University Libraries, Virginia Polytechnic Institute and State University, Blacksburg, Va., 1996. This informative and poignant work, authored by Marshak's son, Prof. Stephen Marshak, is so felicitously written that we have with permission incorporated some passages verbatim; 2) Harry Lustig. Two presidencies: The City College of New York and the American Physical Society. In *A Gift of Prophecy. Essays in Celebration of the Life of Robert Eugene Marshak,* ed. E. C. G. Sudarshan, pp. 303-309. Singapore: World Scientific, 1994. Permission to quote from this article has been granted by the publisher; and 3) Harry Lustig, Susumo Okubo, E. C. G. Sudarshan. Robert E. Marshak (obituary). *Phys. Today*, p.105, Nov. 1993.

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