Edward B. Davis

Prophet of Science—Part One: Arthur Holly Compton on Science, Freedom, Religion, and Morality

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American physicist Arthur Holly Compton (1892–1962), who shared the Nobel Prize with C. T. R. Wilson in 1927, was a leading public intellectual in the decades surrounding World War II. A very active Presbyterian, Compton's "modernist" Christian beliefs influenced his views on several important topics: evolution and the design argument, human freedom and the limits of science, immortality, anti-Semitism, and the morality of atomic warfare. Considering his seminal contributions to physics and his strong commitment to writing and speaking about science and religion, it is surprising that no one has previously studied this aspect of his career in detail. Compton wrote a great deal about these topics, and this lengthy article will be published in three parts, continuing in September and ending in December. The opening section follows Compton's family background, education, and early career, emphasizing the strong influence of his father's philosophical and religious views on his attitudes and beliefs, especially on his theology of nature and his understanding of free will.

> Such a solution of the old dilemma of freedom in a world of law means that when the law of causality is replaced by the principle of uncertainty, Socrates' indictment of science as the underminer of morality no longer applies. Man is left by science in control of his own actions within the bounds set by natural law. Moreover, the powerful argument for morality which Pythagoras saw in a world governed by law is emphasized by every advance of science. Instead of removing the foundation of morality, science now presents new reasons why men should discipline their lives, and supplies new means whereby they can make their world more perfect.
>
> –A. H. Compton, 1935[1]

Arthur Holly Compton, the third American to receive the Nobel Prize for physics, was among the most visible public intellectuals of his generation. Author of nearly two hundred scientific papers and review articles and an authoritative textbook on x-rays, he also wrote dozens of essays for the best journals of secular and religious opinion, reviewed important books, and spoke often on the radio.[2] Esteemed by reporters "for his ability to get things said without benefit of polysyllables," he appeared on the cover of *Time* magazine in January 1936, was featured in other major magazines and newspapers, and gave numerous addresses to academics, business organizations, and religious groups—not to mention three books he wrote for the general reader about science, society, and religion.[3]

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At the height of his scientific career in the early 1930s, Compton used Werner Heisenberg's principle of uncertainty to defend human freedom and responsibility, paralleling the views of Arthur Eddington and Robert Millikan. During World War II, his central role in the Manhattan Project brought him into constant contact with the highest government officials and powerful industrialists, and his postwar position as chancellor of Washington University in St. Louis only enhanced his prestige and widened the audience for his heartfelt pronouncements about morality, education, human dignity, and progress in the atomic age. In all of these activities, Compton sought to bring his religious values to bear on the most pressing problems of the time, while proclaiming his liberal Protestant understanding of God, nature, and humanity to millions of ordinary Americans.

Family Background and Education

Compton belonged to one of the most remarkable families in American history.[4] All three Compton boys — Arthur and his older brothers Karl and Wilson — earned doctorates at Princeton; and all three, together with their sister's husband C. Herbert Rice, served as university presidents at the same time, in the exciting but challenging period following World War II. Education was uppermost in the Compton family, second only to God. It began with Elias Compton, a devout Presbyterian who had graduated first in his class at Wooster University (now the College of Wooster) in 1881, and his Mennonite wife, Otelia Augspurger, who earned the top score on her senior examination on Butler's *Analogy* at the Western Female Seminary (now part of Miami University) at Oxford, Ohio. They were both planning to be missionaries, and Elias was still enrolled at Western Theological Seminary (now Pittsburgh Theological Seminary) when he was unexpectedly asked to return to Wooster in 1883 — a sudden illness had left the college in need of someone to teach Latin and English. Having been "providentially brought to Wooster," as he saw it at the time, he stayed for forty-two years, teaching mostly philosophy and psychology and eventually serving as the first academic dean.[5]

Wooster had been founded in 1866 by Ohio Presbyterians as their own coeducational university, and from the start it combined a strong evan-

The Compton family, probably in 1913 or perhaps a bit earlier.
Left to right: Arthur, Mary, Otelia, Wilson, Elias, and Karl.
Courtesy of Arthur Holly Compton Personal Papers, University Archives, Department of Special Collections, Washington University Libraries.

gelical orientation with an open-minded attitude toward science and modern scholarship. This was reflected in its motto, *Scientia et religio ex uno fonte*, science and religion come from a single source—a motto that Arthur Compton liked and attributed to Thomas Aquinas.[6] Wooster's first president, theologian Willis Lord, proclaimed in his inaugural address that the sciences were "the offspring of God" and denied "that the study of the Physical Sciences has any legitimate tendency, antagonistic to moral truth." Evolution had been discussed on campus at least as early as the mid-1870s, but it was probably not viewed too favorably before the 1890s, when Horace Nelson Mateer was lecturing about natural selection and advocating theistic evolution. A physician whom the university recruited in 1886 to teach zoology and geology, Mateer had at first opposed evolution, but the evidence he encountered while preparing his lectures convinced him of its truth. By 1894 his introductory biology course was organized around evolution, and the following year he taught an advanced course on scientific and philosophical aspects of evolution.[7]

Mateer's interpretation of evolution is clearly seen in a talk on "Evolution and Christianity" that he presented to a local reading group in April 1894. Nine months later it was published in *The Post-Graduate and Wooster Quarterly* and issued simultaneously as a pamphlet. Evolution, including human evolution, resulted from "the interaction of certain forces operating in the direction of a progressive change from some unknown primitive condition of things." This was simply "the divine mode of creation whereby God has wrought out the existing order of things through the continuous operation of His creative power." Therefore, he concluded,

> We cease to regard God as sitting idly upon His throne and come to view Him as constantly employing all His powers in the perfection of his works, and thus we come to understand Christ when he said, "My Father worketh hitherto and I work."[8]

Using language that was common among theistic evolutionists of that period (including the specific quotation from John 5:17), Mateer was claiming that evolution was fully consistent with an important element of Christian theology, the immanence of God within the creation. Arthur Compton later held a similar view, and he liked to use the same biblical verse when stating his belief that God used evolution to develop consciousness and responsibility in humans, to the point where we have become God's partners in bringing about God's purposes.[9]

Elias Compton probably did not agree with Mateer's acceptance of evolution at the time, but twenty years later, in 1914, he advanced a similar view himself, in what appears to be a narrative outline of his course on the history of philosophy that was published in *The Bible Magazine*, a short-lived evangelical monthly. "There is no conflict between law and purpose, between uniformity and intelligent will in nature," he proclaimed. "Physical forces are the energy of God. The laws of nature are the habits of God, uniform ways in which He acts." Therefore, "there is no such thing as a self-running nature," and evolution is simply "God's orderly and progressive way of working; and the magnificent product reveals His infinite wisdom and power." Citing *Creative Evolution* (1907) by the great French philosopher Henri Bergson, Elias noted the appearance of something new that cannot be completely explained by prior phenomena, not only "at great exceptional crises, such as the beginnings of life, consciousness, and moral reason, but at every step" of the evolutionary process, and he underscored the reality of divine activity in all of this. "God is in nature, but He is not a prisoner in nature. Evolution is not only His way of working, it is His way of creating."[10] Published just eighteen months after Arthur graduated from Wooster, it is not difficult here to see an important influence of father on son.

Even more significant, however, was Elias Compton's keen, longstanding interest in the interface of philosophy and psychology—an interest shared no less keenly by Arthur. In his valedictory address at Wooster, the young Elias had emphatically rejected psychological determinism and reductionism. He told his classmates,

> The new psychology says that heredity, plus environment, determine the man, thus making him a weather-cock shifting helplessly in the winds of sensibility, a wretched association machine, through which ideas pass, linked together by laws over which the machine has no control.[11]

Elias continued to study the mind/body problem after he returned to Wooster as a faculty member, and at the end of his first year of teaching, Wooster awarded him an M.A.

It was not uncommon then for small colleges like Wooster also to award doctorates, although the work required to earn them does not compare with expectations today. In 1889, the young professor of "mental science" was granted a Ph.D. by Wooster, for a thesis called "Thought Possible without Language." He also spent the summer of 1892 doing graduate work with psychologists G. Stanley Hall and Edmund C. Sanford at Clark University.[12] Elias embraced a philosophical idealism that asserted the fundamental reality of the mind, against the materialism held by most psychologists of the time. His study of William James, for example, led him to conclude that James was "as determined as any Positivist to be rid of the conception of a permanent soul or spirit. He will have psychology a natural science, uncorrupted by metaphysics." This is followed by a significant "Parenthetical query: Why is it unmetaphysical science to assume a substantial material brain, and unscientific metaphysics to assume an abiding spiritual self or soul?"[13] His son would be interested in the same question.

Growing up in such a strongly religious home and respecting his parents as much as he did, Arthur was somewhat hesitant to study science when he was ready for college: he felt instinctively that the mission field was the ideal place for a Compton. But his parents "used the Bible and common sense" to advise their children, and his father had the wisdom and insight to give his blessing. Elias gently told his son that "you can do your best work" in science, and that it "may become a more valuable Christian service than if you were to enter the ministry or become a missionary."[14]

It was obviously the right decision. Before his thirteenth birthday, Arthur had been captivated by the hauntingly beautiful sight of brilliant Sirius close to Orion's belt not long after sunset on a clear winter night. Soon he had purchased a decent telescope from the Sears catalog, constructed a tripod mount, built his own camera, and figured out how to turn an alarm clock into a drive mechanism for the whole apparatus. The hour-long photographs that he made are sufficient proof of his technical ability; a few years later, he used the university's telescope to photograph Halley's comet in May 1910.

The year before the comet appeared, however, sixteen-year-old Arthur had his first three publications, including a letter in *Scientific American*; he published a full article in the same magazine two years later. They all concerned the stability of aeroplanes, a timely subject not six years after the Wright brothers' first flight.[15] He was fascinated by flight, and he wrote from experience: he had built and piloted a glider with a 27-foot wingspan, and he had studied scientific papers by aeronautical pioneer Samuel Pierpont Langley, the recently deceased Secretary of the Smithsonian Institution. But he burned the plane near the end of his first year in college and never again studied aerodynamics with a similar intensity. Arthur recalled many years later,

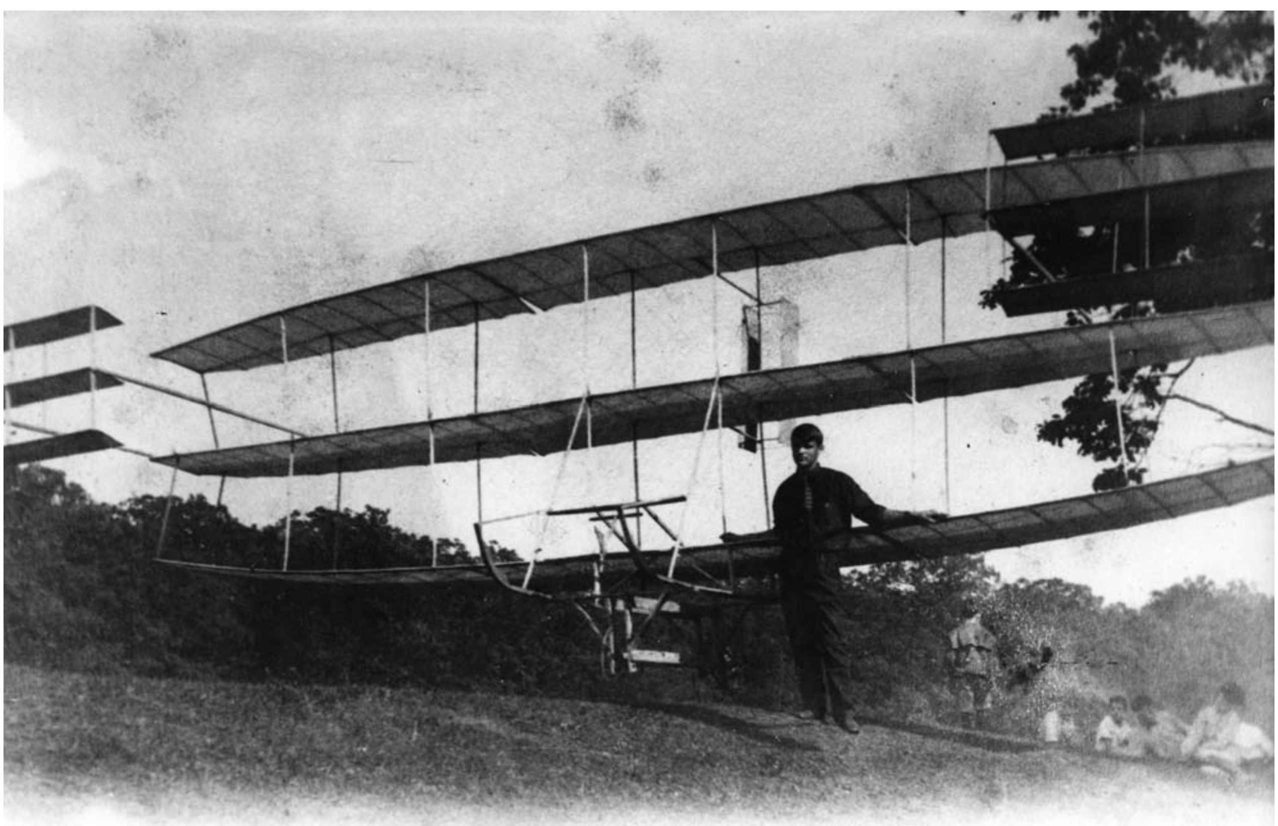
> By the time I reached the age of twenty my interests had become closely confined to research in physics with special regard to the nature of matter and radiation.

Actually he studied as much chemistry as he did physics — but no biology — and it was chemistry professor William Zebina Bennett who had purchased the x-ray equipment that Arthur and his brother Karl used to good effect. In Wooster's alumni magazine a few years earlier, Bennett had pushed the importance of the applied sciences — engineering, architecture, forestry, sanitation, and agriculture — for further progress. Thirteen-year-old Arthur probably resonated with this message. Certainly he read it: his copy, marked to show the passages that caught his attention, survives today among his papers. Mostly he just underlined the occasional word, but two extended passages are delineated in the margins. In one, Bennett advised the young person to consider spending two years at a technical school. The other is about moral character, and in hindsight its significance for Compton is immediately obvious. Character, Bennett said, "is as necessary to success in any line of engineering, as it is in church or Sunday school." The successful person must be trustworthy, and "the world is coming to realize that high moral character, integrity, [and] correct living" garner respect and are commercially valuable. He added,

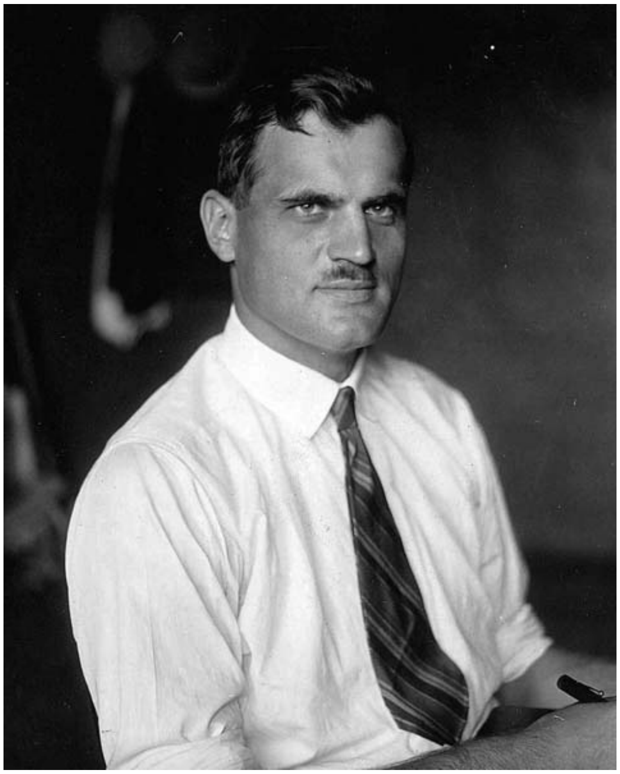
> Develop your character as you develop muscle and intellect, so that you may stand against the manifold temptations which the business world presents. For this end remember that the christian church, the christian school and the christian home are the great agents for the development of such character as the practical engineer will need, and as the successful engineer must have.[16]

In his final year of high school, Arthur had often accompanied Karl to the radiation laboratory—Karl had remained at Wooster to complete a master's degree on the Wehnelt interrupter, part of the electrical equipment needed to operate the x-ray tube. Arthur used the same apparatus for his own experiments about three years later, an experience that "was of substantial help" to him later at Princeton. He also took two years of French, several units of Bible, and a course in apologetics taught by Chalmers Martin, an evangelical Presbyterian who had briefly been a missionary in Laos and had taught Old Testament at Princeton Seminary and Princeton College before joining Wooster's faculty. The text for Martin's course, *The Grounds of Theistic and Christian Belief* (1883) by Yale theologian and church historian George Park Fisher, a former president of the American Historical Association, stressed the reality of miracles and their crucial importance for authenticating Christianity—a position that Arthur certainly did not accept a dozen years later, although I do not know exactly what he thought at the time. Far more influential were six courses in philosophy and psychology—all that Wooster offered, and all probably taught by his father—in which he excelled, earning the philosophy prize; he had a higher grade only in an astronomy course that he took alongside general physics in his junior year.[17]

In class and undoubtedly in numerous informal conversations over many years, Arthur learned his father's views on freedom, dignity, and altruism—and he fully embraced them, from adolescence until death. As valedictorian of the Wooster Preparatory School in 1909, his address on "The Value of a Life" portrayed humanity as sinful creatures, physically insignificant in a vast, impersonal universe. At the same time, we are "a being of infinite possibility," for God has given us "the power to set the law of life in Christ" over "the law of death in sin." Thus, "The only great thing in the world is man, and the only great thing in man is his individual will." Life, Compton told his classmates, "is just what we make it," and "real success" resulted from service



Arthur holding his triplane glider, c. 1909.
Courtesy of Arthur Holly Compton Personal Papers, University Archives, Department of Special Collections, Washington University Libraries.



Arthur Compton,
at an unknown date early in his scientific career.
Courtesy of Special Collections, The College of Wooster Libraries.

to others: "it is he who *gives* the most, not he who *gets* the most, who reaches the highest success."[18]

He reiterated this message in a commencement oration when he graduated third in his college class in June 1913. Using the missionary physician David Livingstone and others as examples of "serving others because of love for their fellowmen," Compton cited the words of Jesus in Matt. 23:11,

> These men and women have heard the message of Him who died to render the greatest of all services to mankind: "He who would be great among you, let him be servant of all."

This contrasted with the pursuit of personal pleasure, which "is as natural as the law of self preservation." Education was the way to instill altruism—especially at the Christian college: "Founded primarily *not* for technical training, but for the building of character, it exists *not* to help its students make a *living* but to help them make a *life*." Such institutions were therefore assets of great value to the nation.[19]

For a more detailed exposition of his views at Wooster, however, I turn to his senior thesis, a remarkable sixteen-page typed essay on God, nature, and humanity that warrants close attention. In the opening paragraph, he announced,

> I feel that unless clearly prevented by logic, I should make my theory of the world agree as far as possible with the principles laid down by the Master Thinker, Jesus Christ.

Then he plunged into a critique of dualism, "the doctrine which I held before I began to study philosophy," according to which "there are in reality two distinct kinds of substances, mind and matter." On this view, God created elementary matter such as electrons "at some definite time" that Compton did not specify. The electrons then "combined and evolved, forming first the chemical elements and chemical compounds, then the stellar universe under the action of gravitation, and finally life was evolved in simple forms." Natural selection "produced all the higher animals and man as we know them." According to Compton, God's role in this picture was only at the beginning "and at such stages as at the beginning of life and the beginning of consciousness where he either inserts a 'new principle,' or starts a 'new force' to work in the universe as it stands."[20]

This was a typical view for theistic evolutionists of the late nineteenth and early twentieth centuries. An influential prototype was (for example) the Scottish philosopher and theologian James McCosh, who had become president of the College of New Jersey (now Princeton University) in 1868, partly owing to his progressive attitude toward modern science. The first theologian in America publicly to support Darwin, McCosh accepted evolution insofar as it was "properly limited and explained."[21] The principal limit to evolution, in McCosh's opinion, was its inability to account for "new powers" such as life, sensation, intelligence, the soul, and morality; these required a vital force of some unspecified type, under divine guidance—thereby preserving a crucial role for God and ensuring human dignity. Compton would shortly contrast this with the view he favored (below).

As for materialism, "which would make mind a direct product in the evolution of matter," Compton held "that there is a very essential difference between mind and matter which makes it impossible that the former should be developed from the latter." As a "free agent," consciousness "is the source of an indefinite amount of spontaneous energy, so that in directing the actions of the body it violates the principle of the conservation of energy on which materialism rests itself." If consciousness were not free, then it would not be able to control our actions and would have "no conceivable use." Such a consciousness could not have developed by evolution. Furthermore, "the universe as we know it is not eternal," Compton added, and "therefore matter must have had a cause to produce it." Applying the second law of thermodynamics, he argued that "the constant dissipation of radiant energy" meant either that "the universe should have long ago cooled to absolute zero," or else that it should at least "be at absolutely uniform temperature throughout. Since neither of these conditions exists, the universe cannot have been eternal."[22]

But dualism did not escape Compton's analysis unscathed. If space is "ontologically real," he argued, then it "must be unlimited and therefore all inclusive, hence [it] must include our souls and God." If God is everywhere, he asked, then "is all of God" or only "a part of Him" in each part of space? Compton was unhappy with the implications of both answers, so for this and other reasons he rejected the idea that space is an ontological reality. Consequently, "dualism in its ordinary sense, that matter is real and spatial and that mind is likewise real and different from matter," had to be given up.[23]

On the dualist view, he reminded himself, it was necessary for God "to intervene by inserting a 'new principle' or starting a 'new force' to work in the universe as it stands." How much "more probable," he suggested, either

> for man to be evolved out of matter without any interference, or that God should be back of the world continually, sustaining it and controlling it in all its development. The first method would be materialism which we have found untenable, while the second, which is personal idealism, seems quite probable.

In addition, "Since God is a spirit, the creation must have been performed in a spiritual manner," and we can understand this only by "analogy with the action of our own minds." But "our minds can produce nothing but thoughts," so "unless God's creation of the world is altogether different from any experiences of ours, it must have been a process analogous to thinking, and matter must be similar to our states of consciousness."[24] Compton therefore felt "compelled to give up both materialism and dualism," turning instead to personal idealism, "the doctrine that mind is the fundamental reality, and that the objective world is a mere product of the activity of the Supreme Mind or Spirit, God."[25]

In his last three paragraphs, Compton advanced the theology of creation that grounded his overall picture of reality, spelling out "what we mean when we say that the world is a product of God's activity …" Just as we cannot conceive "of a thought or volition which exists apart from mental activity," so "we may think of the physical world as being both produced and maintained by God's mental action." Just as we work out our ideas "by means of more elementary ideas," so "we may think of God developing the universe from the elementary electrons through the various stages to man." By "maintaining and controlling the action of certain electrons," he believed, God "has in mind the purpose of developing them into man." On this view, he concluded,

> the difficulties confronting us on the dualistic system with regard to evolution now disappear, for since the development of the world is continually subject to the will of God, the introduction of life and consciousness are no longer mysterious.

Furthermore, "the uniformities of action in nature are easily explained on the supposition that these are uniformities in the way in which God acts." Although he affirmed that God acts freely, at the same time "God the Master Thinker acts uniformly, thus accounting for the laws of nature." Finally, what about immortality? If "we think of it as the final product of the evolution of God's world," and keeping in mind that "the existence of everything depends only upon God's continued care," then immortality seems "more than probable."[26]

By the twenty-first year of his life, then, Compton found his father's philosophy of personal idealism the most convincing way in which to explain both the universe and our own minds. His theology of creation echoed that of Mateer and his father: God acted continually and purposefully, controlling the universe and life as it developed from the original form that God had given it at some point in the distant past—a conception consistent with the orthodox Christian affirmation that God is both immanent within the world and transcendent over it.

Christ represented the supreme example of self-sacrifice, the triumph of spirit over the law of nature. These elements of his faith and the personal idealism he linked them with would have been embraced by several liberal evangelical thinkers of the time, including Borden Parker Browne, George A. Gordon, Francis J. McConnell, and George Albert Coe.[27] I have found no similar documents from the next period of Compton's life.

Fourteen years later, when he was awarded the Nobel Prize in 1927, he and his wife were members of a church whose overall outlook was far more liberal theologically than anything he had experienced in Wooster. Yet while his mature views developed considerably beyond those of his college days, he never completely left them behind.

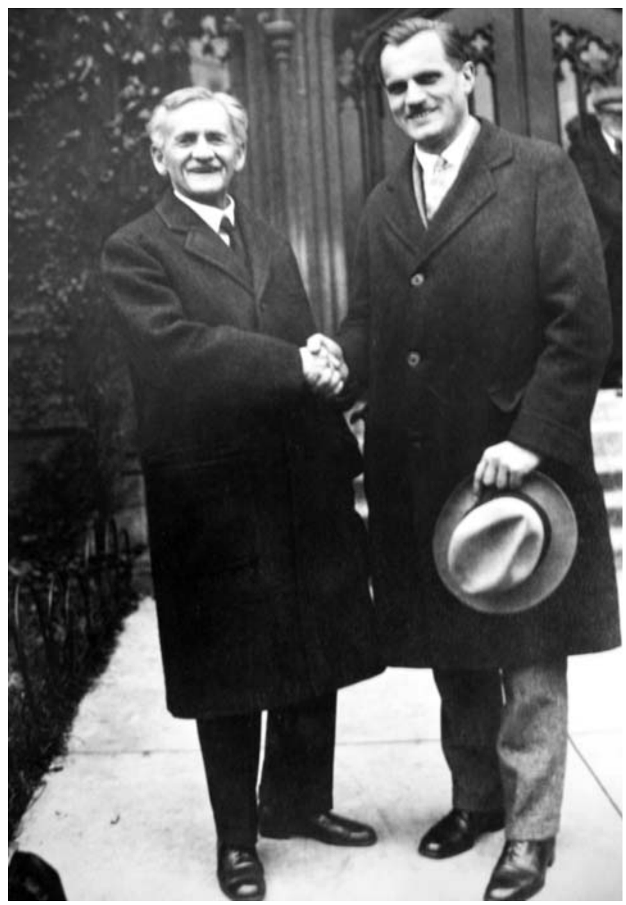
Physics and the Nobel Prize

Only a few weeks after graduating from Wooster, Arthur published an article about an apparatus he had invented to demonstrate the earth's rotation in *Science*, the leading American scientific journal—a prodigious feat for an undergraduate even then.[28] That fall, he followed his brothers Karl and Wilson to Princeton for graduate work.

The "best scientist" Compton encountered at Princeton was future Nobel laureate Owen Willens Richardson, an Englishman who accepted a professorship at King's College London just a few months after Compton arrived on campus and began working with him. Nevertheless, as his former student Robert Shankland has noted, Compton was the designated beneficiary when Richardson was unable to take his x-ray apparatus with him; they became lifelong friends, and Compton would later spend the summer of 1920 in Richardson's London laboratory. Working as a graduate student under H. Lester Cooke, with active assistance from several other Princeton faculty, Compton completed his dissertation on x-ray diffraction by crystals (this was only shortly after the Braggs pioneered this type of research) in 1916 and published the results a few months later in the *Physical Review*.[29]

Having finished his doctorate, Compton promptly married his Wooster classmate, Betty McCloskey, in a double wedding (Betty's sister was the other bride), with his brother Wilson as best man and his father presiding.[30] He taught physics at the University of Minnesota for only one year before accepting a job in engineering research at the Westinghouse Electric and Manufacturing Company in East Pittsburgh, Pennsylvania. Although he always valued the practical uses to which scientific knowledge could be put—as an undergraduate, he had expected to end up eventually in engineering—he found himself increasingly attracted to pure science. In 1918, in the midst of his work for Westinghouse, he spoke to the Wooster Honors Society on "Our nation's need for scientific research," in which he stressed the importance of pure science as the background for practical applications and something that was "in the long run more useful." It is a worthy goal, he assured the audience, to add something "of eternal material value" to our stock of knowledge. But scientists are usually driven by something more. Most scientific men, he said,

> catch a glimpse of what God was thinking when he planned His world, and they needs must



The first American Nobel laureate for physics, Albert A. Michelson, congratulates the third, Arthur Holly Compton, in the fall of 1927.
Courtesy of John J. Compton

> follow that thought as far as He will permit them. The ambition to know more of the world in which we are placed and to help others to know more of it is the chief source of inspiration for the true man of science. And rightly so. For who can say that the development of a man's spirit in striving to think God's thoughts after Him is not of greater value than the greatest of material blessings?[31]

Thus science, his chosen field of endeavor, was ultimately a spiritual enterprise for Arthur Compton.

During the two years he spent with Westinghouse, Compton first learned about new, unexplained phenomena associated with x-rays.[32] His increasing interest in pure scientific research led him to resign his position at Westinghouse. With the benefit of a fellowship from the National Research Council, the Comptons (with their one-year-old son, Arthur Alan) sailed off to post-war England. Arthur spent much of the next year doing gamma-ray scattering experiments at the Cavendish Laboratory in Cambridge, working with the man whom he regarded as "the greatest of the [Cambridge] physicists," Ernest Rutherford, but he had not lost interest in x-rays. Both are forms of electromagnetic radiation and, as Shankland has emphasized, Compton's work in this period was increasingly focused on "the nature of the basic interaction between radiation and electrons and less concerned with the use of X rays as a tool to determine electron distributions in crystal structures."[33]

On his way back to the United States aboard the RMS *Aquitania* in late summer 1920, Compton envisioned the crucial x-ray scattering experiments that he would carry out in his next academic post, at Washington University in St. Louis.[34] During the next two years he worked on x-rays colliding with electrons, leading him to conclude that x-rays behave like particles in such interactions, for which he shared the Nobel Prize for physics with C. T. R. Wilson in 1927. Thirty years later, Nobel laureate Gerty Cori told him a rumor she had heard several times while working with the National Science Foundation: that he had chosen this particular area "after reading in a survey of physics that the field of x-ray diffraction was a neglected field in this country." Compton's recollection was different. Actually, he replied,

> a survey published by the National Research Council shortly after World War I, and supposed to cover the important fields of physics, did not refer at all to the scattering of x-rays. I myself knew that the field was important and was encouraged by the fact that when an authoritative committee overlooked the field entirely there would be an opportunity for me to get my work well in hand before others crowded into the field. Thus, the report was important to me because of what it failed to say.[35]

Compton himself corrected this omission for the National Research Council. He was added to a committee of its Division of Physical Sciences in 1921, a year after three separate reports on x-ray spectra, written individually by committee members, were published late in 1920, all of which cite papers by Compton, who published his own report on x-ray scattering in October 1922.[36] A year later the great German physicist Arnold Sommerfeld was already referring to "Comptoneffekt," and that autumn Compton succeeded Robert Millikan (who had moved to Caltech the previous fall) as professor of physics at the University of Chicago. The Nobel Prize followed four years later.[37]

Although he began to write and speak much more for the general public after receiving the Nobel Prize, Compton's research activities continued unabated for at least another decade, judging from the steady stream of publications in the best scientific journals that appeared under his name right down to World War II. Apart from further work on x-ray scattering, from the accumulated evidence of many elegant experiments he demonstrated conclusively that cosmic rays are charged particles, contradicting Millikan's vociferously defended opinion that they were gamma rays.

All told, he was a superb experimental physicist who became known for the very active role he took in his laboratory, building his own apparatus, blowing his own glassware, and working closely with his assistants.[38] An indefatigable worker, during the war he took on heavy responsibilities with innumerable interminable meetings at all hours that would have worn down many others—as happened to physicist Samuel K. Allison, who was hospitalized for exhaustion while helping Compton run the Chicago branch of the Manhattan Project.[39]

In late November 1927, about two weeks before he actually received the Nobel Prize in Stockholm, Compton was awarded an honorary doctorate from Wooster at a related celebration. According to Allison, this meant more to him than any other honor, owing to his close ties with Wooster.[40] Elias Compton opened the ceremony with an invocation, in which (among other things) he thanked God

> for the prophets of science, … the seers who add to our knowledge of the world, make possible still further discoveries of truth, enlarge our conception of Thyself, and open the way to more applications of science for human good.[41]

Arthur's activities and writings from this point forward demonstrate that he still shared his father's moral vision of the purpose of science, and soon he would begin sharing it with scientific and lay audiences. Arthur Holly Compton was about to become a prophet of science.

Notes

[1]Compton, *The Freedom of Man* (New Haven: Yale University Press, 1935), 66.

[2]Complete lists of his 182 scientific papers are found in *Scientific Papers of Arthur Holly Compton*, ed. Robert S. Shankland (Chicago: The University of Chicago Press, 1973), 763–73, and in *The Cosmos of Arthur Holly Compton*, ed. Marjorie Johnston (New York: Alfred A. Knopf, 1967), 459–68, an excellent anthology cited henceforth simply as *Cosmos*. Many of his other writings are identified below.

[3]"Cosmic Clearance," *Time* (January 13, 1936): 28.

[4]No full biography of Compton has yet been written. "Personal Reminiscences," in *Cosmos*, 3–52, is his longest autobiographical statement. His book, *Atomic Quest: A Personal Narrative* (New York: Oxford University Press, 1956), contains some autobiographical passages and is a key source for his religious views. James R. Blackwood, *The House on College Avenue: The Comptons at Wooster, 1891–1913* (Cambridge, MA: The MIT Press, 1968), offers an insightful picture of his immediate family, though little on Arthur himself; Blackwood's essay, "Arthur Compton's Atomic Venture," *American Presbyterians* 66.3 (Fall 1988): 177–93, complements his book nicely. Samuel K. Allison, "Arthur Holly Compton," *Biographical Memoirs of the National Academy of Sciences* 38 (1965): 81–110, surveys his scientific career.

[5]Quoted in Blackwood, *The House on College Avenue*, 16. On Elias Compton's career at Wooster, see "The Compton Collection," http://library.wooster.edu/services/spc/compton.php (accessed 15 January 2008).

[6]Compton, "The Effect of Social Influences on Physical Science," in *Cosmos*, 81–100, on 93.

[7]Lucy Lilian Notestein, *Wooster of the Middle West*, 2 vols. (Kent, OH: The Kent State University Press, 1971), 1.39–40, 45, 120, 143–4, and 184–5. Mateer was still teaching evolution in 1922, when Presbyterian layman William Jennings Bryan spoke at Wooster and subsequently tried to halt denominational funding of the college; ibid., 2.265–8, and L. Gordon Tait, "Evolution: Wishart, Wooster, and William Jennings Bryan," *Journal of Presbyterian History* 62 (Winter 1984): 306–21. Further details about Mateer's courses are in Mark A. Wilson, "Our Origins of Scientific Thought," *Wooster* (Fall 2002): 14–16. For an interesting overview of religion and science at Wooster and other Ohio colleges in the early twentieth century, see Sherman B. Barnes, "Learning and Piety in Ohio Colleges, 1900–1930," *The Ohio Historical Quarterly* 70 (January 1961): 214–43.

[8]Horace Nelson Mateer, *Evolution and Christianity* (Wooster: The Herald Printing Co., 1895), reprinted in 1908. Quotations from Mateer's article and pamphlet are taken from Wilson, "Our Origins of Scientific Thought," 16; cf. Tait, "Evolution," 310.

[9]For example, *The Religion of a Scientist* (New York: Jewish Theological Seminary of America, 1938), 28; "A Modern Concept of God," in *Man's Destiny in Eternity: The Garvin Lectures* (Boston: Beacon Press, 1949), 3–20, on 19; *The Freedom of Man*, 2; *The Human Meaning of Science* (Chapel Hill: The University of North Carolina Press, 1940), x, 30 and 88; and "The Moral Meaning of the Atomic Bomb," in *Toward a Better World*, ed. William Scarlett (Philadelphia: The John C. Winston Company, 1946), 157–74, on 174. He quoted the verse again to conclude his inauguration address as chancellor of Washington University in February 1946; see "Compton Asserts Faith," *The Christian Century* 63 (March 20, 1946): 379.

[10]Elias Compton, "A Short History of Philosophy," *The Bible Magazine* 2.12 (December 1914): 1069–1130, on 1122–4.

[11]Quoted in Blackwood, *The House on College Avenue*, 14.

[12]Information about his doctorate is from Compton Collection, Special Collections, The College of Wooster Libraries, folder on "Compton, Elias—Programs—1889 June 18." Denise Monbarren found this on my behalf. On his work at Clark University, see Blackwood, *The House on College Avenue*, 29–30.

[13]Elias Compton, "What Is the Thinker?" *Transactions* (1910): 51–9, quoted in Barnes, "Learning and Piety in Ohio Colleges," 220.

[14]"Cosmic Clearance," *Time* (January 13, 1936): 32; Milton S. Mayer, "Mother of Comptons," *Scientific Monthly* 47.5 (November 1938): 458–61, on 459; Compton, "Personal Reminiscences," 16. For a slightly different version of Elias' words of advice, see *Atomic Quest*, 206–7.

[15]"A Criticism of Mr. C. W. Williams's Article, 'Concerning Aeroplanes,'" *Fly* 1 (February 1909): 13; "Comparison of Wright and Voisin Aeroplanes," *Scientific American* 100 (February 1909): 135; "Striving for Perfect Machine," *Aeronautics* 5 (August 1909): 58ff; and "Aeroplane Stability," *Scientific American Supplement* 72 (August 1911): 100–2.

[16]Compton, "Personal Reminiscences," 16; W. Z. Bennett, "The Call of Science, or the New Learned Profession," *The Wooster Quarterly* no. 77 (October 1905): 1–14, quoting 11–12 in the marked copy from Arthur Holly Compton Personal Papers, University Archives, Department of Special Collections, Washington University Libraries, series 1, box 1. Further references to this collection are given as AHC Papers. On Bennett, see Notestein, *Wooster of the Middle West*, 1.107–8 and 171–3. I am grateful to Suzanne Bates, Registrar, The College of Wooster, for information about Arthur's course of study.

[17]Compton, "Personal Reminiscences," 17, and note 42:8 on 427. Elaine Smith Snyder, Special Collections Associate at The College of Wooster Libraries, provided information about Elias Compton's teaching load and the content of Martin's course. On Martin, author of *Apostolic and Modern Missions* (New York: Fleming H. Revell, 1898), see Herbert R. Swanson, "Prelude to Irony: The Princeton Theology and the Practice of American Presbyterian Missions in Northern Siam, 1867–1880," doctoral dissertation at The Melbourne College of Divinity, 2003, available at www.herbswanson.com/thesis_irony/thesis.php (accessed October 1, 2007). On Fisher, see *American National Biography,* s.v. "Fisher, George Park."

[18]"The Value of a Life," AHC Papers, series 1, box 1, folder 4, his underlining. John J. Compton shares my view of his grandfather's substantive, ongoing influence on his father.

[19]"The Purpose of the Christian College," AHC Papers, series 1, box 1, folder 4, his emphasis.

[20]"My Philosophy: A Thesis Showing the Comparative Merits of Dualism, Materialism and Personalism," AHC Papers, series 1, box 1, folder 4, dated March 29, 1913, 1–2.

[21]James McCosh, *The Religious Aspect of Evolution*, rev. ed. (New York: Charles Scribner's Sons, 1890), x, quoted by James R. Moore, *The Post-Darwinian Controversies: A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America, 1870–1900* (Cambridge: Cambridge University Press, 1979), 246. I rely here on Moore's analysis of McCosh's views.

[22]"My Philosophy: A Thesis Showing the Comparative Merits of Dualism, Materialism and Personalism," 2–3.

[23]Ibid., 6–8.

[24]Ibid., 10–12.

[25]Ibid., 12–13.

[26]Ibid., 14–16.

[27]I am indebted to Jon H. Roberts for suggesting these specific names.

[28]Compton, "A Laboratory Method of Demonstrating the Earth's Rotation," *Science* 37 (May 23, 1913): 803–6.

[29]Compton, "Personal Reminiscences," 17. For Shankland's study of the relationship between Compton and Richardson, see *Scientific Papers of Arthur Holly Compton*, 751–5. I have also benefitted from Shankland's summary of Compton's early career, on xiii–xxix.

[30]Compton listed details of his family history in an outline dated March 26, 1952, which he sent to his secretary Marjorie Johnson and to his son John J. Compton, AHC Papers, series 3, box 15, folder "Personal."

[31]"Our nation's need for scientific research," holograph essay in a blue book, AHC Papers, series 1, box 1, folder 4. An edited version is found in *Cosmos*, 239–42. I quote the holograph version, corresponding to passages on 240 and 242 in the published version.

[32]George W. Gray, "Compton Sees a New Epoch in Science," *New York Times* (March 13, 1932): 20. Compton told Gray that his interest in x-rays was piqued by reading a paper by an unnamed British scientist at the end of World War I.

[33]Compton, "Personal Reminiscences," 29; Shankland, *Scientific Papers of Arthur Holly Compton*, xvii–xviii.

[34]"Problems to be tackled at Saint Louis," photocopy of incomplete manuscript (missing pages 3 to 9), ACH Papers, series 3, box 1, folder "1921–1922." Roger H. Stuewer draws attention to this in *The Compton Effect: Turning Point in Physics* (New York: Science History Publications, 1975), 160–3.

[35]Cori to Compton, June 2, 1952, and Compton to Cori, June 6, 1952, AHC Papers, series 3, box 15, folder "Personal."

[36]William Duane, "Data Relating to X-ray Spectra," *Bulletin of the National Research Council* 1.6 (November 1920): 383–408; Bergen Davis, "Intensity of Emission of X-rays and Their Reflection from Crystals," *Bulletin of the National Research Council* 1.7 (December 1920): 409–26; and David Locke Webster, "Problems of X-ray Emission," *Bulletin of the National Research Council* 1.7 (December 1920): 427–55; Compton, "Secondary Radiations Produced by X-rays, and Some of Their Applications to Physical Problems," *Bulletin of the National Research Council* 4.2 (October 1922): 1–56, quoting 1. Compton chaired this committee from 1923–1925, according to the information in *American Men of Science*, ed. J. McKeen Cattell and Jacques Cattell, 5th ed. (New York: The Science Press, 1933), 221.

[37]Sommerfeld to Compton, October 23, 1923, AHC Papers, series 3, box 1, folder "1914–1930"; Stuewer, *Compton Effect,* reproduces the original letter with a translation on 247–9. Stuewer argues (pp. 217–8) that Compton was led to his discovery as a consequence of his own evolving experiments and theoretical insights over the preceding six years and not because he was directly influenced by Einstein's light-quantum hypothesis. Indeed, as one support for his claim, Stuewer points out that Compton did not cite Einstein's paper in his own paper of 1923, nor did he even mention Einstein's name in it. Robert S. Shankland points out that Karl Compton's dissertation was based on experiments on the photoelectric effect, but, as Stuewer notes, like his advisor Richardson he did not accept Einstein's light-quantum hypothesis. Shankland agrees that Arthur Compton probably arrived at his conclusions "by a different route, namely, from the classical electrodynamics that he had learned so thoroughly at Princeton …" *Scientific Papers of Arthur Holly Compton*, xix.

[38]"Cosmic Clearance," *Time* (January 13, 1936): 32.

[39]Samuel K. Allison, "Arthur Holly Compton, Research Physicist," *Science* 138 (November 16, 1962): 796.

[40]Ibid., 797.

[41]Elias Compton, "Invocation," in Compton Collection, box 1c, "AHC—Prayers [about] 1927 Nov 28?" Courtesy of Special Collections, The College of Wooster Libraries.