



Edward B. Davis

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

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The second part of this article discusses Arthur Holly Compton's religious activities and beliefs, especially his concept of God. Compton gave a prominent role to natural theology, stressing the need to postulate "an intelligence working through nature" and using this to ground religious faith. At the same time, this founder of quantum mechanics used Werner Heisenberg's uncertainty principle against the widespread view that humans are trapped in a mechanistic universe that permits no freedom of action.

Whence then comes our world? Though science does not offer a positive answer to this question, it can point out that an intelligible world in which intelligent creatures appear seems reasonably to imply an intelligence working in the world, a basis on which most scientific men build their approach to religion. This implies that if our God is the God of Nature, we must recognize the laws of nature as describing the way in which God works, and a basis for a theology is found. We find that through the long, hard struggle of evolution men have come to the stage where they are partly responsible for the development of life, even their own life, on the earth. Thus science can lead to the conception of man as a co-worker with God toward making this world what he wants it to be.

—A. H. Compton, 1938¹

Arthur Compton's emergence as a public intellectual after winning the Nobel Prize followed directly from a visit to India he had made the previous year. His sister Mary and her husband, C. Herbert Rice, had been educational missionaries together in India since their October 1913 wedding. Rice was heavily involved with Forman Christian College in Lahore (now part of Pakistan), teaching psychology and serving as principal for several years. Supported by a Guggenheim Fellowship, Arthur spent the academic year of 1926–1927 in Lahore, at the University of the Punjab, where Rice would later become president after the partitioning of India and Pakistan.

Upon his arrival in Calcutta, Arthur learned that he was expected immediately to lead a cosmic ray expedition to Darjeeling in the foothills of the Himalayas—and that he was supposed to supply the experimental apparatus. Seeking out physicist C. V. Raman, who would win the Nobel Prize in 1930, he got the help he needed to rig an electroscope out of the bowl of a hookah—and it worked. Conversations with the

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scientists who accompanied him into the mountains, some of whom later held positions of responsibility in India and Pakistan, was something of an epiphany for Compton. “Years later,” he recalled in his brief autobiography, “I told my friends that it was the beginning of my education.” Seeing a foreign culture close up forced him to examine his own, and “the new values that I found unsuspectingly hidden in Oriental culture were balanced by a new depth of insight into the values of life in my own country.” The “active interest in philosophy, especially ontology, as taught by my father,” which “had lain dormant” since his student days, was awakening, spurred on by his “broadening culture interests” and by recent “developments of quantum theory that seemed to have interesting philosophical implications.” He became particularly interested in determining “whether physical laws are sufficient to account for the actions of living organisms,” and he began to consider “the relation of science to religion, a problem with which my father had wrestled, and which we had frequently discussed in my college days.”²

Compton’s View of God, Nature, and Humanity

Arthur Compton had always been a religious man, and some of his personal habits connected him with many conservative Protestants even if his increasingly liberal theological beliefs did not. He abstained from hard liquor and rarely smoked. Author Sherwood Eddy quoted an unnamed friend saying that “his home is a praying home. Above all his life is joyously, radiantly religious, minute by minute.”³ As a boy and during his undergraduate days at Wooster, he and his family attended Westminster Presbyterian Church, which was founded as the university church in 1874. While a graduate student, he taught Sunday School at the First Presbyterian Church (now Nassau Presbyterian Church) in Princeton, where his students included the two sons of the distinguished physicist Augustus Trowbridge, both of whom became Episcopalian priests.⁴

For the next four years, when he lived briefly in Minnesota, Pennsylvania, and England, his church activities are not known, but while at Washington University from 1920 to 1923, the Comptons joined Grace Methodist Episcopal Church (now Grace United Methodist Church), located not far from the university on the west side of St. Louis, where they

sang in the choir. In December 1925, after Compton succeeded Robert Millikan in Chicago, they joined the Hyde Park Baptist Church (now Hyde Park Union Church), just down the block from their ample brick home at 5637 South Woodlawn Avenue in the leafy neighborhood bordering the university. He taught Sunday school for four years and served as deacon for three years. When the Comptons returned to St. Louis after the War, they joined the Second Presbyterian Church in March 1947. Arthur was an elder there from 1948 until his death in 1962; Betty became an elder at some point after the denomination in 1964 permitted women to hold that office. And each summer starting in 1935, the Comptons attended the First Congregational Church (now First Congregational United Church of Christ) of Gaylord, Michigan, close to the family cottage on Otsego Lake. They were drawn there, according to their son John J. Compton, by “a remarkable, Oberlin-educated pastor, Rev. [L. Mervin] Isaacs,” who “inspired my grandparents and parents with his thinking and prophetic social gospel messages ...”⁵

For understanding Compton’s adult religious views, the Chicago congregation is by far the most important of these associations. It was a church of almost singular significance for its geographical and theological location at the center of the self-styled “modernist” movement in American Protestantism, some of whose leading representatives were connected with the University of Chicago and its widely influential Divinity School. The university’s first president, Hebrew scholar William Rainey Harper, had been a member of Hyde Park Baptist for many years until his death in 1906, and his scholarly example helped to shape the church’s identity. Harper’s close friend Shailer Mathews, dean of the Divinity School for a quarter century, was probably the most prominent member when the Comptons arrived in Chicago; their colleague, the radical modernist theologian Gerald Birney Smith, was also an active member.⁶ So was philosopher and intellectual historian Edwin Arthur Burtt, a secular humanist (he signed the “Humanist Manifesto” of 1933) whose book, *Religion in an Age of Science* (1930), contains a sharp critique of liberal Protestant efforts to accommodate modern scientific attitudes and conclusions that must be read partly as a highly unsympathetic commentary on his fellow members’ ideas. Considering the historical “conflict” of religion and science, he wrote,

“How much can I still believe?” is the question pathetically asked ... Beginning with two score or more doctrinal articles there ensues a process of elimination and attenuation till today, in liberal circles, the minimum creed seems to have been reduced to three tenets: belief in God, confidence in immortality, and conviction of spiritual uniqueness in Jesus of Nazareth ... Thus the pathetic game of give what must, hold what can, continues.⁷

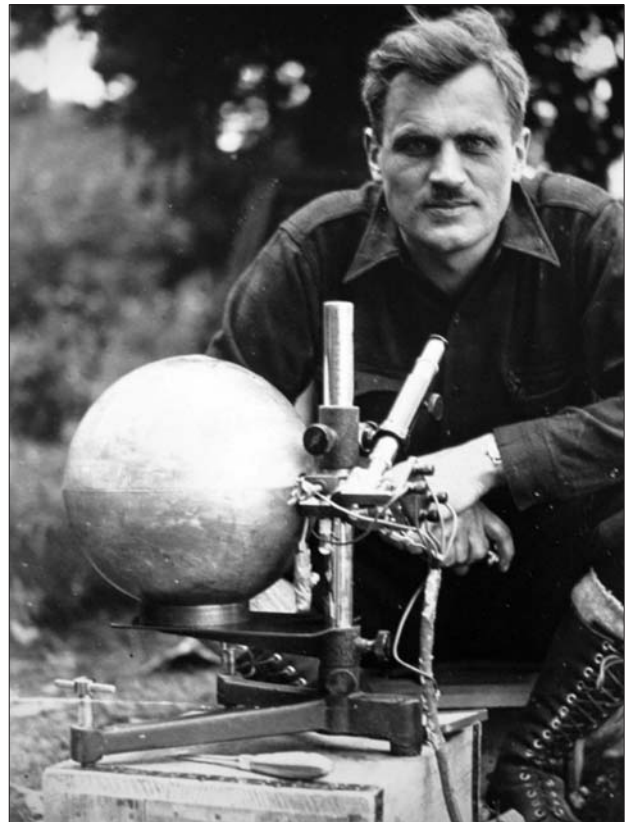
At least a few members of Hyde Park Baptist Church probably doubted even these three tenets, but Compton did not. In short, the church was not only a hotbed of religious liberalism, but also a gathering place for leading intellectuals who did not necessarily share even a basic commitment to theism. Thus, Compton’s views were developed and expressed within a friendly but theologically contentious environment that reflected the vigorous intellectual climate of a major university, with which probably a large majority of the membership were closely connected.⁸

When the Comptons joined Hyde Park Baptist in 1925, the pastor was Charles Whitney Gilkey (whose son, the late Langdon Gilkey, would become a leading theologian), an inclusive religious thinker who was already, at forty-three years of age, regarded by his peers as one of the twenty-five most influential Protestant ministers in the nation.⁹ The following year he was named professor of preaching at the Divinity School, and his diverse congregation decided “to receive all serious Christians into membership without regard for mode of baptism or other tests of belief.”¹⁰ The Comptons and the Gilkeys soon became good friends, and when Gilkey stepped down from his pulpit three years later to assume similar duties as dean of the magnificent new chapel on campus (later named in memory of the donor, John David Rockefeller), Compton provided highly visible, ongoing support. As chair of a student-faculty committee that gave oversight to the chapel, he read the dedicatory service in October 1928; short addresses were given by John D. Rockefeller, Jr. and Haverford College historian Rufus Matthew Jones, an influential Quaker mystic who served as visiting university preacher at the time.¹¹

In 1930, responding to student requests, Compton organized an Easter symposium on “Immortality,” at which he and Mathews both spoke—a crucial

event in his intellectual life that will be discussed in part three (in the next issue of this journal). We must not overlook the importance of this type of public witness in his own eyes. According to his son, “my father strongly felt the need to show students and his often suspicious colleagues that a man of science could also be a man of religious faith. So he arranged programs on the campus, wrote and lectured widely on science and religion,” and helped plan the chapel programs.¹²

The decidedly ecumenical stance of Hyde Park Baptist epitomized the modernist religious attitude: what mattered most was Christian social action and moral conduct, not adherence to any specific set of doctrinal beliefs or even conversion experiences. The modernists also stressed divine immanence—the idea of God as dwelling and working “within” nature and the human heart, not “outside” of nature as the transcendent God of Christian tradition was believed to do. In their view, Jesus was not literally the second person of God become incarnate; rather, he was the supreme moral example who had trusted



Arthur on an expedition to study cosmic rays, ca. 1932–33, possibly on Mt. Evans in Colorado. The counting apparatus was designed to be carried on the back of a mule.

Courtesy of John J. Compton.

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and obeyed his heavenly Father and loved his fellow human beings self-sacrificially. The immanent God was thus immanent in Jesus, and by following his example, God could also be immanent in us. Where classical Christian theology understood God in terms of *both* immanence *and* transcendence, the modernists of the 1920s typically stressed divine immanence much more than divine transcendence, often ignoring the question of transcendence and, in a few cases, perhaps even doing away with it entirely as an objective category.¹³

A number of leading American scientists of that decade were committed modernists, such as Caltech physicist Robert Millikan (whose Neighborhood Church in Pasadena was a near duplicate of Hyde Park Baptist), Harvard geologist Kirtley Mather, Chicago botanist John Merle Coulter, and Carnegie Institution eugenicist Charles Davenport. Compton fits into this group fairly well, although he had a more robust understanding of divine transcendence than Millikan or Shailer Mathews; certainly he was no longer an orthodox Christian.¹⁴ According to his son, Arthur Compton's religious beliefs

quite naturally evolved away from Elias' Christian orthodoxy and philosophical idealism, but kept their moral and ethical core. He knew the Bible thoroughly and quoted it often, but there was little of his parents' piety and I never heard any testimony of special religious experiences. There was nothing about sin and salvation or about having Jesus in your heart! He had little sympathy with theological doctrines, sacraments, or creeds. I was sitting next to him in the Second Presbyterian Church in St. Louis one Sunday morning when I noticed that he had fallen silent while everyone around us was reciting the Apostle's creed. So I asked him why. His answer was simply that "It's because I don't believe everything in it and I don't want people to think I do."¹⁵

With characteristic candor, Arthur Compton had answered his son's question directly. What then did he believe, if not this classic confession of Christian beliefs?

The main elements of Compton's religious beliefs are set down in his book, *Atomic Quest* (1956), which, though written near the end of his life, summarizes what he had probably believed for at least thirty years and perhaps longer. I begin with his

understanding of God. "To me God appears in three aspects," he wrote, yet he did not mean the traditional doctrine of the Trinity even though his thoughts included the Father, Son, and Spirit. First, and "universally recognized," God "is simply the best one knows, to which he devotes his life," including love for others, truth for living, and "harmony of adjustment that brings beauty and graciousness and smooth cooperation in every aspect of human affairs." The Christian "finds his own soul" through commitment to this cause, which is "greater than himself." The "pre-eminent importance of what happens to persons," Compton observed, is the "central point" of agreement among world religions. With "its insistence on the inherent value of individual men and women," he emphasized, "Christianity has the key to survival and the good life in the modern world." Overall, he confessed that "making it possible for men and women to grow to their fullest worth as persons can be my highest form of worship."¹⁶

A second aspect was God's "conscious Power," possessing "a special concern for its conscious creatures who share the responsibility for shaping their part of the world." This goes beyond just "the forces of nature that science recognizes," to an awareness of other persons as being like ourselves. "More particularly," Compton said, "I follow Jesus' teaching that this Power that is the basis of existence holds toward me and all other persons the attitude of a wise and loving father." Thus, for Compton, we humans are co-creators with God, and "the opportunity to share with God the shaping of the conditions of life is a tremendous challenge and the great responsibility that comes with freedom." Our greatest task, therefore, "is to make it possible for others who are equally God's children to do their responsible share," and, in this way, we become "more worthy of God's companionship."¹⁷

"The third aspect of God that I recognize," Compton continued, "is that which shows itself in the lives of noble men," those "whose love of their fellows, whose unselfish devotion, and whose integrity of spirit have meant much to their community and have enriched their own lives." Such persons were for him "the embodiment of God" and were greatly to be emulated. The supreme example was Jesus. His life and teaching "form the most reliable guide that I have found for shaping my own actions." It is in following him "that I call myself

a Christian." Jesus exemplified for Compton, in his own version of 1 Cor. 13:13, "love of neighbor as expressed in helpful service, hope for the future that inspires his followers, faith in God and fellowmen." "Based upon the records," Compton concluded, "I have so idealized Jesus that he has become for me the Son of God to a unique degree." Furthermore, Jesus' spirit "is an aspect of God, now alive in men and women," and it shapes the world through us. "This is what I mean when I say that Jesus is God," and, therefore, also "an aspect of the God I worship."¹⁸

Former Harvard President James Bryant Conant, a chemist who had worked closely with Compton on the Manhattan Project and knew him very well, understood this chapter as "a clear statement of the

doctrine of Unitarianism (though you may not admit it)."¹⁹ Conant had hit the mark. Though happily a lifelong Presbyterian, Compton understood Jesus as a unique human being, but not divine, essentially the Unitarian view. It is not insignificant that his pastor at Gaylord, Michigan, a very liberal Congregationalist trained at Oberlin, once closed a sermon by quoting this very part of Compton's book.²⁰

Science fit into this picture in at least two ways. First, Compton quite literally saw divine providence at work in atomic energy. Given that supplies of fossil fuels are dwindling, "atomic energy is coming just in time to meet a fundamental human need." "Is it surprising," he asked more than rhetorically, "if we should see here working the hand of Providence?" We needed fossil fuels to reach our



The Compton family—all four siblings, their spouses, and their parents—
at their summer home on Otsego Lake, near Gaylord, Michigan, ca. 1937.
Courtesy of Special Collections, The College of Wooster Libraries.

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present level of scientific and technical accomplishment, and if they had been much less abundant, they would have run out before we were ready to use uranium. Likewise, “the fortunate fact” of half a century’s experience with radium and x-rays “introduced us to the dangers as well as the possibilities of atomic radiation,” without which we might face a “human tragedy” with nuclear energy. There was also a moral benefit, since “this gift of new power is forcing man toward a higher level of human development.” We must “learn humanity” as “the condition for survival in the atomic age.”²¹ Specialists must cooperate more fully, educational opportunities must be enhanced, and “we must find objectives on which we agree.” Compton’s own objectives were unapologetically democratic—and for the most part, they probably fell on sympathetic ears during the Cold War. “In the development of the inherent value of every person,” he concluded, “we thus find the fundamental and inspiring goal upon which we may hope that free men will agree.” Love for others was the key to reaching this goal, bridging science and religion: “Life takes on meaning in a technological society if our hearts are in the human growth of those for whom we work.” In other words, quoting his father, “Providence works through people, and we must do what we can to give Providence a chance.”²²

Compton also believed that science strongly supported the existence of an intelligence behind nature, a theme he was discussing in public talks by the late 1920s, including an address to the General Assembly of the Presbyterian Church in 1929.²³ At times, he made arguments that might fairly be seen to involve an early form of the anthropic principle, arguments that resemble some of those associated with the modern “intelligent design” movement—although he saw design as a philosophical and theological inference *from* science, not as an explanation *within* science to be employed when other explanations failed. He used the very term “intelligent design” in a lecture he gave in 1940 at the Church of our Father, Unitarian (now Unitarian Universalist Church) in Lancaster, Pennsylvania. “The chance of a world such as ours occurring without intelligent design,” he said, “becomes more and more remote as we learn of its wonders.” In one of the strongest endorsements of natural theology that any modern scientist has ever uttered, he added that “the study of natural science is the primary source of the raw

material for building our idea of God.” His talk inaugurated an annual series about immortality and modern concepts of God, established by the will of the retail merchant Milton T. Garvin, a founder of the Lancaster church.²⁴

The two printed editions of Compton’s lecture have some nicely worded passages—he was an articulate speaker. However, I will summarize instead the longer, more scholarly version of the same material, in chapters three and four of a book he dedicated to his father, *The Freedom of Man* (1935), an expanded version of the three Terry Lectures he delivered at Yale University in November 1931.²⁵ The ideas about God, nature, and humanity expressed there were crucially important to Compton. He repeated them (often verbatim) in several other lectures and publications over the next fifteen years, including (among others) his Garvin Lecture and an address he gave to the Jewish Theological Seminary of America in New York in November 1938—not to mention the prestigious John Calvin McNair Lectures at the University of North Carolina in November 1939, which were published the following year as *The Human Meaning of Science*.²⁶

Preparing for the Terry Lectures only reinforced Compton’s youthful confidence in a divine intelligence. As he told an interviewer four months later, “The study of physics has changed my conception of the kind of god, but has strengthened my confidence in the reality of God. I feel surer of a directive intelligence than I did at 20.” Hydrogen atoms, carbon molecules, and living cells were “all built up out of simple units: electrons and protons. It seems to the n^{th} degree improbable that such an intricate and interesting world could have ordered itself out of particles with random character.” The world revealed by modern physics “can only be the result of an intelligence working through nature.”²⁷ Elaborating on this in *The Freedom of Man*, Compton began by observing that, while some scientists still felt “the need for a Creator to start the universe,” the design argument “has never been adequately refuted,” and “few indeed are the scientific men of today who will defend an atheistic attitude.” Faith in God could even be “a thoroughly scientific attitude,” if “based on the experience that the hypothesis of God gives a more reasonable interpretation of the world than any other,” and if it enhances the life of the religious believer. Openness to new evidence

would probably lead to some changes in one's conception of God, Compton commented, "but a man is a scientific or religious coward if he is unwilling to brave the storm in the hope of reaching the firmer ground on the other side."²⁸

He went on to show how specific problems in physics, astronomy, and biology all illustrated the presence of intelligence in the universe. First, he considered the characteristics that protons, neutrons, and electrons needed to have "in order that they may be capable of massing themselves together to form a complex and interesting world such as ours." Employing various models in which the properties of these fundamental particles were allowed to vary, physicists had tried unsuccessfully to produce a hypothetical world capable of developing into one of comparable complexity. Compton wondered, could the formation of our world be just an accident? "If so," he suggested a bit sarcastically, then "chance can choose much more wisely than the best scientific minds of today."²⁹

Turning to astronomy, Compton pointed out that scientific opinion on the age of the universe was "sharply divided," but that "the prevailing view at the moment seems to be that the universe as we know it had a beginning at a more or less definite time," anywhere from a few billion to a few quadrillion years ago.³⁰ This reflects early versions of what would later become known as the big bang theory. As for the ultimate fate of the universe, some astronomers agreed with the great Cambridge astrophysicist Arthur Eddington that the second law of thermodynamics ruled out a cyclical universe; others, such as Chicago astronomer William MacMillan, Caltech physicist Richard C. Tolman, and Yale philosopher F. S. C. Northrop, defended an eternally cyclical cosmos.³¹ But "many of the defenders of both views," Compton noted, especially Eddington and Northrop, "have found it difficult to understand the world as other than the expression of the activity of a high Intelligence."³²

Finally, echoing views he had held since college, Compton claimed that many biologists and paleontologists saw evolution not as a purely random Darwinian process, but rather as a directional process taking a direct course. On this particular point, his views were rapidly becoming passé—it was during the 1930s that the neo-Darwinian synthesis came together—but as he saw it, all three sciences

supported the inference that there is an underlying intelligent power.

What sort of power could this be—friendly, or indifferent, to humanity? Where Einstein and others spoke of an impersonal creator, equivalent to rational order in the universe, Compton wanted his God to take special interest in human beings. We are quite special, he believed, and inhabited planets, like the earth, are of great rarity, even in an enormous and enormously old universe. Compton had recently taken such a position in the pages of *Science*, only to be challenged by Cincinnati astronomer Jermain G. Porter. Compton had replied by citing Eddington and James Jeans for support.³³ He repeated this claim in the Terry Lectures:

There is reason to believe that we may occupy at present the highest position in the universe with respect to intelligent life. Does it seem then too bold to assume that the intelligent Creator, whose existence as we have seen is by far the most reasonable basis for accounting for our world, should take an active interest in the welfare of the uniquely intelligent beings he has created on our earth?³⁴

Granted, the world "is a vast machine," characterized by "immutable" natural laws, and "the world plays [no] favorites by showing partiality toward man." Through evolution, however, we have acquired the ability to learn those laws and live accordingly—indeed, this is "the great contribution of science to humanity." Admittedly there has been "tragic, apparently ruthless, suffering" at each point in our evolutionary history, but Compton could not imagine a more effective way of "achieving adaptation to environment ... than the one we see now working in nature." What is more, he saw this as a process of almost unlimited potential, in terms of human mental development. We are "clearly in the early stages of evolution. It would be a gross understatement," he added without blinking an eye, "to claim that with regard to such attributes as clarity of reason, appreciation of beauty, or consideration of our fellows, our remote descendants may be expected to excel us as greatly as we are in advance of the Java ape-man."³⁵

There was nothing particularly unusual about Compton's evolutionary optimism. Scores of liberal Protestant scientists and clergy from that period believed that evolution would, with our active

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involvement, bring about moral improvement in one way or another. For more than a few, eugenics was part of that process, but I have found no evidence that Compton supported eugenics.³⁶ He did not hesitate, however, to find biblical support for his confidence in evolutionary progress, quoting what he erroneously referred to as “two Old Testament statements,” when, in fact, both come from Paul’s letter to the Romans. In his opinion, the friendliness of natural laws “to the well-adapted organism” finds an “exact parallel” in Romans 8:28 (“All things work together for good for him who serves the Lord”), while the opposite principle is well captured by Romans 6:23 (“The wages of sin is death”). With exegesis such as this, it is not hard to understand why Protestant fundamentalists found their liberal co-religionists so hard to tolerate.³⁷

Compton’s picture of our moral history and prospect was directly influenced by his colleague at Chicago, the famous Egyptologist James Henry Breasted, author of *The Dawn of Conscience* (1933), a work that also influenced Millikan. Breasted dated what he called the “Age of Character” to between four and five thousand years ago, and he believed that we still find ourselves only at the dawn of that era, with a bright noon yet to come in the distant future.³⁸ Up to that point, Compton asserted, “God held in his own hands the whole responsibility for evolution of life upon this planet. Gradually this responsibility is being shifted to our shoulders,” leaving us with the challenge “of working with the God of the Universe in carrying through the final stages of making this a suitable world and ourselves a suitable race for what is perhaps the supreme position of intelligent life in His world!” This led Compton to conclude as follows:

Science can thus have no quarrel with a religion which postulates a God to whom men are as His children. It is possible to see the whole great drama of evolution as moving toward the goal of the making of persons, with free, intelligent wills, capable of learning nature’s laws, of seeing dimly God’s purpose in nature, and of working with him to make that purpose effective.³⁹

Such a broad vision is not without its difficulties, as Compton realized. Most of all, he was worried about theodicy, “God’s undoubted responsibility for permitting evil to be present in the world, if our view

is correct that the laws of nature represent His mode of action.”⁴⁰ Here he was particularly impressed by the ideas of the English mathematical physicist Ernest William Barnes, author of *Scientific Theory and Religion* (1933). During his tenure as a Cambridge don, Barnes had been ordained an Anglican minister, and six years after being elected to the Royal Society, he left Cambridge for an equally distinguished career in the church, culminating in his appointment as Bishop of Birmingham in 1924.⁴¹ Compton probably encountered Barnes’ ideas during the academic year 1934–35, when he was George Eastman Visiting Professor at Oxford—he cited the 1934 edition of Barnes’ book, he completed *The Freedom of Man* in May 1935, and he added passages borrowed from Barnes to the typescript on separate handwritten pages, after the text was all but finished.⁴²

Barnes argued that we could not discern the reason why God used the struggle of evolution to produce our higher moral and intellectual faculties, but that is what God had done, and we are the unexpected result. As Compton put it, “such evils must be present in order that man’s moral character shall develop.” At this point, he simply waved his hands, gesturing at his final chapter (which will be discussed in part three in the next issue of this journal), in which he endorsed Barnes’ conclusion that immortality would ultimately justify the goodness of God. What about God’s mercy, given the suffering of all creatures inherent in evolution? Compton offered only a “very real” mercy that was limited to “the psychological rather than the physical realm.” We know that we have done our best; God and our fellow humans also know this. This suffices to “protect us from the too keen cutting edge of conscience. Here it is that a sane well-balanced religion offers the solace for which men yearn.”⁴³

Prophet of Science: Human Freedom and Scientific Indeterminism

The Freedom of Man is manifestly about freedom, and, at that time, freedom was widely perceived to be under attack from science, especially from psychology and experimental biology. Jacques Loeb, a leading physiologist, epitomized this threat in *The Mechanistic Conception of Life* (1912). In his view, the ultimate goal of biology was to explain all aspects of life in terms of physics and chemistry.

We may wish to believe that we can act freely, Loeb argued, but in reality, even our higher feelings and ideals are nothing more than tropisms, involuntary responses to external stimuli. “Not only is the mechanistic conception of life compatible with ethics,” he wrote, “it seems the only conception of life which can lead to an understanding of the source of ethics.”⁴⁴ Loeb died in 1924, the same year in which attorney Clarence Darrow invoked psychological determinism to defend another Loeb, not related to the first. Richard Loeb and Nathan Leopold were gifted and privileged young college graduates who had kidnapped and viciously murdered a fourteen-year-old boy, simply for the thrill of trying to commit the perfect crime. The Leopold-Loeb trial was sensational, and the strategy Darrow employed was not only successful—he persuaded the judge not to impose death sentences—but it was also consistent with his personal beliefs.⁴⁵

The following year, shortly before Darrow went to Tennessee to defend John Scopes in an equally famous trial, paleontologist Henry Fairfield Osborn blamed psychology for the irreligious image of science. Writing in *The Forum*, a prominent national magazine, he claimed that “psychologists have lost touch with the soul,” an impression he confirmed through his friend James McKeen Cattell, the former Columbia psychologist who edited the journal *Science*. Osborn quoted Cattell as saying,

I can talk more intelligently about any other subject than the soul. It is well known that psychology lost its soul long ago and is said now to be losing its mind. You should inquire of Descartes and the Catholic Church; it is a good subject for a paleontologist like yourself!⁴⁶

Compton had long rejected reductionist approaches to psychology. As a deeply religious man with a moral vision for science, the very possibility of religion and morality as he understood it depended crucially on the reality of human freedom: without freedom, we cannot choose to do what Jesus did. Even apart from religious considerations, he believed that freedom was the root of our meaning and worth as human beings.⁴⁷ But how could we be free, if scientific study since the time of Galileo and Newton has so completely established that nature is deterministic? This is how he saw the conundrum of religion in a scientific age, and he solved it to his satisfaction by challenging determinism itself. Compton knew

quantum physics as well as anyone in the world—his own work on the particulate aspect of x-rays had been a key component of wave-particle duality, which in turn was central to the new physics—and he saw in the work of Werner Heisenberg a fissure in the deterministic wall of classical physics.

I do not know when Compton first met Heisenberg; it might have been at the International Conference on Physics at Lake Como in September 1927, which both men attended; they also attended the Fifth Solvay International Conference on Electrons and Photons in Brussels the following month. In any case, Compton invited him to give a series of lectures on quantum mechanics (in German) at the University of Chicago, and he came for several months in the spring and summer of 1929. At the same time, Paul Dirac was visiting the University of Wisconsin; the previous year, he had turned down Compton’s offer to appoint him to a new chair at Chicago and also an invitation to visit Chicago. Dirac and Heisenberg probably met several times during this period, including at least once in Chicago, and they decided to sail together from San Francisco to Japan, where they had both been invited to speak.⁴⁸ (Heisenberg came back to Chicago in 1939 for a conference on cosmic rays. On that occasion he stayed with the Comptons and played classical music on the piano in their living room. Arthur urged Heisenberg to remain in America, but the German sensed war coming and felt that his nation would need him.⁴⁹)

Heisenberg’s lectures were a model of clarity, notwithstanding the liberal use of advanced mathematics for which he was well known. What stuck out in Compton’s mind, however, was not the elegant mathematics but a short prose section on Niels Bohr’s concept of complementarity. As Heisenberg explained,

the resolution of the paradoxes of atomic physics can be accomplished only by further renunciation of old and cherished ideas. Most important of these is the idea that natural phenomena obey exact laws—the principle of causality.⁵⁰

Having shown the door to classical physics, Heisenberg advised those physicists still in the room “to review the fundamental discussions, so important for epistemology, of the difficulty of separating the subjective and objective aspects of the world.”⁵¹

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Compton quoted the first of these two passages in a talk about causality and science that he gave to the Physics Club of Chicago in early November 1930; his numerous subsequent lectures and writings on this general topic show that he took the second passage no less seriously.⁵²

Looking more closely at this talk—delivered just as Compton was re-examining, at the height of his career, an issue that had interested him so much as a student—I am struck by his heavy reliance on *A History of Science and Its Relations with Philosophy and Religion* (1929), by William Cecil Dampier. Compton once told a theological educator that this

book was “of great value” for its “appreciation of the relationships between science and philosophy and religion.”⁵³ Like many other historians of science from that period, Dampier wrote about religion and science from the now-discredited “warfare” perspective, which consequently colors Compton’s approach.

Following Dampier, Compton presented Socrates as an enemy of scientific thought, owing to his skepticism and his opposition to the mechanistic thinking of the ancient atomists, which “left no room for that freedom of choice which is the basis of morality ...” When Socrates placed mind over



Physicists gather in front of the Ryerson Physical Laboratory in Chicago in 1929, probably in April or May in connection with Heisenberg’s lectures.

Left to right (front row): Werner Heisenberg, Paul Dirac, Henry G. Gale, and Friedrich Hermann Hund; (back row): Compton, George S. Monk, Carl Eckart, Robert S. Mulliken, and Frank C. Hoyt. Eckart had earned the B.S. and M.S. degrees in engineering from Washington University in St. Louis, while Compton was chairing the physics department there. Eckart and Hoyt translated Heisenberg’s Chicago lectures into English, with a foreword by Compton, as *The Physical Principles of the Quantum Theory* (1930). Mulliken had worked with all three European physicists, especially Hund, with whom he developed the Hund-Mulliken theory of molecular orbitals. At the time this photograph was taken, Compton was the only Nobel laureate in the group, but Heisenberg (1932) and Dirac (1933) would soon join him in winning the physics prize, and Mulliken was awarded the Nobel Prize for chemistry in 1966. Max-Planck-Institute, courtesy AIP Emilio Segre Visual Archives. (Gift of Max-Planck-Institute via David C. Cassidy.)

matter, he put morality against science. Plato's idealism did likewise; his followers only denigrated science and abandoned the idea of natural law, especially when they imbibed "Chaldean magic, miracles, and astrology," leading to "a super-rational idealism known as Neoplatonism." In this analysis, ancient science failed because "its apparent denial of the effectiveness of purpose showed its uselessness. Science had failed to illuminate man's path of life."⁵⁴

The rise of Newtonian science two thousand years later, according to Compton, forced us to accept a clockwork universe "over whose operation we have not the slightest control," raising once again the question of morality and freedom. This time, however, "it was no longer possible to laugh science out of court. Men had too much common sense to abandon again the great truths that science had given." The scientist was content to leave freedom to the philosopher, Compton commented, ignoring "the logical inconsistency of his position. He must have faith that his world is one of law," but "if his own actions are 'with a cause and by necessity' he cannot in truth 'make a search' at all."⁵⁵ In other words, freedom is indispensable to the actual practice of science—an important insight that Compton would keep repeating for the rest of his life.

The dilemma evaporated, however, with the coming of Heisenberg. Perhaps causality still holds for some unobserved properties of atomic particles, but for experimental purposes this does not matter: "it is as a *physical* principle that the law of causality must be abandoned," Compton proclaimed with evident glee. Einstein might not like it, but "the younger generation of physicists considers this principle an inescapable consequence of existing data ..." To this the thirty-eight-year-old Compton added, "I myself should consider it more likely that the principle of the conservation of energy or the second law of thermodynamics would be found faulty than that we should return to a system of strict causality."⁵⁶

At this point, extending physical uncertainty into biology, Compton appealed to a prescient article by the distinguished physiologist Ralph Stayner Lillie, his colleague at Chicago. Lillie's paper had appeared in *Science* just a few months after the publication of Heisenberg's derivation of the uncertainty relation for position and momentum—which

Lillie did not cite, although he did cite a recent paper on quantum theory by German physicist Pascual Jordan. In a wide-ranging, philosophically oriented discussion of nervous activity, Brownian motion, genetics, and other "ultramicroscopic" phenomena in organisms, Lillie suggested that quantum indeterminism "would conceivably explain the indeterminism or inner freedom seen in voluntary action ..."⁵⁷ For his part, Compton noted that indeterminacy at the quantum level would lead to unpredictable initial conditions for macroscopic events within organisms, as a nerve pulse at the molecular level is amplified many times. "Considering the complexity of the small-scale events associated with any of our deliberate acts," he wrote, "one may say with assurance that on a purely physical basis the end result must have a relatively great uncertainty." Compton did not believe that he had thereby solved "the old question of *how* mind acts on matter," but he did maintain that the new physics allows for it, "and suggests where the action may take effect."⁵⁸ What he really sought, we might say, was freedom to believe in freedom, not scientific proof of it—an attitude that he later clarified for his critics in *The Human Meaning of Science*.⁵⁹

In the twelve months between his talk for the Physics Club of Chicago and his Terry Lectures at Yale, Compton's views on this topic became increasingly visible. In March 1931, he shared his ideas with what a reporter described as "a large audience" in New York. In August, in five short paragraphs on a single page in *Science*, he cited Lillie's paper against the determinist views of the noted physicist Charles Galton Darwin, grandson of the great naturalist. The following month, the *Yale Review* published a revised version of the talk he had given in Chicago the previous November, and a few months later Compton reiterated his thoughts in the third and final Terry Lecture.⁶⁰

The version published four years later as the first two chapters of *The Freedom of Man* has the same overall argument as the others, but develops some points more fully. Most physicists just ignore the implications of classical physics, he noted, adding that "probably most of us have had an ill-defined idea that in our own actions some influences are effective which are not describable by physical laws." If nothing in our lives goes beyond electrodynamics, then "we are in truth merely complicated machines; whereas if other factors are significant,

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our laws of physics are incomplete descriptions of the world in that they do not describe our own actions." It has to be one or the other, and it is obviously important for the physicist to "know the realm within which his laws are applicable, and how far they are adequate to give a complete description of the world." To understand the actions of a living creature, he argued, psychological factors such as motives had to be taken into account; knowledge of the physical circumstances alone does not suffice to predict what a creature will do. Given the indeterminism inherent in quantum theory, however, "it is no longer justifiable to use physical law as evidence against human freedom."⁶¹ What is more, although differences in states of consciousness are "not detectable by any known type of physical test," they must nevertheless exist. Natural selection has in higher animals "brought consciousness to an ever higher level of development," something that should not happen "if consciousness were of no value to the life of the animal," or if "the animal were incapable of affecting its course of action."⁶²

A founder of quantum theory, Compton was convinced that the new physics was closely related to this, since quantum uncertainties affecting microscopic events "may result in an equal uncertainty

in an event of great magnitude." For example, let a faint ray of light pass through a very narrow slit, and put a pair of amplifiers in the path of the diffracted beam coming out of the slit (fig. 1). Attach one amplifier to an explosive charge that would destroy the apparatus, and attach the other to a switch that turns off the apparatus. If a single photon comes through the slit, then the apparatus will either explode or turn itself off. Both events are equally probable, but the precise outcome is unpredictable. Suppose now that a physicist sets up a similar apparatus with two photocells attached to amplifiers, and then decides to go home for lunch when the next photon enters photocell A. "Here is a human action which is definitely subject to Heisenberg uncertainty," Compton concluded. Citing Lillie's paper, he added "that all deliberate actions of living organisms seem to be events of this kind." Nerve pulses are "presumably electrochemical reactions on a minute scale," and mental processes are probably similar, in which case the small number of molecules involved results in "an appreciable uncertainty."⁶³

By combining uncertainty in quantum mechanics with causality in other aspects of nature, Compton believed that he had solved "the old dilemma of freedom in a world of law." In such a world, "man

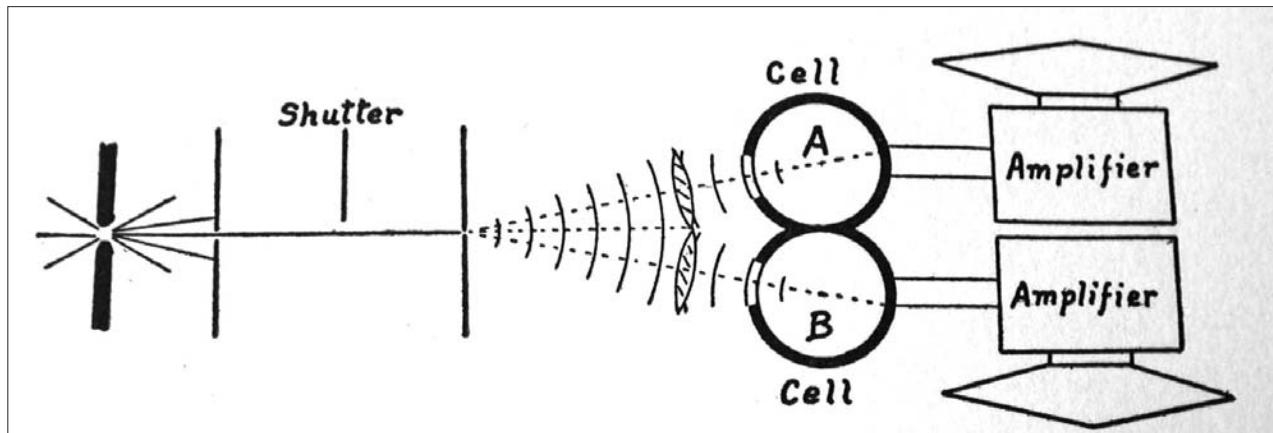


FIGURE 1

Nature does not obey exact laws. On successive trials, photons of light which traverse the slits do not always enter the same photoelectric cell.

Figure 1. Diagram of photon diffraction experiment from A. H. Compton, *The Freedom of Man* (New Haven, CT: Yale University Press, 1935), 39. Reproduced by permission of John J. Compton.

is left by science in control of his own actions within the bounds set by natural law," and "the powerful argument for morality ... in a world governed by law," which Compton associated with Pythagoras, is "emphasized by every advance of science." Thus science, rather than overturning morality, "now presents new reasons why men should discipline their lives, and supplies new means whereby they can make their world more perfect." Furthermore, he stated, "our physical laws have acquired a new generality," since now "we may justifiably assume that these laws apply equally to living and non-living matter," whereas Newtonian physics lacked universal validity "unless human freedom was considered fictitious."⁶⁴

Significantly, Compton did not, at that point in time, make a similar case for divine freedom. He did not argue explicitly that quantum uncertainties offer a possible locus for divine action in the universe. He touched on it only implicitly, when he was asked in May 1930 what the new physics "has to say about the old problems of free-will, immortality, and God?" Heisenberg's uncertainty principle, he answered, undermines mechanistic accounts of consciousness and "leaves room for an effective intelligence behind the phenomena of nature."⁶⁵ He went further than this only in an address he gave to the American Philosophical Society many years later in 1956, saying that the mechanistic universe "not only rules out the effectiveness of an assumed *Divine* Agent, but rules out also the effectiveness of the *human* will in determining the course of physical events." The demise of determinism changed all this:

[T]he physical laws as they are now known, are not inconsistent with the effectiveness of purpose in shaping the events in nature. This ... applies equally to one's own actions with reference to his responsibility for what he does, and to events occurring in the external world as related to other intelligences, either of men or of God. That is to say, we recognize now that we cannot call on physics and astronomy to give evidence for the effective action of free minds, either human or divine. But at the same time we recognize also that we cannot, on the basis of any kind of physical observation, deny that either human or divine minds may be effective in determining the course of certain types of events, in particular the actions of living organ-

isms. Whether mind may participate in determining the course of events simply cannot be answered by physical observations.⁶⁶

Even here, the possibility of God acting on nature at the quantum level is not stated openly, though Compton may have had it in mind.

Others did explicitly suggest this possibility in the 1950s, however, when theologians Karl Heim and Eric Mascall and physicist William Pollard all advanced versions of that idea. And in some ways, as Nicholas Saunders has noted, Compton's discussion of human agency in *The Freedom of Man* resonates with later efforts to understand divine agency—especially his point that unpredictable quantum events can have important macroscopic consequences.⁶⁷

Compton understood that his ideas about the reality of free will and the limits of science would be controversial, but at least a few other leading physicists held similar views. Robert Millikan, for example, believed that the "philosophical determinism which has always been a presumptuous and a scientifically unwarranted generalization is now shown by experimental physics itself to be a false generalization." Like Compton, he held that a more limited "scientific determinism" was "merely a convenient working hypothesis, certainly no more difficult to reconcile with free will than are the wave properties of electrons and photons to reconcile with their corpuscular properties." Applied mathematician Warren Weaver of the Rockefeller Foundation, a friend of both Millikan and Compton, suggested that the conscience plays a role in our behavior "similar to that played by Schrödinger's ψ function relative to the behavior of electrons." As a devout Quaker, Arthur Eddington's commitment to human freedom was, if anything, even stronger than that of Compton, and he, too, stressed the role of consciousness in amplifying uncertainties at the microscopic level.⁶⁸ Indeed, Compton thought that "there is perhaps nothing better" than Eddington's book, *The Nature of the Physical World*, when it came to dealing with "the metaphysical implications of modern physics."⁶⁹

Most philosophers, however, have not been very enthusiastic about Compton's defense of freedom. An outstanding exception is Karl Popper, who in 1965 gave the Compton memorial lecture at Washington University, published the next year as a

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booklet, *Of Clouds and Clocks* (1966). Popper's argument resonates with Compton's: consciousness evolved from the physical world, but it is not itself physical, and it can to some extent control things that are physical.⁷⁰ As for neurologists, Compton recognized the possibility, perhaps being realized in our own day, that "future psychological studies may inform us" whether a thought in the mind "may correspond to the formation of a particular pattern of paths of nerve currents ... in the brain," which thus determines other currents. However, he always remained skeptical of deterministic conclusions that were "so contrary to the dictates of common sense." With Socrates, he felt "that the knowledge which comes to us intuitively through direct experience is of a more fundamental kind than that based upon intricate arguments concerned with delicate tests," so he might still affirm free will if he were living today, despite recent advances in neurology.⁷¹

Notes

¹Arthur Holly Compton, "The Natural Sciences," in *On Going to College: A Symposium* (New York: Oxford University Press, 1938), 141–68, on 159. For a similar passage of comparable eloquence, see Compton, *The Freedom of Man* (New Haven, CT: Yale University Press, 1935), 118–9.

²Compton, "Personal Reminiscences," in *The Cosmos of Arthur Holly Compton*, ed. Marjorie Johnston (New York: Alfred A. Knopf, 1967), 3–52, quoting 41–2; this anthology is cited henceforth simply as *Cosmos*.

³"Cosmic Clearance," *Time* (January 13, 1936): 32; Sherwood Eddy, *Man Discovers God* (New York: Harper and Brothers, 1942), 177.

⁴Compton, "Personal Reminiscences," 18.

⁵John J. Compton to Edward B. Davis, June 27, 2007. For further information, see James R. Blackwood, "Arthur Compton's Atomic Venture," *American Presbyterians* 66, no. 3 (Fall 1988): 177–93; the records of Hyde Park Union Church; "About Westminster Presbyterian Church," www.wooster.edu/westminster/about.html; "History [of Grace United Methodist Church]," www.graceumc-stl.org/history.htm; and "A Brief History of Hyde Park Union Church," www.hpuc.org/History/Hist%20-%20History.htm (all accessed 28 May 2009).

⁶Charles Harvey Arnold, *God Before You and Behind You: The Hyde Park Union Church through a Century, 1874–1974* (Chicago: The Hyde Park Union Church, 1974), includes lengthy discussions of the views of many prominent members from the 1920s. For a short summary of Mathews' theological views, see W. Creighton Peden, "Shailer Mathews," in *Makers of Christian Theology in America*, ed. Mark G. Toulouse and James O. Duke (Nashville, TN: Abingdon Press, 1997), 392–8.

⁷Edwin Arthur Burtt, *Religion in an Age of Science* (London: Williams and Northgate, 1930), 122–3.

⁸According to Arnold, *God Before You and Behind You*, 65, "perhaps seventy percent of the members were connected with the University" during the 1920s.

⁹Charles Clayton Morrison, *The American Pulpit: A Volume of Sermons by Twenty-Five of the Foremost Living American Preachers, Chosen by a Poll of All the Protestant Ministers in the United States, Nearly Twenty-Five Thousand of Whom Cast Their Votes* (New York: The Macmillan Co., 1925).

¹⁰This occurred at an unspecified date in 1926; see "A Brief History of Hyde Park Union Church," www.hpuc.org/History/Hist%20-%20History.htm (accessed 1 October 2007).

¹¹"The New University of Chicago Chapel," *Chicago Baptist News* 8, no. 2 (November 1928): 1; Arnold, *God Before You and Behind You*, 78. On Jones' thought, see Matthew Stanley, *Practical Mystic: Religion, Science, and A. S. Eddington* (Chicago: University of Chicago Press, 2007), 37–40.

¹²John J. Compton, "Ariadne's Thread—or How It Helps to Have the Right Ancestors," unpublished and unpaginated typescript cited by permission of the author.

¹³Gary Dorrien, *The Making of American Liberal Theology: Idealism, Realism, and Modernity: 1900–1950* (Louisville, KY: Westminster John Knox Press, 2003); Kenneth Cauthen, *The Impact of American Religious Liberalism*, 2d ed. (Lanham, MD: University Press of America, 1983); David Henry Koss, "The Development of Naturalism at the Divinity School of the University of Chicago with Special Emphasis on the Doctrine of God" (PhD diss., Northwestern University, 1972).

¹⁴On Millikan's idea of God, see Edward B. Davis, "Robert Andrews Millikan: Religion, Science, and Modernity," in Nicolaas A. Rupke, ed., *Eminent Lives in Twentieth-Century Science and Religion*, rev. ed. (Frankfurt am Main: Peter Lang, 2009), 253–74.

¹⁵Compton, "Ariadne's Thread"; cf. his similar comments in Blackwood, "Arthur Compton's Atomic Venture," 191.

¹⁶Arthur Holly Compton, *Atomic Quest* (New York: Oxford University Press, 1956), 344–5.

¹⁷*Ibid.*, 345–6.

¹⁸*Ibid.*, 346–7.

¹⁹Conant to Compton, January 14, 1957, Arthur Holly Compton Personal Papers, University Archives, Department of Special Collections, Washington University Libraries, series 6, box 17, folder "C." Further references to this collection are given as AHC Papers.

²⁰L. M. Isaacs to Compton, January 10, [1957?], AHC Papers, series 6, box 17, folder "I."

²¹Compton, *Atomic Quest*, 324–5, 331.

²²*Ibid.*, 341–2, 336, 352.

²³Compton to George Derby, July 29, 1930, AHC Papers, series 3, box 1, folder "1929–30." He told Derby that he had not yet published anything about this, but that he was then "writing for publication an article along this line ..." It is not clear to which article he was referring.

²⁴This lecture was printed as a pamphlet, *The Idea of God as Affected by Modern Knowledge* (Boston: American Unitarian Association, 1940), and reprinted with talks by eight more Garvin lecturers as "A Modern Concept of God," in *Man's Destiny in Eternity: The Garvin Lectures* (Boston: Beacon Press, 1949), 3–20; quoting 13 and 5 in the pamphlet or 11 and 5 in the book (the wording of the second quotation is slightly different in the book). Identical passages appear in the fourth of five Norton Lectures he gave at Southern

Baptist Theological Seminary in March 1941, under the title "Some Religious Implications of Science," typescript archived at Southern Baptist Theological Seminary Library, Louisville, Kentucky.

²⁵The three lectures became five chapters in the book. For reports on the second and third lectures, see "Compton Sees Life Beyond All Science," *New York Times*, November 13, 1931, p. 25, and "Compton Says Man Guides Own Destiny," November 14, 1931, p. 13.

²⁶Compton, *The Human Meaning of Science* (Chapel Hill, NC: The University of North Carolina Press, 1940) consists almost entirely of material reprinted verbatim from *The Freedom of Man* and a related essay, "The Natural Sciences," in *On Going to College: A Symposium* (New York: Oxford University Press, 1938), 141–68; I will not discuss it further. He presented similar ideas as the Elliot Lectures at Western Theological Seminary (Pittsburgh, 1931), the Loud Foundation Lectures at the University of Michigan (1935), the Lowell Lectures (Boston, 1938), and the Norton Lectures at Southern Baptist Theological Seminary (Louisville, March 1941). Further published versions of these ideas include a pamphlet, *The Evolution of the Soul*, a lecture at Plymouth Congregational Church, Lansing, Michigan, November 10, 1938 (William F. Ayres Foundation, 1938); another pamphlet, *The Religion of a Scientist*, an address at the Jewish Theological Seminary of America on Monday, November 21, 1938 (New York: Jewish Theological Seminary of America, 1938) and subsequent printings; "The Religion of a Scientist," *Sermons in Brief* 1, no. 1 (January 1940): 88–95; "A Scientist's View of Religion," *The Chicago Theological Seminary Register* 30, no. 2 (March 1940): 5–8; and "Freedom," in *Rab Saadia Gaon: Studies in His Honor*, ed. Louis Finkelstein (New York: Jewish Theological Seminary of America, 1944), 107–16.

²⁷George W. Gray, "Compton Sees a New Epoch in Science," *New York Times*, March 13, 1932, p. 20.

²⁸Compton, *Freedom of Man*, 73–6.

²⁹*Ibid.*, 80–81.

³⁰*Ibid.*, 84.

³¹For valuable background on cosmology in the 1930s, see Helge Kragh, *Cosmology and Controversy: The Historical Development of Two Theories of the Universe* (Princeton: Princeton University Press, 2006), esp. 73–9; and Kragh, *Matter and Spirit in the Universe: Scientific and Religious Preludes to Modern Cosmology* (London: Imperial College Press, 2004), 88–103. Kragh's statement in the latter book (92) that Compton "paid less attention to natural theology" than Millikan accurately applies to their disagreement about cosmic rays, but would be incorrect as a broader generalization.

³²Compton, *Freedom of Man*, 88–9.

³³Porter, "Are Planets Rare?" *Science* 72, no. 1859 (August 15, 1929): 170; and Compton, "Are Planets Rare?" *Science* 72, no. 1861 (August 29, 1929): 219. Porter nevertheless agreed with Compton, "That a directive intelligence is evident in the universe is undoubtedly held by a great majority of scientists ..."

³⁴Compton, *Freedom of Man*, 109.

³⁵*Ibid.*, 110–3.

³⁶For a wide-ranging account of religious views of eugenics in this period, see Christine Rosen, *Preaching Eugenics: Religious Leaders and the American Eugenics Movement*

(New York: Oxford University Press, 2004). Edward B. Davis, "Samuel Christian Schmucker's Christian Vocation," *Seminary Ridge Review* 10, no. 2 (Spring 2008): 59–75, provides a detailed study of a scientist who was at the peak of his fame in the 1920s as a popularizer of eugenics and liberal religion.

³⁷Compton, *Freedom of Man*, 113–4.

³⁸James H. Breasted, *The Dawn of Conscience* (New York: Charles Scribner's Sons, 1933), esp. the introduction. Millikan, who belonged to the same church as Breasted, cites him in *The Autobiography of Robert A. Millikan* (New York: Prentice-Hall, 1950), 253, 280.

³⁹Compton, *Freedom of Man*, 114–5. It is interesting to note that another scholar from Chicago, theologian Philip Hefner, has recently advanced a view of humanity that strongly resembles that of Compton, except for a strong ecological emphasis. Hefner sees humanity as "created by God to be a co-creator in the creation that God has brought into being and for which God has purposes." And, "The conditioning matrix that has produced the human being—the evolutionary process—is God's process of bringing into being a creature who represents the creation's zone of a new stage of freedom and who therefore is crucial for the emergence of a new creation." Hefner, *The Human Factor: Evolution, Culture, and Religion* (Minneapolis, MN: Fortress Press, 1993), 32.

⁴⁰Compton, *Freedom of Man*, 116.

⁴¹On Barnes, see Peter J. Bowler, *Reconciling Science and Religion: The Debate in Early-Twentieth-Century Britain* (Chicago: University of Chicago Press, 2001), 260–70.

⁴²Preliminary typescripts of chapters from *The Freedom of Man* are in AHC Papers, series 6, box 9, folders 6 and 15; those in folder 15 clearly supercede the others and probably date from 1932, except for handwritten additions from 1934–1935.

⁴³Compton, *Freedom of Man*, 116–8.

⁴⁴Jacques Loeb, *The Mechanistic Conception of Life: Biological Essays* (Chicago: The University of Chicago Press, 1912), 31. On Loeb's scientific work and the interpretation he gave it, see Garland Allen, *Life Science in the Twentieth Century* (New York: John Wiley and Sons, 1975), 73–81. The famous behavioral psychologist John B. Watson studied neurology with Loeb at Chicago.

⁴⁵Edward J. Larson, *Summer for the Gods: The Scopes Trial and America's Continuing Debate over Science and Religion* (New York: Basic Books, 1997), 71 and note 26 on 278; Simon Baatz, "Criminal Minds," *Smithsonian* (August 2008): 70–9.

⁴⁶Osborn, "Credo of a Naturalist," *The Forum* 73 (April 1925): 486–94, quoting 487.

⁴⁷On this particular point, see Compton, "Science and Man's Freedom," *Atlantic Monthly* 200, no. 4 (October 1957): 71–4 (reprinted in *Cosmos*, 115–24).

⁴⁸For details on the itineraries of Heisenberg and Dirac in America, see Helge S. Kragh, *Dirac: A Scientific Biography* (Cambridge: Cambridge University Press, 1990), 71–5, and Laurie M. Brown and Helmut Rechenberg, "Paul Dirac and Werner Heisenberg—A Partnership in Science," in *Reminiscences About a Great Physicist: Paul Adrien Maurice Dirac*, ed. Behram N. Kursunoglu and Eugene P. Wigner (Cambridge: Cambridge University Press, 1987), 117–62, on 132–7.

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⁴⁹Interview of Charles Weiner and Betty Compton, April 1968, cited by Blackwood, "Arthur Compton's Atomic Venture," 184; John J. Compton confirmed this story.

⁵⁰Werner Heisenberg, *The Physical Principles of the Quantum Theory*, trans. Carl Eckart and Frank C. Hoyt with foreword by Compton (Chicago: University of Chicago Press, 1930), 62.

⁵¹*Ibid.*, 65.

⁵²Compton, "The Effect of Social Influences on Physical Science," in *Cosmos*, 81–100, on 83. The editorial introduction to this essay (81) underscores the influence of Heisenberg on Compton at this point in his life.

⁵³Compton to Georgia L. Chamberlin, May 6, 1931, American Institute of Sacred Literature Records, Special Collections Research Center, University of Chicago Library, box 17, folder 2, henceforth cited as AISL Records.

⁵⁴Compton, "The Effect of Social Influences on Physical Science," 88–90; Dampier, *A History of Science and Its Relations with Philosophy and Religion* (Cambridge: The University Press, 1929).

⁵⁵*Ibid.*, 94–5.

⁵⁶*Ibid.*, 96.

⁵⁷Ralph S. Lillie, "Physical Indeterminism and Vital Action," *Science* 66, no. 1072 (August 12, 1927): 139–44, on 140. Lillie's article seems to have gone largely unnoticed, apart from Compton's writings. An exception would be Martín López Corredoira, "Quantum Mechanics and Free Will: Counter-Arguments," *The Journal of Non-Locality and Remote Mental Interactions* 1, no. 3 (October 2002), an online journal www.emergentmind.org/corredoira13.htm (accessed 29 January 2008), offering a heated, mainly a priori denial of all types of top-down causation.

⁵⁸Compton, "The Effect of Social Influences on Physical Science," 97, 100, emphasis his.

⁵⁹Compton, *The Human Meaning of Science*, viii–x, 49–50.

⁶⁰"Sees Deity Ruling World of Chance," *New York Times*, March 27, 1931, p. 27; Compton, "The Uncertainty Principle and Free Will," *Science* 74, no. 1911 (August 14, 1931): 172; and Compton, "Do We Live in a World of Chance?" *Yale Review* 21 (September 1931): 86–94. The outline and pencil manuscript of this last item are in AHC Papers, series 6, box 9, folder 6.

⁶¹Compton, *Freedom of Man*, 26–9.

⁶²*Ibid.*, 41–4, 55–6.

⁶³*Ibid.*, 49–50.

⁶⁴*Ibid.*, 66–7.

⁶⁵Philip Kinsley, "Antics of Atom Impel Science to Think of God: Compton Tugs at Veil of Mystery," *Chicago Tribune*, May 25, 1930, pp. 1, 20; cf. "Compton to Offer New View of Atom," *New York Times*, May 25, 1930, p. 25. He repeated those words to an audience in New York the following year; "Sees Deity Ruling World of Chance," *New York Times*, March 27, 1931, p. 27.

⁶⁶Compton, "The World of Science in the Late Eighteenth Century and Today," *Proceedings of the American Philosophical Society* 100 (August 1956): 296–303, on 301, italics his. Cf. Compton, "Science and Man's Freedom." If he said something similar earlier, I am not aware of it.

⁶⁷For details, see Nicholas Saunders, *Divine Action and Modern Science* (Cambridge: Cambridge University Press, 2002), 94–110.

⁶⁸Millikan, *Time, Matter, and Values* (Chapel Hill: University of North Carolina Press, 1932), 30, 98–9; Warren Weaver, "Statistical Freedom of the Will," *Reviews of Modern Physics* 20, no. 1 (January 1948): 31–4, quoting 33; Eddington, *The Nature of the Physical World* (New York: Macmillan, 1928), esp. chaps. 10–15. Eddington spoke about this initially in his Gifford Lectures at Edinburgh in the winter of 1927, a few weeks before Heisenberg published his paper on the uncertainty relation. On Eddington's approach to religion and the limits of science, see Matthew Stanley, *Practical Mystic*, 153–68, 194–209, esp. 206–9; and Allen H. Batten, "A Most Rare Vision: Eddington's Thinking on the Relation Between Science and Religion," *Quarterly Journal of the Royal Astronomical Society* 35 (1994): 249–70. For a short history of efforts to relate quantum mechanics to human and divine action, see Daniel Patrick Thurs, "That Quantum Physics Demonstrated the Doctrine of Free Will," in *Galileo Goes to Jail and Other Myths about Science and Religion*, ed. Ronald L. Numbers (Cambridge: Harvard University Press, 2009), 196–205. Saunders, *Divine Action and Modern Science*, 94–172, provides a much more detailed account of several important efforts to relate quantum mechanics to divine action.

⁶⁹Compton to Georgia L. Chamberlin, May 6, 1931, AISL Records, box 17, folder 2.

⁷⁰Karl Popper, *Of Clouds and Clocks: An Approach to the Problem of Rationality and the Freedom of Man* (St. Louis: Washington University Press, 1966).

⁷¹Compton, *Freedom of Man*, note 9 on 58, 59–60.

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