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Gonzaga Lecture II

There is a war going on; there has been for centuries. It is not a war between science and religion. It is a war between religion and a philosophical opinion that is often called “scientific materialism”. Scientific materialism is the idea that the ultimate reality is matter governed by the laws of physics and blind chance. Materialists often wrap themselves in the mantle of science and claim to speak in the name of science. They tell us what the implications of science are. Tonight I would like to talk about one particular battleground of the war between materialism and religion, namely the debate over the nature of man.

What are human beings? To this the materialist and the religious believer give radically contradictory answers. The materialist says that human beings are just animals, and like all other animals are merely complex physical systems. The Jew or Christian, on the other hand, claims that there is something more to our natures, something that goes beyond the physical.

In the Biblical account of creation, only of man is it said that God breathed into him the breath of life and that he “became a living soul” (Gen 2:7). This has always been understood to symbolize the fact that only upon human beings, among all the living things of earth, did God confer a spiritual nature similar in some way to his own. Only man is said to be made “in the image of God” (Gen 1:26-27).

But in what way are we made “in the image of God” and in what way do we have a “spiritual” nature? The traditional teaching says that we are made in the image of God primarily in the sense that, like God, we have **rationality** and **freedom**. We find, in the second century AD, St. Irenaeus of Lyons writing, “Man is rational and therefore like God; he is created with free will and is master over his acts”. When religious believers say that man has a “spiritual soul”, therefore, we are not referring to something occult or magical. We are referring to the faculties of intellect and free will that are familiar to and constantly employed by all human beings. This is a view held by Protestants and Jews as well as Catholics. For example, Calvin wrote, “God [exalted] man above all the other animals to separate him from the common number, because he has attained to no vulgar life, but a life connected with the light of

intelligence and reason, -- [this] at the same time shows how he was made in the image of God.” The *Catechism of the Catholic Church* says this: “By virtue of his soul and spiritual powers of **intellect and will**, man is endowed with freedom, an ‘outstanding manifestation of the divine image.’ ”

According to theology, these “spiritual powers of intellect and will” are “transcendental”, meaning that they allow human beings to transcend or “go beyond” the level of mere sense, appetite, instinct, to perceive what is objectively true, beautiful, and good. These powers, it is claimed, not only exceed the endowments of the lower animals, but necessarily exceed the capacities of anything that is purely physical. In the words of the *Catechism*, “[In] his openness to truth and beauty, his sense of moral goodness, his freedom and the voice of his conscience, ... [man] discerns signs of his spiritual soul. The soul, the ‘seed of eternity we bear in ourselves, **irreducible to the merely material,**’ can have its origin only in God.”

For the materialist, of course, there is no such thing as a “soul”, “spirit”, or “seed of eternity”; there is only matter. For him, a human being, no less than a frog or a rosebush, is a complex aggregate of subatomic entities --- particles or perhaps superstrings --- arranged in a hierarchy of structures, from atom, to molecule, to cell, to organ. That is the whole of human reality for the materialist. A human being is a physical system; and to know all the parts of that system and how they are moving through space and time is to know, in the final analysis, everything that there is to know about him.

The materialist sees the entire course of scientific history as leading inevitably toward this conclusion. In particular, he would point to four developments.

First, it has been shown that biology is reducible to chemistry and physics.

There was a time when many scientists felt that in order to explain living things laws and principles of a fundamentally new kind would be needed. This is now seen to be wrong. It is increasingly clear that the chemistry of living things and of non-living things involve the same basic elements reacting according to the same basic laws.

Second, man appears physically to be an animal like other animals.

This was recognized long before the theory of evolution, of course, but that theory has rubbed our noses in the fact. It is now generally accepted that *Homo sapiens* evolved from now-extinct apelike creatures. A commonly given sequence is *Australopithecus afarensis*, *Homo habilis*, *Homo erectus*, and *Homo sapiens*. Many biologists even argue that the gorilla and chimpanzee should be classified in the genus *Homo*. Certainly, genetically we are close to chimpanzees: chimpanzee and human DNA overlap by about 98%.

Moreover, research on animal intelligence has somewhat narrowed the gap between animals and humans. Chimpanzees and gorillas have been taught to use sign language. And chimpanzees do use and even make tools. They strip the branches and leaves off of sticks so that they can be inserted into holes to draw out the ants or termites for food.

Third, research is learning more and more about the intimate correspondence mental experiences and physical events in the brain.

Here is an interesting example reported in the science pages of the New York Times a few years ago. Researchers found that electrical stimulation of a certain small region of the brain produces amusement or even hilarity in experimental subjects. (“At low currents only a smile was present, while at higher currents a robust contagious laughter was induced.”)

Fourth, computers have shown that machines can perform what we would recognize as “mental” tasks.

Computers can receive data about the world around them from sensory devices, encode this information, analyze it, store it in memory, retrieve it, use it to make decisions, and put those decisions into effect by means of other devices controlled by them. Machines can, in a sense, thus be said to perceive, to choose, and to do. They can perform very well at certain tasks that, for humans anyway, require intelligence, such as playing chess.

Indeed, it has become a widespread opinion among neuroscientists, philosophers of mind, and researchers in artificial intelligence, that the human mind is nothing more than the functioning of a vastly complicated computer. Some think the day not far off when artificial machines will actually think and

become conscious.

For the materialist, the trend is clear: every development in science seems to narrow the gaps between human, animal, and machine, seeming to justify the belief that we are just animals, or as Marvin Minsky, one of the founders of the field of Artificial Intelligence, put it, “Machines made of meat”. Every advance seems an advance toward a mechanistic view of man, in which there is no room for any spiritual element that is “irreducible to matter” -- any “ghost in the machine” as it has come derisively to be called.

Before getting down to the real issues that divide materialist and believer, it is necessary to dispose of some false ones. There is no question that all four of the scientific developments I have just discussed are consistent with the materialist view. However, they are **also** entirely consistent with the religious view. They have little relevance, therefore, to the debate between religion and materialism.

For example, it has never been a part of Jewish or Christian doctrine that the human body differed in any essential way materially from animal bodies or inanimate matter. In fact, the symbolic language of the book of Genesis teaches quite the opposite when it says that man was formed from the “dust of the ground” (Gen 2:7). Some biblical literalists interpret this to mean that we were fashioned directly from dust, rather than arising through a gradual process of evolution. But in either case, whether directly or gradually, the Bible certainly claims that it is from this dust that we ultimately came. This point is made repeatedly throughout the Bible, as in Psalm 103: “Like as a father pitieth his children, so the Lord pitieth them that fear him. For he knoweth our frame; he remembereth that we are dust.” (Ps 103:13-14) On every Ash Wednesday, from time immemorial, Christians were admonished, “Remember, man, that thou art dust, and unto dust thou shalt return.”

Nor does it in any way contradict traditional Jewish and Christian belief to say that physical speaking we are animals, and that our bodies are like the bodies of other animals. This could not be said with more brutal frankness than it was in Ecclesiastes:

“I said in mine heart concerning the estate of the sons of men, that God might manifest them, and that they might see that they themselves are beasts. For

that which befalleth the sons of men befalleth beasts; even one thing befalleth them: as one dieth, so dieth the other; yea, they all have one breath; so that a man hath no preeminence above a beast: for all is vanity. All go unto one place; all are of the dust, and all turn to dust again.” (Eccl 3:18-20)

The medieval Scholastic theologians accepted the Aristotelian definition of man as “a rational animal”.

As far as the link between mental phenomena and physical events in the body and brain, biblical religion has never denied it. Religion only denies that **certain** of the capacities of human beings -- specifically their intellect and free will -- can be **entirely** reduced to the material. Religious people recognize that the brain is **necessary** for much and perhaps for **all** mental functioning, however, they deny that it is **sufficient** for **some** mental functioning. We do not think of the mind as separate from the body, even if it has aspects that transcend the physical. The *Catechism of the Catholic Church*, for example, teaches that: “The unity of soul and body is so profound that one has to consider the soul to be the ‘form’ of the body. ... spirit and matter, in man, are not two natures united, but rather their union forms a single nature.”

One did not need neurophysiology to tell us that physical events in the body affect thinking. That has been known since ancient times. A sharp blow to the head can cause unconsciousness. Too much alcohol causes drunkenness. Fatigue makes it hard to concentrate. It is not surprising that electrical stimulation of a part of the brain can cause hilarity, when tickling someone in the ribs can have the same effect.

It is obvious that the brain is involved in mental activity; and the brain certainly is a material structure. So it should come as no surprise that an artificial material structure, the computer, can perform many of the same “mental” tasks that we do, such as perception, memory and decision-making. After all, animals do these things too, and no Christian or Jew claims that animals have a spiritual nature.

It is important to keep firmly in mind what it is that the religious person sees as constituting the “spiritual” element in human beings. It is not tool-making, making fire, an opposable thumb, walking upright, communicating with sounds or gestures. Rather, what makes us spiritual is **intellect and free will**.

Computers can do many of the things that we do, in some cases better or faster than we do them, and in other cases much worse. However, there is no evidence that they can understand anything, or that they can make free choices. So far, at any rate, their limitations correspond exactly to what the religious person would expect.

We have come, then, to the real issue: can the human faculties of intellect and free will be understood in purely physical and mechanical terms? This is really the crux of my talk.

Let us consider first the power of free will. What has science to say about it? For a very long time it seemed that everything science had to say cut against the Jewish and Christian belief in free will. For what science found was that the whole physical world is subject to precise “deterministic” mathematical laws. Determinism means that if the state of the physical world is completely specified at one time then its state at all future times is uniquely determined and could therefore -- in principle -- be calculated. The universe, so to speak, runs on rails. In 1819, the great French physicist and mathematician Laplace famously wrote, in his *Philosophical Essay on Probability*, “[To] an intelligence which could know all the forces by which nature is animated, and the states at some instant of all the objects that compose it, nothing would be uncertain; and the future, as well as the past, would be present to its eyes.” That would mean that every action of your body, everything that happens in your brain follows exactly, uniquely, and inevitably from what was happening in the physical world long before you were born. What room, then, for freedom?

Even in ancient times, the motions of the stars and planets were known to obey precise mathematical rules. Although the planets seemed to wander about a bit, they did so in a way that could be predicted very well using Ptolemy's, and later Copernicus's and Kepler's, models of the solar system. In the seventeenth century Newton showed that these motions followed from a few simple equations that applied equally well to objects on earth and in the heavens. As time went on more and more phenomena were found to be explicable by Newton's laws of motion: the propagation of sound waves, the dynamics of fluids, and the flow of heat, for example. And in the late eighteenth and early nineteenth century electrical and magnetic phenomena

began to yield their mathematical secrets as well. Thus, by 1819, when Laplace wrote the words that I quoted, a great deal was known about the character of the laws of nature. And everything that was known at that time, and for a hundred years after that, seemed to justify the claim Laplace made that the laws of physics were deterministic.

If this determinism were correct, then the **material** world would form a “causally closed” system: it would be sealed off from any possible influence by non-material entities. So even if the human mind has a non-material component, that component could not have any effect on matter. It could not affect the matter of the brain, or the matter of the rest of the body. It would stand apart, having no effect on human behavior. Human behavior would be as rigidly determined as everything else in the physical world.

This issue of determinism and free will is one of the few where scientific theories have the potential of being in contradiction to religious doctrine; and such a contradiction really seemed to exist in the nineteenth century. Religious believers at that time were in the uncomfortable position of having to argue, against all scientific theory, that somewhere along the line determinism would fail.

And fail it did! Completely against the expectations of the scientific world, determinism was overthrown in the 1920s by quantum theory. What quantum theory says is this: completely specifying the state of a physical system at one time, does **not** uniquely determine its future behavior. Rather, the laws of physics only tell one the **probabilities** of various future outcomes. Unlike the laws of so-called “classical” (or pre-quantum) physics, the laws of quantum physics are inherently probabilistic in nature.

One can give a simple example. Many subatomic particles are “unstable”. That means that given enough time, they will “decay” or disintegrate into other particles. For example, a uranium-235 nucleus will eventually decay by “spontaneous fission” into smaller nuclei. Such decays are the source of the phenomenon of radioactivity. The laws of physics do not say when a particular unstable particle will decay; they only assign a probability for it to happen within a given period of time. This probability is usually stated in terms of the “half-life”.

Does this quantum indeterminacy have anything to do with free will? There are many who argue that it does not and cannot. They note that quantum indeterminacy is usually irrelevant to the behavior of objects much larger than atoms, such as the neurons that make up the brain. The point is that for systems containing many atoms the quantum uncertainties tend to average out. Here's an analogy: a particular voter from Massachusetts may act quite unpredictably, but the state of Massachusetts, made up of millions of voters, acts very predictably in national elections. Similarly the neurons in the brain, being made up of huge numbers of atoms, should act in an essentially deterministic way.

This argument has some force, but it is far from being a proof of anything. For, while it is true that quantum indeterminacy can ordinarily be ignored for things as large as neurons, it is also true that quantum indeterminacy **can** produce effects at the macroscopic level. Moreover, very little is yet known about the detailed functioning of the brain.

Another objection that is raised against the relevancy of quantum indeterminacy to free will is that quantum indeterminacy simply introduces an element of pure chance or randomness into the subatomic realm; and we would not want to explain a human being's free acts as being the result of pure chance. Someone who acts unpredictably simply because of random processes in his brain is not really acting freely.

True enough. However, the many people who have argued, since the 1920s, that quantum indeterminacy may have something to do with free will, have not been suggesting, by and large, that it would **explain** free will. They have not been looking for a **physical mechanism** that accounts for free behavior. Indeed, to say that free will is physically explicable would be to deny that there was anything spiritual involved. No, what they have suggested is only that the indeterminacy of physics creates an **opening** for the essentially spiritual power of free will to operate. It unlocks the shackles that the laws of physics had seemed to place upon human action.

The fact, and it is a fact of great importance, is this: For centuries there was an argument against the Jewish and Christian idea of free will that was based upon the deterministic character of the laws of physics; and this argument has lost much, if not all, of its force. In 1931, the great mathematician and

physicist Hermann Weyl expressed it this way:

“We may say that there exists a world, causally closed and determined by precise laws, but ... the new insight which modern [quantum] physics affords ... opens several ways of reconciling personal freedom with [the laws of nature]. It would be premature, however, to propose a definite and complete solution of the problem. One of the great differences between the scientist and the impatient philosopher is that the scientist bides his time. We must await the further development of science, perhaps for centuries, perhaps for thousands of years, before we can design a true and detailed picture of the interwoven texture of Matter, Life, and Soul. But the old classical determinism of Hobbes and Laplace need not oppress us longer.”

I have been talking about the old physics-based argument against the possibility of free will. But one can turn the argument around. The reality of free will is in fact an enormously powerful argument against the philosophy of materialism.

If free will, as it is traditionally understood, is real, then scientific materialism is certainly wrong. The reason is simple. Scientific materialism is the view that (a) only matter exists, and (b) matter is governed by the laws of physics and chance and nothing else. But after four hundred years of experience, we can say something rather definite about what a “law of physics” is.

Physics is quantitative. Experiments always measure quantities, theorists calculate quantities. If human behavior or anything else is reduced to quantities, two things only can be found. To the extent that the behavior is predictable, it falls under some deterministic rule. To the extent that it is unpredictable, it appears to mathematical analysis to be merely random. There is nothing else that a quantitative analysis and therefore physics can yield.

However, according to the traditional view of free will, an act is “free” only to the extent that it is *neither* random *nor* determined by rule. Like random behavior it is not predictable, but unlike random behavior it is the product of rational choice rather than chance. Free behavior is a *tertium quid*, a third kind of thing. And therefore there is no way that it can be fully explained by a mathematical theory of physics. This is almost a matter of definition.

Since free will is fatal to scientific materialism, materialists are forced to deny its reality. Some of them call it an illusion. Other materialists say that they believe in free will, but when you look closely at what they mean by free will, you find that they are talking about something else. What **they** mean by our having free will is that our choices are not coerced by causes outside our selves. In that sense a computer when it is playing chess is choosing its moves “freely”. It makes its moves based upon its own internal processes. No one is reaching in from outside and overriding those processes. The computer is presented with an array of possible moves and it makes a choice among them. It is true that its program operates according to fixed, deterministic procedures, so that in a sense it cannot make any move but one in a given position. However, humans also, so the argument goes, have such internal programs. It is just that, because these human programs operate largely subconsciously, we are not aware of how our choices are made or of the fact that they are really determined. Our own choices are thus opaque to us, and we attribute them to some mysterious power of the “will”. In the words of Francis Crick, one of the co-discoverers of DNA, “What you're aware of is a decision, but you're not aware of what makes you do the decision. It seems free to you, but it's the result of things you are not aware of.” The eminent biologist Edward O. Wilson subscribes to the same view: “The hidden preparation of mental activity gives the illusion of free will.”

Some might complain that, if freedom meant no more than this, we would not be able to hold anyone responsible for his actions, in the sense of punishment or reward. But that is not so. An animal, even without free will, can respond to punishments and rewards. Even a machine can be programmed to do so.

However, what does disappear if free will is redefined in this way is the notion that rewards and punishments can be deserved. No sensible person makes moral judgments about the behavior of animals or machines. We do not really “blame” a computer program for what it does; if anything we blame its human programmers. We do not condemn a man-eating tiger, in the moral sense, or grow indignant at the typhoid bacillus. And yet we do feel that **human beings** can “deserve” and that their behavior can be morally judged. We believe this precisely because we believe that human beings make free choices. When we believe that a human being is not acting freely, as in cases of truly compulsive behavior or insanity, we do not assign moral praise or

blame.

The fact is that the mechanical view of free will does not correspond to our intuitions and experience. Most people believe that when faced with a choice they have real alternatives. That is, they believe that it is physically and actually possible for them to do either the one thing or the other thing. They experience this as a “power” of choice. It is not convincing to say that this is an “illusion” based simply on their ignorance of the actual unconscious processes underlying their acts. After all, when my finger or eyelid twitches involuntarily, as happens on occasion, I am certainly not aware of the processes in my body that caused it. But even though the twitch seems unpredictable and uncaused, I do not have the experience, in **that** case, that I am exercising a power of choice. The same is true at the mental level. Thoughts often pop into my mind “unbidden”, including urges to act in certain ways. This also does not produce in me the experience of having exercised the power of choice.

It is unscientific to deny the reality of free will because of a theory. Scientific theories are based on facts that are experienced. Indeed, the words “experiment” and “experience” have the same root.

As the physicist Andrei Linde observed, “Our knowledge of the world begins not with matter but with perception. I know for sure that my pain exists, my ‘green’ exists, my ‘sweet’ exists. I do not need any proof of their existence, because these events **are a part of me**; everything else is a theory.”

Our acts of free will, like our acts of understanding, and our acts of seeing or tasting, occur **in us**. It is madness to doubt their reality.

Dr. Johnson, the great eighteenth century man of letters, who was as famous for his massive common sense as for his literary gifts, made this point in his characteristically incisive way. In the course of a discussion on free will he posed the following question to his friend Boswell: “If a man should give me arguments that I do not see, though I could not answer them, should I believe that I do not see?”

We have every scientific right to believe in our freedom, whatever the state of our scientific or philosophical theories, **because we exercise it**, it is an empirical fact. When you are told that there is no empirical evidence for religious doctrines, remember that.

Let me now turn to the other power of our spiritual souls, namely intellect.

What is intellect? It is a power of the mind that involves **understanding** and **judgment** --- more specifically: the understanding of **abstract concepts** and propositions, and rational judgment about the **truth** of those propositions.

The difficulty for the materialist is that his philosophy is not big enough to deal adequately with “minds”, “concepts”, “understanding”, and “truth”. For the materialist only matter exists. So minds, concepts, understanding, and truth must be either material things or patterns in material things.

Consider the abstract concept “4” --- that is, the number 4. What is the materialist to make of it? The number 4 is clearly not something material, but it could be thought of as a pattern in something material, like the four-leggedness of a cow or the four-sidedness of a table. With simple mathematical concepts like 4, such a crude approach may work, at least up to a point. But what about numbers like the 7th root of 19 or pi? Where are they to be found, even as a patterns, in the material world? Nowhere. You might think that pi exists as a pattern in circular objects. But that would only be true of exactly circular objects, and there are no exactly circular objects in the physical world.

Now, some philosophers of mathematics would say that mathematical concepts and propositions are just patterns of symbols, for example formulas written on a page or on a blackboard. This is an extreme version of the view called “formalism”. Formalism, however, has serious difficulties. Most philosophers of mathematics would say that behind the formulas, behind the patterns of symbols written in ink or chalk, lie meanings, meanings that exist in minds. It is minds that write the formulas, and minds that read the formulas, and minds that understand the formulas.

It seems fairly obvious, then, that mathematical concepts, like the 7th root of 19 or pi, exist in minds. They are mental realities. Most schools of thought in the philosophy of mathematics adopt this view. But that raises the question of what a mind is. The **materialist** has no choice but to say that the mind and its concepts are just patterns within the brain --- either patterns of things in the

brain or patterns of activity in the brain. So the materialist cannot really get beyond patterns to their underlying meanings in the mind, for the underlying meanings in the mind are also nothing but material patterns. Behind the patterns of ink or chalk are just patterns of neural activity.

For example, an article written a few years ago summarized the views of a well-known “cognitive scientist” this way: “Numbers are ... neurological creations, artifacts of the way the brain parses the world.” In other words (he is saying) our nerve cells **create** numbers! The number pi exists as electrochemical nerve impulses. It has no more fundamental reality than a toothache. An article in *Newsweek* said it this way: “Thoughts are not mere will-o’-the-wisps, ephemera with no physicality. They are instead electrical signals.” If this is true, then why don’t your TV set and CD player have thoughts too?

The reason I am dwelling on mathematical concepts and understanding is twofold. First of all, mathematics is a very pure example of the human intellect at work. And second, the ideas of modern science, and especially physics, the most fundamental branch of science, are made up of mathematical concepts. One of the absurdities of so-called scientific materialism is this: it says that the ultimate truth is science, but the truths of science are just electrical signals in our brain. Einstein’s theory of relativity, Maxwell’s equations of electromagnetism, superstring theory are just nerve impulses.

A similar problem arises for the materialist with regard to truth itself. What does it mean to say an idea is true, if ideas are electrical signals? How is a nerve impulse true or false? How is a toothache true or false? They are just patterns of neural activity in your brain and in my brain, so why is one more true or false than the other?

If my thoughts are just physical processes that follow a path set out for them by the laws of matter, how does “truth” enter into the picture? In the final analysis, my thoughts would not be “reasonable” or “unreasonable”, they would just be the thoughts that I **must** have given the way the molecular motions in my brain and the rest of the world have happened to play out. The mathematician Hermann Weyl, in the 1931 lectures from which I have already quoted, said this: “[There must be] freedom in the theoretical acts of

affirmation and negation: When I reason that $2 + 2 = 4$, this actual judgment is not forced upon me through blind natural causality (a view which would eliminate thinking as an act for which one can be held answerable) but something purely spiritual enters in.” He goes on to explain that thought which is rational, and therefore free, must not be entirely determined by physical factors (in which case it would be “groundless” and “blind”) but must be “open” to meaning and truth.

Writing in the same year the biologist J. B. S. Haldane argued, “If materialism is true, it seems to me that we cannot know that it is true. If my opinions are the result of the chemical processes going on in my brain, they are determined by chemistry, not the laws of logic.” In *Orthodoxy*, his brilliant defense of Christianity written in 1908, G. K. Chesterton noted that the materialist skeptic must sooner or later ask, “Why should anything go right; even observation and deduction? Why should not good logic be as misleading as bad logic, [if] they are both movements in the brain of a bewildered ape.” Stephen Hawking worried about the same issue in connection with the “theory of everything”, which many physicists are seeking. A theory of physics that explained everything would also have to explain why some people believed it and some people did not. Their belief (or disbelief) in the theory, then, would be the result of inevitable physical processes in their brains rather than being a result of the objective validity of the arguments made in behalf of the theory.

Eventually Haldane changed his views in favor of materialism. He was impressed by the development of computers. He felt that computers showed how a material thing following the laws of physics could also follow the laws of logic. This, of course, overlooks the crucial point that computers simply manipulate formulas, or symbols, or “bits” in a mindless fashion. They do not understand what those bits mean. However, there is another point of equal importance.

A computer can be programmed to follow the laws of logic. But it can also be programmed to give illogical answers, or even complete gibberish. If the computer operates “intelligently” it is because someone intelligent programmed it, the intelligence does not reside in the computer but in the programmer. A small boy who can make change correctly is intelligent. A vending machine that makes change correctly is not. Rather the engineers who designed the vending machine had intelligence. It is only when any task has

been routinized to the point that it can be done without intelligence that a computer can be programmed to do it.

This raises a question: if a computer only acts “intelligent” because it was programmed by a human, who programmed the humans? The materialist has a ready answer: evolution programmed us. And that answer is quite plausible, up to a point. It is certainly true that thinking straight has great advantages in the struggle for survival. But it leaves some questions unanswered. There are certain powers of the human intellect that are very hard to explain as simply those of a machine programmed by natural selection.

One of those powers is the power to recognize that something is true “of necessity”. That is, not only true here and now, or true in my environment, or true in the world in which we live, but necessarily true in all possible situations in all possible worlds.

Again, let me use an example from mathematics. The statement “317 is a prime number” is not only true, but **necessarily** true. It must have been true 5 billion years ago. It must be true 5 billion years from now. It must be true in galaxies too distant to observe. It must be true in other universes. **And the necessity of this truth is known to me.** Yet, how can evolution have given me access, as it were, to that knowledge? Evolution works by trial and error. Nature tries out various designs or strategies, and those are selected which work better. It presumably “works better” to get the right answers when we think about numbers. But how can a process that arrives at things by trial and error lead to conclusions about what is necessarily true in all possible situations in all possible worlds? The surprise, to change the example, is not that I get 10 when I add 3 and 7. A calculator which gets that answer, including the calculator in my skull, is more useful in practice if it gets that answer. So that is the type of calculator which Nature selected for me in its blundering empirical way. However, I do more than spit out the useful answer 10 when given $3 + 7$. In some mysterious way I also know that $3+7=10$ is a universal truth.

This power of the human intellect, made in the image of the God, to recognize necessary truths greatly impressed Galileo. He wrote, “It is true that the divine intellect knows mathematical truths in infinitely greater fullness than does our own (for it knows them all), but of the few mathematical truths that

the human intellect may grasp, I believe that our knowledge of them equals that of the divine intellect as regards objective certainty, since man attains the insight into their **necessity**, beyond which there can be no higher degree of certainty.”

If we are asked what science tells us about the human intellect, then, the first thing we should say in reply is that the **very fact** that we can **do** science and mathematics at all is a testimony to the tremendous powers of the human intellect, powers “not reducible to the merely material”, as the *Catechism* put it. But are there particular discoveries of science that point to this irreducibility of the human intellect? As a matter of fact there are.

One of the deepest discoveries of twentieth century mathematics (namely Gödel’s Theorem) and the deepest discovery of twentieth century physics (namely quantum theory) both arguably point to this irreducibility of the human mind to the merely material or mechanical. I mentioned these discoveries briefly in my talk last night; I would like to say now a bit more about them.

First, I will talk about Gödel’s Theorem and its implications.

As I mentioned, there is a school of thought about the nature of mathematics called “formalism”. The formalists believe that mathematics is ultimately just a matter of formulas, i.e. patterns of symbols. The symbols don’t have to mean anything. All that matters is that there are rules for manipulating these symbols. One could imagine a student who doesn’t really understand anything about arithmetic --- who doesn’t know what numbers are, or what addition, subtraction, multiplication or division are --- but who has learned the mechanical rules for doing long division, say. He can follow the recipe --- write this numeral here, draw a horizontal line here, when a 2 appears below a 5 put a 3 underneath the line, etc. He gets the right answers every time, but has no idea what he is doing or why. Far-fetched? Well, that is exactly what computers do. They manipulate symbols according to rules. The rules are called programs. For computers, the meaning of the symbols doesn’t matter.

So if we mean by mathematics, mathematics as machines do it, then the formalists are certainly right about it; it is just a matter of formulas, patterns of

symbols, patterns of bits. But are they right about mathematics as human minds do it? The **materialist** has to say yes; for he believes that the human mind **is** just a machine.

However, almost everyone admits that there are serious problems with this mechanical view of what mathematics is. It is generally recognized that the theorems proven by the great mathematical logician Kurt Gödel in 1931 dealt a severe blow to the “formalist” school of thought. One of the things Gödel showed is that mathematics does **mean** something, and the meanings cannot be simply reduced to symbols and mechanical rules for manipulating them. Mathematics is more than **machine mathematics**, so to speak. And that has profound implications. For mathematics is made up of concepts, and concepts exist in minds. So if there is more to mathematics than machine mathematics, then there is more to minds than mere machines.

More specifically, what Gödel proved is this. Take any part of mathematics that includes at least arithmetic. It cannot be reduced to the mindless application of rules to symbols, as the uncomprehending student or machine would do. Gödel showed that if you tried to reduce even arithmetic to such a mindless system of rules, there would always be **truths** of arithmetic that could not be reached by following those rules. There is something about truth --- even in so seemingly simple a context as arithmetic --- that is beyond mere blind, mechanical computation.

Gödel himself believed that the human mind was more than a machine. In fact he called materialism a “prejudice of our time”. However, he never spelled out in detail the argument against materialism based on his own theorem. The first person to do this was a philosopher named John R. Lucas. Here is what Lucas said in his 1961 article:

“Gödel's theorem seems to me to prove that Mechanism is false, that is, that minds cannot be explained as machines. So also has it seemed to many other people: almost every mathematical logician I have put the matter to has confessed to similar thoughts, but has felt reluctant to commit himself definitely until he could see the whole argument set out, with all objections fully stated and properly met. This I attempt to do.”

There are a couple of ways to understand the Gödelian argument as Lucas

framed it. Remember I said that Gödel showed that if you tried to reduce even arithmetic to a mindless system of rules for manipulating symbols, there would always be truths of arithmetic that could not be reached by those rules. So one of the implications of Gödel's Theorem is that if some shows you a computer program for doing arithmetic, then you can always outwit the program in the following way: you can find statements of arithmetic that are true and that you can show to be true, but that the **program** cannot show to be true using its rules. So Lucas asked the following question: What if you **were** a computer and you knew the program your **own brain** uses to do mathematics. Then you could outwit your own brain. That is, you would be able find statements of arithmetic that **you** could show to be true, but that that your **brain's program** could not show to be true! But that is obviously a contradiction. So you must be more than a computer.

Another way to explain the argument is this. Gödel's Theorem implies that a computer program that operates in a logically and mathematically consistent way is not able to recognize its own consistency. But human beings are able to recognize (at least some of the time) their own consistency. So, again, we must be more than computers.

The Gödelian argument of Lucas was widely attacked. It made few if any converts from materialism. One person who took it seriously, however, was the eminent mathematician and physicist Sir Roger Penrose. In recent years Penrose has taken up the argument himself, answering its critics and sharpening its logic. The Gödelian argument remains highly controversial. However, no one has succeeded in refuting it. Many people dismiss it. And yet the reasons they give for dismissing it, are often remarkably shaky. One of the most common arguments they make is that Gödel's Theorem applies only to **consistent** computer programs, so that the argument of Lucas and Penrose, they say, proves only that human beings are not consistent machines. It leaves open the possibility that we are fundamentally inconsistent machines. Not, mind you, simply machines that sometimes malfunction, but machines that are radically inconsistent in the sense of being unable to distinguish valid arguments from invalid ones. In other words, some materialists, in order to maintain the belief that they are merely machines, are willing to doubt the soundness of their own minds.

Finally, let us turn to the second twentieth century discovery that may point

toward the irreducibility of the human mind to matter: namely quantum theory.

Ever since quantum theory came along 80 years ago, there has been a great deal of controversy about its philosophical implications. This has given rise to many schools of thought. Some adhere to the original “Copenhagen Interpretation” of quantum theory, which is also called the “traditional”, “standard”, or “orthodox” interpretation. In this traditional interpretation, a crucial role is played in the logic of the theory by what are called “**observers**”. Some people think that the traditional interpretation gives far **too** much importance to the observer, and even implies that the observer makes things real simply by observing them. This is the point of the famous Schrödinger’s Cat Paradox --- the question there is, “Does the cat really become dead or alive only when the observer takes a look and **sees** that it is dead or alive? Such paradoxes can be resolved in a reasonable way. Nevertheless, even defenders of the traditional interpretation of quantum theory have to admit that it raises puzzling questions.

To avoid these puzzling questions people have sought alternatives. Such as the so-called “Many Worlds Interpretation” of quantum theory, and the pilot-wave or Bohmian variants of quantum theory. What I shall say is based on the traditional interpretation, which, though not without puzzling aspects, remains in my view the most sensible and sound.

First, let me explain very briefly why one has to talk about “observers” in the traditional interpretation. The reason stems from the fact that quantum theory is, as I noted earlier, inherently **probabilistic**. The use of probabilities implies that someone has incomplete knowledge. If I **know** the outcome of something (say a sporting event or an election) then I don’t have to use probabilities to talk about it. Probabilities are, in a sense, a measure of one’s ignorance or lack of knowledge. In quantum theory, the probabilities that are calculated are probabilities of outcomes of experiments or observations. The observer is the one who learns the outcomes of the experiments or observations. It is his (or her) knowledge or lack of knowledge that the probabilities are describing.

So think of the “observer” as a **knower**, someone with an intellect, who makes judgments of truth and falsehood about the physical world. According to an argument that goes back to the great mathematician John von Neumann

in the 1930s, the laws of physics cannot completely describe the mind of the observer. Why?

The reason is the following: if you try to describe someone completely using the laws of physics, you make him part of the physical system being studied, in which case he no longer can play the role of observer of that system. I cannot go through the details of the argument here, but the upshot of it is that one cannot both be completely within the system and observe the system. To use a crude analogy, you cannot be acting in the movie and watching the movie at the same time. Observers, insofar as they are acting as observers, are not completely describable by physics.

This von Neumann argument led a number of eminent physicists to conclude that there is something about the human mind that cannot be reduced to physics. Sir Rudolf Peierls, one of the leading physicists of the twentieth century, put it this way:

“The quantum mechanical description [of the world] is in terms of knowledge and knowledge requires **somebody** who knows.”

He went on to say,

“The premise that you can describe in terms of physics the whole function of a human being ... including its knowledge, and its consciousness, is untenable. There is still something missing.”

The Nobel Prize-winning physicist Eugene Wigner, asserted flatly that materialism is not “consistent with present quantum mechanics.”

Again, these ideas are highly controversial. But all viewpoints about quantum theory and its philosophical implications are controversial. It is nonetheless highly significant that there is an argument that human beings are “irreducible to the merely material” that comes from fundamental physics, has been vigorously defended by leading physicists, and never been refuted.

To sum up what I have said tonight. There are powerful arguments, some purely philosophical, and some based on the most profound discoveries of the

twentieth century, that point to this conclusion: Our intellects and our free wills are not reducible to mechanical processes or to mere matter.