Modern man, by that very title, shows his awareness of the temporality of his condition — that he has a history and carries with him his past. It has often been pointed out that today theology also has a sense of time and that it cannot stand aside from its past. But in the modern world generally, time itself is a category more and more defined by its usage and understanding in science and in particular in physics. Thus modern philosophy carries over this definition of time or at least must recognize and respect how science defines time. Thus Theology too finds itself in dialogue with modern physics if it wants to understand and be understood in the modern world.

I wish here to treat of only some aspects of the problems of time to illustrate the evidence of the dialogue possible between modern physics and Theology. In particular, I will touch on the following three: (1) the Arrow of Time and Sacred Scripture; (2) the initial condition problem and the apologetics of Evolution; and (3) the Uncertainty Principle’s extension into General Coherence and the Mystery of Providence. Obviously no one of these vast topics will be explored in depth but the three together can show us how twentieth century physics can throw light on some of the ancient mysteries of the Faith.

I. THE ARROW OF TIME

When the mathematical formulation of the laws of mechanics came from the hand of Isaac Newton in 1686, time was treated as a parameter, a numerical variable whose value could be any real number, positive or negative. This means the laws of gravitational physics, the laws governing the attraction of the planets in the Solar System to the sun and to each other, can just as well be formulated with time running backwards (negative time) as well as forward (the parameter for time, \( t \), being a number greater than zero). The motion of the planets then would simply be retrograde — the reverse direction — to the present motion but the laws of nature, gravity, would be the same.

When this same idea of time as a parameter and the laws of nature consequent upon this idea were finally applied to the world of the primary building blocks of the material world — the atoms of the 19th century — there arose an asymmetry. Whereas before the number of material bodies able to be incorporated within the foundation of the theory was without an upper limit, yet in practice this number was some finite, experimental number, such as the nine planets and the sun.

But with the investigation of the world of atom, the microscopic world, it soon became apparent that the number of material atoms in even the smallest practical body was virtually infinite — of the order of a one with twenty-three zeros after it. Thus physicists gave up finding laws for individual atoms and began to develop a calculus of the aggregate or statistical collection of atoms. And now arose the Arrow of Time.

Intrinsic to the composite, cumulative or aggregate picture is the concept of Order. Any aggregation of atoms — and therefore any material body — obeys the law of Entropy, the law of increasing disorder. This in turn will define a direction for Time. Since Entropy is always increasing in the universe, then the direction of increasing disorder is the correct direction of time. But what then of the perfect symmetry of the laws of physics of the centuries before? Who was right, the followers of Newton or the atomists of the 19th century?

Contemporary physics, following the school of Ilya Prigogine,\(^2\)

\(^2\) The writings of Ilya Prigogine are voluminous but a good introduction, although needing some previous knowledge of science, would be Ilya Prigogine, *From Being to Becoming* (San Francisco: W. H. Faumann, 1980).
has been able to reconcile these two schools of physics by saying that both are correct in their own way. By expanding the mathematical basis for the formulation of the laws of statistical physics, time can be shown to be essentially uni-directional at all levels of formulation of the laws of nature; the apparent backward nature of time is only being encountered because the mathematical scheme is too restricted.

Turning to Theology, we may see here in this first example an interesting basis for dialogue. The Scriptural tradition also sees an Arrow of Time in the Biblical account of Salvation History. We find progression of the Jewish people and nation in their knowledge and appreciation of who God is. The historical encounter with God moves along the path of Jewish national history and finally is called to be completed in a movement beyond time but at the end of the Arrow of Time.

II. THE INITIAL CONDITION PROBLEM

The second aspect of time that modern physics has elucidated for modern man is that of how the laws of Newton in physics actually operate. In the centuries after Newton, naturalists were more and more looking for laws in their own scientific discipline parallel to those of Newton in gravitational physics. In the area of Biology, this meant formulating an Arrow of Time as an Arrow of Progression in the development of living forms. Species would now be generally evolved and diversity need no longer be postulated as primeval in origin.

Thus the universe of universal physical law reached even to the living forms, and the God of the Universal Laws was only needed as a caretaker, if at all. Thus Laplace used to tell Napoleon that his mathematical physics grasped all the laws of the material universe and had no use for God: “that hypothesis.” In that spirit, evolution would further remove any need for the Transcendent Hypothesis.

But Laplace’s surety presupposed something that modern physics of the past fifteen years has put into question. Laplace could be sure of his mathematics because he had sure knowledge of the initial conditions — the starting positions and velocities of all the material bodies whose subsequent motion is described
by the laws of Newton. As long as he knew these initial positions and velocities, for instance, of the planets and comets and asteroids in the Solar System, Laplace had confidence in the mathematical surety of his equations. He could exactly predict all subsequent positions and velocities.

But modern physics has discovered that things are not so simple. There has been found to be profound significance to these initial conditions far beyond what Laplace could have suspected. With the help of the computers which can do calculations requiring life times previously, we now know that in the real world of complex interactions, such as the Solar System, even if we do know the initial conditions, the laws of physics do not exactly predict the subsequent motion. For the kind of exactitude Laplace expected we would have to know the initial conditions to a precision beyond human capability. Given the finite precision of any real measurement of position and velocity, the subsequent motion of the bodies in the solar system is chaotic — unpredictable and random.\(^3\)

Here again Theology can profit from this insight of modern physics. If the very laws of the exact science, physics, are themselves subject to chaos, then how much more are the evolutionary "laws" of the living world seen to give way to uncertainty. What was once held up as inevitable — that given enough time and enough material (presumably a universe) life would evolve, all according to the laws of evolution — can no longer be taken to be so certain. Even more problematic is the Deist God Who is no longer needed once the laws of nature are set running. Chaos can exist even in those very mathematical laws, and so the Hand of God is very much in the picture.

III. THE UNCERTAINTY PRINCIPLE

A third possible area for dialogue between modern physics and theology is that of the Uncertainty Principle in Quantum Physics. This law of the microscopic world states that the position

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3. With the advent of the computer, non-linear problems in mathematical physics have come under ever-increasing scrutiny. An interesting application in the area of bio-physics and evolution can be found in Stuart A. Kruffman, "Antichaos and Adaptation," *Scientific American* 265/2 (Aug. 1991) 64-84.
and momentum of an atomic-scale object can never be so exactly known that the product of the uncertainty in position times, the uncertainty in momentum, is less than a certain number. Thus no matter how refined the instrumentation of the laboratory becomes, we cannot in principle ever exactly know the position and momentum of an atomic particle, at the same time. Accustomed as we are to exact knowledge of these variables on the microscopic level where I know for example that the table I am writing on is exactly here and not moving — this fundamental principle came as a shock to physicists when it was formulated in the 1920’s.

It is not just that our instruments are not exact enough. Rather the Uncertainty Principle says that intrinsically the laws of the atom world are such that we can never know exactly at any time these kinds of variables. Today recent experiments (1991) have even extended this Principle and established what I will call the Principle of Coherence.

This means that on the atomic scale material objects have a certain amount of coherence. Once this has been expended by direct measurement, the quantum system will have lost its uncertainty characteristic and with it the ability to correlate with itself, a phenomenon known as interference. But recent experiments have shown that the measurement process which destroys the interference need not operate on only the principal part of the atomic structure. Even measurements in the subsidiary structures of the atomic system can do this.

Theologically, the Uncertainty Principle has been used to justify speculation on the inherent freedom of the material world and its consequent independence of the fore-knowledge of God. Since the Uncertainty Principle shows that in principle the smallest components of the material world have a certain unknowability as to their physical parameters in time, even God Himself would not know the outcome of the evolutionary processes. Uncertainty has even been used to ascribe a material basis for freedom of the will and thus human freedom in general.⁴

⁴ For a readable amount of the history of this interesting topic of Uncertainty one cannot do better than the author himself, Prof. Heisenberg. See Werner Heisenberg, Physics and Beyond (New York: Harper & Row, 1971).
But the generalization of the Principle of Uncertainty to the broader Principle of Coherence shows us that there exists not so much intrinsic unknowability as rather intrinsic potential for coherence. The principle has been shifted from the realm of the knowable to the realm of interaction, in particular self-interaction. Thus philosophical potential shows itself again and with potency the allied philosophical category of contingency. Elevated to Theology, this suggests that modern physics can aid models of the world making it a contingent creation and thus leading the insightful to a Creator.

These three examples, all encompassing time in some form, are suggested here to illustrate that while metaphysics does not necessarily come from science, yet in the modern picture of the world generated by science, long-standing philosophical and theological issues can meaningfully be discussed by both theologians and scientists.\(^5\)

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