EN Tech. J., vol. 4, 1990, pp. 147–157

Why Does Mathematics 'Work'?

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OUTLINE

I. Mathematics is based upon presuppositions.
- A. Humanistic: Mathematics is merely and only the autonomous creation of the human mind.
- B. Biblical:
  - (1) Mathematics is, in a sense, the creation of man's mind.
  - (2) But mathematics is more than just the creation of man's mind.
  - (3) Because of its applicability to the physical world, mathematics is reflective of the Creator of all things.

II. Mathematics: The present state of the art.
- A. Minority opinion reflects a biblical perspective:
  - Mathematics is a tool that enables man to discover order in a pre-established universe.
- B. Majority opinion reflects a commitment to human autonomy:
  - Mathematics is a man-made method that enables man to create order out of a universe of assumed chaos.

III. The arising tension point: Why does mathematics 'work'? Why does mathematics so effectively describe and predict the workings of the physical world?
- A. Humanistic answer:
  - (1) No explanation has been presented; responses to this question contain phrases like 'miraculous', 'unreasonable' and 'incredible.'
  - (2) Why no answer? Wilful rejection of biblical truth.
- B. Biblical answer:
  - (1) Mathematics 'works' because man's mind and the workings of the physical world **cohere or fit together** due to the fact of a common Creator.
  - (2) The mathematical properties of creation reveal a good, wise, and loving Creator Who works in an orderly way.
  - (3) Mathematics is for man a reflection of the 'language fabric,' the word of God's power, that sustains all things (Colossians 1:17).

'The eternal mystery of the world is its comprehensibility.'

Albert Einstein[1]

Why would someone of the stature and calibre of Einstein make a statement like this? In this article, I would like to show that, if a person begins with the idea that the reason of man is autonomous in mathematics, then a description of the comprehensible applicability of mathematics to reality is very difficult to construct and will inevitably abound with words like 'mystery' and 'incredible'.

THE MYTH OF NEUTRALITY

Early in the twentieth century, Bertrand Russell (1872–1970) reacted to recent paradoxes in mathematics with this statement:

'Mathematics is the subject in which we never know what we are talking about, nor whether what we are saying is true.'[2]

Then, using the medium of logic, Russell and Alfred North Whitehead (1862–1947) tried to build a secure and indubitable foundation for mathematics. In 1930, the insightful analysis of the Czechoslovakian, Kurt Gödel (1906–1978), stopped them dead in their tracks.[3] Toward the end of his life, Russell evaluated his efforts:

'I wanted certainty in the kind of way in which people want religious faith. I thought certainty is more likely to be found in mathematics than elsewhere . . . After some twenty years of very arduous toil, I came to the conclusion that there was nothing more that I could do in the way of making mathematical knowledge indubitable,'[4]

Russell's perspective of life and mathematics revealed a clear presuppositional stance:

'Man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocations of at-

oms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labour of the ages, all the devotion, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins — all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built.'[5]

A look at the history of mathematics and science shows that what an individual or culture believes concerning the origin, purpose and destiny of the cosmos affects the way mathematics is viewed, and ultimately the way mathematics progresses.[6,7] In the words of Oswald Spengler:

'The style of any mathematic which comes into being . . . depends wholly on the culture in which it is rooted, the sort of mankind it is that ponders it.'[8]

Mathematics is not a neutral discipline; it is always linked with presuppositions. In fact, in its presuppositional base, mathematics either thrives or dies. In the civilizations of antiquity, mathematics progressed for a few centuries, then stagnated due to a false world view of nature and time. Great and creative mathematical stirrings took place from 1250–1650 in a Western European culture that was steeped in a biblical view of creation and time. Today, many mathematicians and scientists philosophically deny the world view that birthed modern science. Given this stance, what is the present condition of mathematics and where will it end up? Will it die?

Francis Schaeffer observes that:

'the world view determines the direction such creative stirrings will take, and how . . . and whether the stirrings will continue or dry up.'[9]

It is a fact that, in the twentieth century, more work has been done in mathematics than all other centuries combined. If mathematics should die in a culture steeped in humanism, the belief in the autonomy of man's mind, why all this activity? Schaeffer continues:

'Later, when the Christian base was lost, a tradition and momentum had been set in motion, and the pragmatic necessity of technology, and even control by the state, drives science on, but . . . with a subtle yet important change in emphasis.'[10]

That change in emphasis, from Christianity to humanism, has serious ramifications. Stanley Jaki makes this clear as he comments on the philosophical movements in the eighteenth and nineteenth centuries:

'The next two centuries saw the rise of philosophical movements, all hostile to natural theology. Whatever their lip service to science, they all posed a threat to it. The blows they aimed at man's knowledge of God were as many blows at knowledge, at science, and at the rationality of the universe.'[11]

It is extremely important to note that many scientists today believe in a cosmology that posits an 'oscillating' universe. Through observational astronomy, distant galaxies are thought to be receding from ours, the Milky Way, at great speed. The farther these galaxies are away from ours, the greater is their speed away from us thought to be.[12] To many astronomers, this indicates that the universe is 'breathing out.' If the universe is exhaling, there had to be a point in time when this 'breathing' began. At one time in our distant past, say these astronomers, all the matter of the universe found itself concentrated in one extremely dense tiny ball the size of an atom. Then an explosion occurred called the 'Big Bang', and the elements of the universe 'galloped off' into space. Now, and it is essential to note this, many of these astronomers do not conclude their theory with a universe 'breathing' out. If the universe is now exhaling, it will need to 'inhale' again. That is, the elements of the universe will eventually 'breathe in' coming together again into one extremely dense tiny ball. This is what is meant by an 'oscillating' universe. This idea is a mirror-image of the ancient eternal cycle theory.

Stanley Jaki sees the theory of the oscillating universe as the gravest perplexity of the modern scientific world. He says:

'The very roots of that perplexity form a mirror-image of the age-old need to make a choice between two ultimate alternatives: faith in the Creator and in a creation once-and-for-all, or surrender to the treadmill of eternal cycles. Such indeed be the case, as the present is always a child of the past. The present and past of scientific history tell the very same lesson. It is the indispensability of a firm faith in the only lasting source of rationality and confidence, the Maker of heaven and earth, of all things visible and invisible.'[13]

If Western man continues to aim his blows at the revelation of God in His Word and in His works, Western civilization will stagnate and die just like the cultures of antiquity. This fact has been graphically portrayed to the West through the articulate and heart-rending writings of the Russian exile and one-time mathematics/physics teacher, Aleksandr Solzhenitsyn (1918–2008).

In mathematics, presuppositions can be based either upon the autonomy of man or in the biblical revelation of the sovereign, Creator God. A world of difference separates the two. One believes that all things happen by chance, the other by design. One, using the words of Bertrand Russell, is the philosophy of empty despair and the other the dynamic of living certainty.

THE STATE OF THE DEBATE

These two presuppositional camps can be delineated as we inspect the statements made by twentieth century

mathematicians.

Sir James Jeans (1877–1946), famous British mathematician and scientist, said in 1930:

> *'The universe shows evidence of a designing or controlling power that has something common with our own mathematical minds . . . the tendency to think in a way which, for want of a better word, we describe as mathematical.'*[14]

He adds:

> *'The essential fact is simply that all the pictures which science now draws of nature, and which alone seem capable of according with observational fact, are* ***mathematical*** *pictures . . . Nature seems very conversant with the rules of pure mathematics . . . In any event it can hardly be disputed that nature and our conscious mathematical minds work according to the same laws.'*[15]

Pierre Duhem (1861–1916), French science historian, agreed with Jeans by observing that:

> *'it is impossible for us to believe that this order and this organization produced by theory are not the reflected image of a real order and organization.'*[16]

Referring to the givens of nature, the eminent mathematician Hermann Weyl (1885–1955) saw in mathematics *'a wonderful harmony between the given on one hand and reason on the other.'*[17]

Max Planck (1858–1947), a German theoretical physicist, laid the foundations for the development of the quantum theory; a theory which revolutionized physics. Near the end of his life, he said:

> *'What has led me to science and made me since youth enthusiastic for it is the not at all obvious fact that the laws of our thoughts coincide with the regularity of the flow of impressions which we receive from the external world, (and) that it is therefore possible for man to reach conclusions through pure speculation about those regularities. Here it is of essential significance that the external world represents something independent of us, something absolute which we confront, and the search for the laws valid for this absolute appeared to me the most beautiful scientific task in life.'*[18]

Although Albert Einstein talked about a *'God who does not play dice,'* he remained an agnostic most of his life.[19] Stanley Jaki remarks that in Einstein's *'cosmic religion'* there was *'no room for creation or Creator.'*[20] Einstein himself defined his conception of God as follows:

> *'Certain it is that a conviction, akin to religious feeling, of the rationality or intelligibility of the world lies behind all scientific work of a higher order. This firm belief, a belief bound up with deep feeling, in a superior mind that reveals itself in the world of experience, represents my conception of God.'*[21]

He then admitted that his conception of God, the superior mind, was pantheistic in nature.[22] When it came to his scientific and mathematical work, he placed his faith in, using the words of seventeenth century mathematician, Gottfried Wilhelm Leibniz, a *'pre-established harmony in the universe.'*[23]

All of the above scientists assumed mathematics to be a tool that enables man to discover order in a pre-established universe. This assumption is in agreement with biblical revelation, even though most, if not all, of these men would not overtly align themselves with the Christian faith. Unfortunately, their belief is the minority opinion of twentieth century mathematicians.

THE MAJORITY VIEW

John W. N. Sullivan (1886–1937), who wrote many interpretive works on science, expressed the majority opinion by saying:

> *'We are the law-givers of the universe; it is even possible that we can experience nothing but what we have created and that the greatest of our mathematical creations is the material universe itself.'*[24]

Percy W. Bridgman (1882–1961), a 1946 Nobel Prize winner in physics, said:

> *'It is the merest truism, evident at once to unsophisticated observation, that mathematics is a human invention.'*[25]

Arthur Stanley Eddington (1882–1944), British astronomer, graphically explained the origin and originator of the universe:

> *'We have found that where science has progressed the farthest, the mind has but regained from nature that which the mind has put into nature. We have found a strange foot-print on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last, we have succeeded in reconstructing the creature that made the foot-print. And lo! it is our own.'*[26]

Mathematics historian Morris Kline (1908–1992) gives affirmation:

> *'It may be that man has introduced limited and even artificial concepts and only in this way has managed to institute some order in nature . . . Nature itself may be far more complex or have no inherent design.'*[27]

To the majority of mathematicians today, the universe does not reveal a pre-established harmony. Hence, to these men, mathematics, as a method, does not reveal a harmonious order established by the biblical God, but enables man to create order out of a universe of assumed chaos.

The difference in perspectives is clear. Man is either a discoverer or an autonomous creator. Since both viewpoints posit explanations concerning the origin, purpose and destiny of the cosmos, then both are integrally religious in nature. As Rousas J. Rushdoony points out, *'The*

issue in mathematics today is root and branch a religious one.'[28]

A DEEPER LOOK

Perhaps no one has been more prolific in writing about mathematics in the late twentieth century than Morris Kline. Obviously well-qualified, talented and articulate, his erudite works on the history and scientific applications of mathematics have had beneficial influence worldwide.

But, at the same time, he is an apparent thorn in the flesh to the professional mathematical community. In 1973, he published a critical appraisal of the new mathematics curriculum of the 1960s entitled **Why Johnny Can't Add: The Failure of the New Mathematics.** After shooting down the methodology of pre-university mathematics, he next took aim at the university professors of mathematics. In 1977, his publication **Why the Professor Can't Teach: Mathematics and the Dilemma of University Education** certainly did not win him too many friends in the higher circles of the educational elite. Finally, in 1980, the publication of **Mathematics: The Loss of Certainty** unveiled a most thorough indictment of modern mathematics. We will leave it to the mathematics professionals to quibble over Dr Kline's bombastic exposures. In the meantime, we will take note of some of Kline's revealing conclusions concerning mathematics. In his introduction to **Mathematics: The Loss of Certainty,** he states:

> *'It behooves us therefore to learn why, despite its uncertain foundations, and despite the conflicting theories of mathematicians, mathematics has proved to be so incredibly effective.'*[29]

In his preface to **Mathematics and the Physical World,** he reflects:

> *'Finally, a study of mathematics and its contributions to the sciences exposes a deep question. Mathematics is man-made. The concepts, the broad ideas, the logical standards and methods of reasoning, and the ideals which have been steadfastly pursued for over two thousand years were fashioned by human beings. Yet with this product of his fallible mind man has surveyed spaces too vast for his imagination to encompass; he has predicted and shown how to control radio waves which none of our senses can perceive; and he has discovered particles too small to be seen with the most powerful microscope. Cold symbols and formulae completely at the disposition of man have enabled him to secure a portentous grip on the universe. Some explanation of this marvellous power is called for.'*[30]

Kline is not alone in this acute cry for an explanation. Richard Courant, formerly head of the mathematics department at the pre-Hitler world's centre for mathematics, the University of Göttingen, and then head of the Courant Institute of Mathematical Sciences of New York University, remarks:

> *'That mathematics, an emanation of the human mind, should serve so effectively for the description and understanding of the physical world is a challenging fact that has rightly attracted the concern of philosophers.'*[31]

Richard E. von Mises (1883–1953), born in Austria and later a lecturer at Harvard University, agrees with Courant by stating that *'the coordination between mathematics . . . and reality cannot be reached by a mathematicized doctrine . . .'*[32] He goes on to remark:

> *'None of the three forms of the foundation of mathematics, the intuitionist, the formalist, or the logistic, is capable of completely rationalizing the relation between tautological systems and (extramathematical) experiences . . .'*[33]

Norman Campbell, British physicist and philosopher of science, queries about the remarkable power of mathematics in prediction:

> *'Why do they predict? We return once again to the question which we cannot avoid. The final answer that I must give is that I do not know, that nobody knows, and that probably nobody ever will know,'*[34]

All of these men begin with the explicit assumption that mathematics is merely and only a creation of the human mind. Given this premise, they are unable to completely explain the marvellous power of mathematics; the power of describing and predicting the workings of the physical world. In finality, they must consign themselves, as Kline does, to the use of the expression, *'It is a mystery'*.[35]

THE CONFESSIONS OF A NOBEL PRIZE WINNER

In 1963, Eugene Wigner (1902–1995) won the Nobel prize in physics for his research in quantum mechanics, an aspect of science that deals with atomic particle theory. In 1960, he wrote an article with a revealing title: 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences.' To begin his discussion, he quoted the philosopher Charles Sanders Peirce (1839–1914):

> *'It is probable that there is some secret here which remains to be discovered.'*[36]

Then he presented his thesis:

> *'The enormous usefulness of mathematics in the natural sciences is something bordering on the mysterious and . . . there is no rational explanation for it.'*[37]

He explains these successes using an interesting metaphor:

> *'We are in a position similar to that of a man who was provided with a bunch of keys and who, having to open several doors in succession, always hit on the right key on first or second trial. He became skeptical concerning the uniqueness of the coordination of keys and doors.'*[38]

He continues to express his bafflement over the fact that *'it is not at all natural that "laws of nature" exist, much less that man is able to discern them.'*[39] Concerning the effectiveness of Newton's universal law of gravitation, he says that it *'has proved accurate beyond all reasonable expectations*.'[40]

He continues to illustrate the mysterious usefulness of mathematics by citing the application of imaginary numbers (e.g. √-1) in the laws of quantum mechanics. First, he observes that

> *'the use of complex numbers is in this case not a calculational trick of applied mathematics but comes close to being a necessity in the formulation of the laws of quantum mechanics*.'[41]

Given this fact, he responds with this amazing remark:

> *'It is difficult to avoid the impression that a miracle confronts us here*.'[42]

Finally, he concludes:

> *'Fundamentally, we do not know why our theories work so well*.'[43]

And to this, he adds:

> *'The miracle of appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve. We should be grateful for it and hope that it will extend, for better or for worse, to our pleasure even though perhaps also to our bafflement, to wide branches of learning.*'[44]

MORE MIRACLES, MYSTERY AND WONDER

Erwin Schrödinger (1887–1961) developed the famous wave equation of quantum mechanics (for the structure of the atom — see Figure 1) which includes the 'miraculous' imaginary number mentioned by Wigner.[45] He affirms Wigner in observing that humanity's power to discover the laws of nature is beyond human understanding.[46]

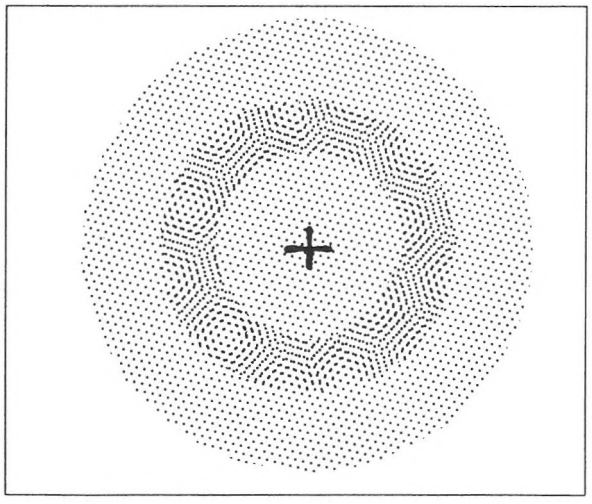

Figure 1. THE STRUCTURE OF THE ATOM IN QUANTUM MECHANICS. In the hydrogen atom, electrons are pictured as clouds that orbit the positive nucleus. The darker section of this time-average view shows where the electron is most probably found.

In 1980, R. W. Hamming, university professor, tried to explain the mystery proposed by Dr Wigner. He introduced his treatise:

> *'We must begin somewhere and sometime to explain the phenomenon that the world seems to be organized in a logical pattern that parallels much of mathematics*.'[47]

After several pages of discourse, he came to his conclusion:

> *'From all of this I am forced to conclude both that mathematics is unreasonably effective and that all of the explanations I have given when added together simply are not enough to explain what I set out to account for*.'[48]

Dr Remo J. Ruffini, physicist at Princeton University, reacted to the successful landing of men on the moon:

> *'How a mathematical structure can correspond to nature is a mystery. One way out is just to say that the language in which nature speaks is the language of mathematics. This begs the question. Often we are both shocked and surprised by the correspondence between mathematics and nature, especially when the experiment confirms that our mathematical model described nature perfectly*.'[49]

Albert Einstein once remarked concerning this issue:

> *'The eternal mystery of the world is its comprehensibility*.'[50]

One of his friends, Maurice Solovine, asked Einstein to clarify this remark. Einstein replied:

> *'You find it surprising that I think of the comprehensibility of the world . . . as a miracle or an eternal mystery. But surely* a priori (independent of experience — J. N.), *one should expect the world to be chaotic, not to be grasped by thought in any way. One might (indeed one should) expect that the world evidence itself as lawful only so far as we grasp it in an orderly fashion. This would be a sort of order like the alphabetical order of words of a language. On the other hand, the kind of order created, for example, by Newton's gravitational theory is of a very different character. Even if the axioms of the theory are posited by man, the success of such a procedure supposes in the objective world a high degree of order which we are in no way entitled to expect* a priori. *Therein lies the "miracle" which becomes more and more evident as our knowledge develops . . . and here is the weak point of positivists* (true knowledge is that which can only be verified by the senses or experience — J. N.) *and of professional atheists, who feel happy because they think that they have not only pre-empted the world of the divine, but also of the miraculous. Curiously, we have to be resigned to recognizing the*

"miracle" without having any legitimate way of getting any further. I have to add the last point explicitly, lest you think that, weakened by age, I have fallen into the hands of priests.'[51]

To Einstein, there was no 'legitimate' way to get around recognizing the miracle. To him, to explain the miracle in terms of the 'divine' would be 'falling into the hands of priests' and therefore, in accordance with his convictions, sacrilegious. Stanley Jaki exposes the obvious by remarking that Einstein

'perceived that such a train of thought was not only a road of science but it also came dangerously close to turning at the end into a way to God.'[52]

Dr Ruffini is another scientist who openly admitted, after his testimony above, that the mystery of mathematical effectiveness can be solved by positing the biblical God. But, as Einstein, he considered this explanation to be unacceptable. According to Rousas J. Rushdoony, Ruffini '*prefers to deny the theoretical possibility of a correlation and meaning than to admit the reality of the Creator God.*'[53]

Most scientists, however, run away from this problem and do what Morris Kline describes:

'Indeed, faced with so many natural mysteries, the scientist is only too glad to bury them under a weight of mathematical symbols, bury them so thoroughly that many generations of workers fail to notice the concealment.'[54]

THE REAL ISSUE

Why bury and conceal? Is the mathematician, in fact, running away from an issue he does not want to confront? Yes. Using the words of Herbert Schlossberg:

'Scientific scabbards fall away to reveal ideological swords.'[55]

Morris Kline summarizes the attitude of most mathematicians today:

'Many mathematicians are happy to accept the remarkable applicability of mathematics but confess that they are unable to explain it.'[56]

Willem Kuyk, professor of mathematics at the University of Antwerp in Belgium, explains why mathematicians do not want to explain:

'The question whether it is possible to make some kind of ontology (the question of existence — J. N.) *the basis of modern mathematics is left open by most people working in mathematical fields. Fearing to introduce into mathematics arguments of a metaphysical nature, the philosophically minded mathematician will avoid as much as possible reference to mathematical existence independent of human thought. In general it can be said that under the impact of the pragmatist attitude, for the philosopher of mathematics the workability of mathematical systems rather than their interpretability has become a central point of view. Reflections of an epistemological nature as well as reflections regarding for example mathematical truth are not readily undertaken by mathematicians of the pragmatistic type.*'[57]

Most mathematicians today would rather hide in the dark closet of pragmatism than come out into the bright light of constructive debate, or biblical revelation.

THE WONDERS OF CREATION

The structure of the honeycomb is a series of interlocking regular hexagonal prisms (see Figure 2). Through

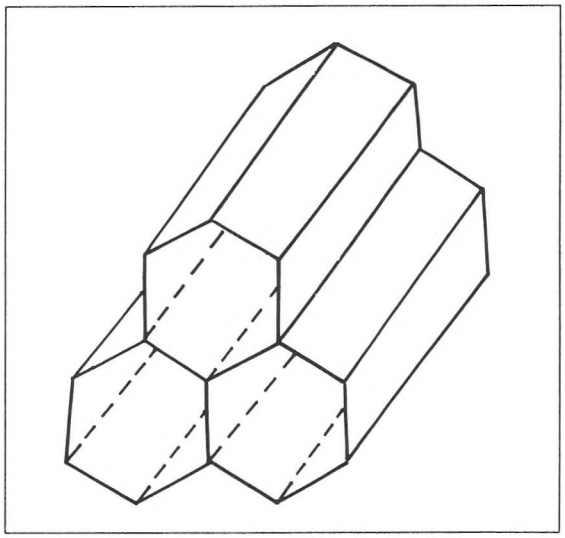

Figure 2. THE STRUCTURE OF THE HONEYCOMB.

advanced differential calculus, one can determine that this design is one of the most efficient possible for enclosing space. It wastes little space at all and is a most effective structure for strength against collapsing.

Creation is revelatory of God's attributes, the way God is. What is made reflects something about the maker. In the case of the honeycomb, we see the wisdom of the infinite Creator.

In Scripture, the rainbow is a sign of God's covenant mercies. The structure of a rainbow is complex and intricate. Detailing it could fill a large book. H. E. Huntley reflects:

'The light of day is reflected, chromatically refracted, reflected again and dispersed by gently falling water spheres into a thousand hues, conforming the while to lovely theorems of mathematics so simple in some respects that the schoolboy may understand, so complex in others as to defy analysis.'[58] (See Figure 3.)

The path of light can be determined by the laws of geometric optics. Each time that the beam strikes the surface of an individual droplet, part of the light is reflected and part is refracted. The degree of reflection/refraction is governed by the following laws:

Let I = the angle of incidence,
R = angle of reflection,
r = angle of refraction,
V(I) = velocity of light in the incident medium (air in this example), and
V(R) = velocity of light in the refraction medium (water in this example).

According to the law of reflection, I = R.
According to the law of refraction, sin I/sin r = V(I)/V(R).

Light rays that are directly reflected from the surface are designated as TYPE 1 rays (see Figure 3). Those rays transmitted directly through the droplet are classified as TYPE 2. TYPE 3 rays emerge from the droplet after one internal reflection. These rays produce the primary rainbow. A much fainter bow, called the secondary rainbow, is sometimes seen around the primary rainbow. This bow is made of TYPE 4 rays, which have undergone two internal reflections.

According to Larry Zimmerman, Christian educator: *'The knowledge of mathematics unveils not only vistas of beauty and power unsuspected before but also an order, symmetry and infinitude which stuns and awes the beholder.'*[59]

Not only is mathematics useful in helping man to fulfil the dominion mandate of Scripture (see Genesis 1:26; Psalm 8), it also uniquely reveals certain attributes of the Creator God. After this God finished creating the heavens and the earth, He pronounced everything to be good. Although made by the word of His power and designed by His infinite wisdom, the works of God ultimately reflect the goodness of God. The heart of goodness is generosity. In its essence, goodness is the desire to do good, to create a medium through which one can communicate freely and extravagantly. One could expect that, being infinite, the biblical God communicates Himself to the degree of infinity! The voice of the good God is everywhere, waiting to be heard by those who have ears to hear.

The whole of creation was, and still largely is, for man's enjoyment, services, and food. There is nothing in creation that does not contribute something to our welfare in providing for our means, our health, our clothing, our service, or being for our sheer and unmitigated delight.

Mathematics is a unique method of describing the arrangement of God's good creation. In this arrangement,

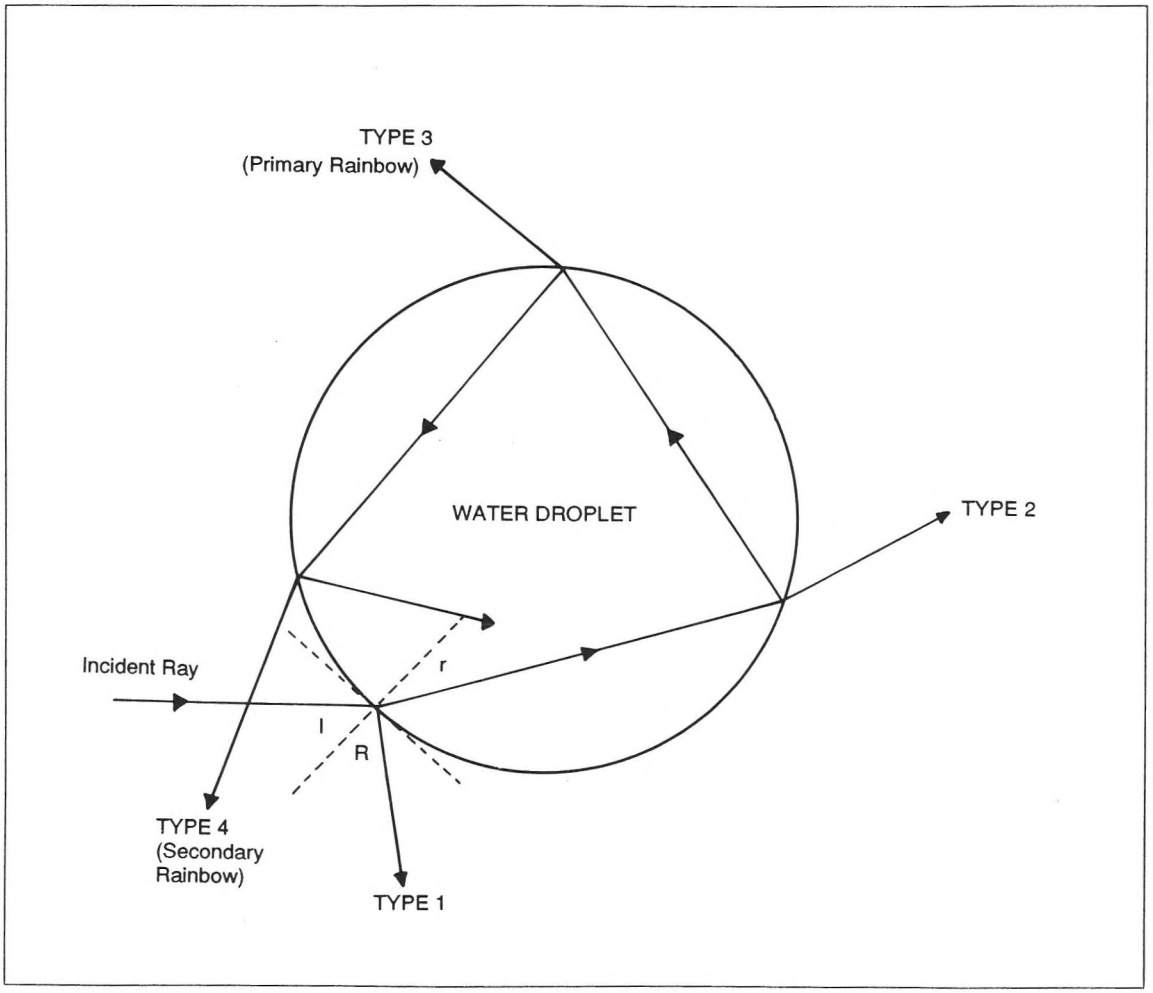

Figure 3. THE PATH OF LIGHT THROUGH A WATER DROPLET.

we see God's great and gracious concern to bless man. Over and above the mathematical formulae describing matter, motion, and forces, there is a message conveyed through the magic touch of personality. Through the manifold works of God, from the variegated rainbow to the delicate rose, the language of love reaches our hearts.

GUILTILY BLIND

We must expect that humanistic mathematicians will miss the whole point of the place of mathematics in the purposes of God. Not willing to submit their lives to their Maker, they are guiltily blind to the glory of God reflected in the unique mirror of mathematics. Because of this wilful denial and suppression of evident truth, the mathematical structure of creation will be misunderstood and ultimately perverted.

Yet, if their practical day to day work is to be effective, scientists and applied mathematicians must make biblical assumptions about the physical world that are contrary to their voiced humanistic presuppositions. In the words of Albert Einstein:

> *'Don't listen to their words, fix your attention on their deeds'*[60]

He continues:

> *'Without the belief that it is possible to grasp the reality with our theoretical constructions, without the belief in the inner harmony of our world, there could be no science.'*[61]

Mathematicians and scientists today are living on borrowed capital; they are earning interest off a deposit that they no longer acknowledge or recognize to be genuine. As Stanley Jaki states:

> *'Science is now in possession of such a vast interconnection of data, laws, and instruments as to continue its progress even if no attention is paid any longer to that faith which played an indispensable role in its rise.'*[62]

Cornelius Van Til is direct and to the point:

> *'Sinners use the principle of chance back of all things and the idea of exhaustive rationalization as the legitimate aim of science. If the universe were actually what these men assume it to be according to their principle, there would be no science. Science is possible and actual only because the non-believer's principle is not true and the believer's principle is true. Only because God has created the universe and does control it by His providence, is there such a thing as science at all.'*[63]

The rationalist John W. N. Sullivan echoed Van Til's remark by querying:

> *'Why the external should obey the laws of logic; why, in fact, science should be possible, is not at all an easy question to answer.'*[64]

Scientists must accept objective coherence in a universe, not a multiverse, if there is to be any such thing as real science. If not, using the words of Stanley Jaki:

> *'any analysis of knowledge becomes a celebration of incoherence.'*[65]

MATHEMATICAL REALITY

James Clerk Maxwell (1831–1879) developed mathematical equations that enabled scientists to accomplish wonders with electrical and magnetic phenomena.[66] Not only are these equations profound, comprehensive and effective, they are also extremely beautiful and symmetric. According to Norman Campbell, these equations illustrate:

> *'the marvellous power of pure thought, aiming only at the satisfaction of intellectual desires (e.g. beauty, order, symmetry), to control the external world.'*[67]

When Heinrich Hertz (1857–1894) discovered the existence of radio waves, he verified all of Maxwells' equations and ensuing predictions. The response of Hertz is informative:

> *'One cannot escape the feeling that these mathematical formulae have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than was originally put into them.'*[68]

Philip E. B. Jourdain (1879–1914), mathematician and son of a Derbyshire vicar, observed that:

> *'. . . the nature of Mathematics is independent of us personally and of the world outside, and we can feel that our own discoveries and views do not affect the Truth itself, but only the extent to which we or others see it . . . Some philosophers have reached the startling conclusion that Truth is made by men, and that Mathematics is created by mathematicians, and that Columbus created America . . .'*[69]

Godfrey H. Hardy (1877–1947) considered God to be his personal enemy and prided himself in the claim that none of his mathematics would ever apply to any aspect of the real world. He finally had to confess that:

> *'mathematical reality lies outside of us. Our function is to discover, or observe it, and that the theorems which we describe grandiloquently as our creations are simply notes on our observations.'*[70]

After Hardy's death, his mathematical results were applied to the physical world.[71]

Albert Einstein confessed in 1934:

> *'To him who is a discoverer in this field the products of his imagination appear so necessary and natural that he regards them, and would like to have them regarded by others, not as creations of thought but as given realities.'*[72]

Nicholas Bourbaki, a collective *nom-de-plume* for a group of French mathematicians, said in 1950:

> *'That there is an intimate connection between experimental phenomena and mathematical structures, seems to be fully confirmed in the most unexpected*

manner by the recent discoveries of contemporary physics . . . but we are completely ignorant as to the underlying reasons for this fact . . . and we shall perhaps always remain ignorant of them.'[73]

They conclude:

'Mathematics appears thus as a storehouse of abstract forms . . . and it so happens — without our knowing why — that certain aspects of empirical reality fit themselves into these forms, as if through a kind of pre-adaptation.'[74]

THE UNIFYING FACTOR

Sir Oliver Graham Sutton remarks:

'How can the manipulation of symbols which we have invented, according to rules which we alone make (and sometimes break), reveal that which lies beyond our senses?'[75]

To him this question *'is one which is unlikely to receive a satisfactory answer . . .'*[76] Then, he makes a remarkable and accurate observation:

'The universe, both as a whole and in its microstructure, suggests that in neither aspect can it be treated merely as an enlarged or diminished version of the world which we know through our senses. The ultimate secrets of nature are written in a language which we cannot yet read. Mathematics provides a commentary on the text, sometimes a close translation, but in words we can read because they are our own.'[77]

Why does mathematics 'work'? Why does it fit the real world? What is the reason for this mysterious coherence between mathematical thought and empirical reality? In ultimate, what is the 'language of the universe' that mathematics gives commentary to? If mathematics is just a product of man's autonomous reason, then the answers to these questions will forever remain a mystery.

Early in the twentieth century, Philip E. B. Jourdain remarked that mathematics *'really occupies a place sometimes reserved for an even more sacred Being.'*[78]

For Larry Zimmerman, mathematics is more than just the free creation of the human mind. He says:

'It is possible, that mathematics is an entity which always exists in the mind of God, and which is for us the universal expression of His creative and sustaining word or power . . . So we would expect the deepest scientific probes into the micro- or macro-cosmos to reveal a language fabric in which are woven the forces and relationships governing the tangible creation. This language fabric should itself be suggestive of an intellectual antecedent, an orderly, powerful, infinitude of thought, a "terra incognita *of pure reasoning" which "casts a chill on human glory." '*[79]

Vern S. Poythress, theologian and mathematician, agrees with Zimmerman and reflects upon the linguistic character of God's creation:

'The created world, as result of God's speech, bears within it from top to bottom a kind of quasilinguistic character . . . through God's act of creation, things in the world themselves become wordless voices to the praise of God.'[80]

Henry Morris (1918–2006), a pioneer in the field of creation science, observes:

'The more intensively and thoroughly man probes the universe — whether the submicroscopic universe of the atomic nucleus or the tremendous metagalactic universe of astronomy — the more amazingly intricate and grand are God's reservoirs of power revealed to be.'[81]

In the nineteenth century, Edward Everett (1794–1865), American statesman, gave this remarkable observation:

'The great truths with which it (mathematics — *J.* N.) *deals, are clothed with austere grandeur far above all purposes of immediate convenience or profit. It is in them that our limited understandings approach nearest to the conception of that absolute and infinite . . . In the pure mathematics we contemplate truths, which existed in the divine mind before the morning stars sang together, and which will continue to exist there, when the last of the radiant host shall have fallen from heaven. They existed not merely in metaphysical possibility, but in the actual contemplation of supreme reason. The pen of inspiration, ranging all nature and life for imagery, to set forth the Creator's power and wisdom, finds them best symbolized in the skill of the surveyor.'*[82]

What is made reflects the maker. Creation is a showcase of God's splendour, wisdom and power. Man, made in the image of God, has been, for millennia, using his powers of ingenuity in *'developing fundamental physical laws . . . in terms of a mathematical theory of great beauty and power.'*[83] In probing the creation, man has discovered and formulated relationships that reflect the language fabric of the 'word of God's power' and in so doing has exposed the ingenuity of the Creator.

According to Stanley Jaki, the universe *'has supreme coherence from the very small to the very large . . . It is beautifully proportioned into layers of dimensions and yet all of them are in perfect interaction.'*[84] God, the author of this wonderful, marvellous and coherent display, has gifted the mind of man with the capabilities of grasping it.

The mind of man, with its mathematical capabilities, and the physical world, with its observable mathematical order, **cohere** because of a common Creator.

The biblical revelation of the Creator God is the unifying factor that reconciles what is irreconcilable in the humanistic context.

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$$\frac{\partial^2\psi(x,t)}{\partial^2 x} = -\frac{8\pi^2 m}{h^2}\left[\frac{ih}{2\pi}\frac{\partial\psi(x,t)}{\partial t} - U(x)\psi(x,t)\right]$$

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ACKNOWLEDGMENT

This paper since submission to this journal has been published as a chapter in a new book by the author. This paper is, therefore, **reprinted with permission from** *'God and Mathematics,'* **copyright Ross House Books, Vallecito, California, 1989.**