EIR Science & Technology

The Crab Nebula and The Complex Domain

Investigating and understanding the "Crab" is a great project by which today's "no-future generation" can prove how man is different from the beasts. A challenge by Schiller Institute science advisor Jonathan Tennenbaum.

Here is the presentation, edited for publication, of Jonathan Tennenbaum to the Schiller Institute Summer Academy, held on Aug. 16-17, in Frankfurt, Germany. Attended by some 120 youths from all over Europe, it was also addressed by Lyndon LaRouche and Helga Zepp-LaRouche.

The reason why I invited the Crab Nebula to visit us and to participate in this conference, is because I want to give an additional, new proof, for the difference between human beings and animals, the difference between man and beast. Because it should be clear that it's not enough to have heard that there is a difference between man and animals, not enough to just believe it or to remember that at some time you understood that there was a difference, but you have to keep proving it. It's not one of these things that you prove once, and then you say, "Okay, now we know." You have to keep proving it. In fact you have to *live* the proof. Each person in this room, all the time, has to be a living demonstration of the difference between man and animal.

So, now, how can the Crab Nebula help us in this? There are several different ways, that are all connected with the same core conception. Firstly, you see this image here (**Figure 1**). If man were an animal, we would not be seeing this. Because the Crab Nebula is not visible to our eyes directly. You don't see it. You can look in the heavens all the time; you won't find the Crab Nebula. It's too small, too weak, too faint. And in fact, most of the objects of modern astrophysics are not directly visible to the human eye. We study them using

FIGURE 1
The Crab Nebula

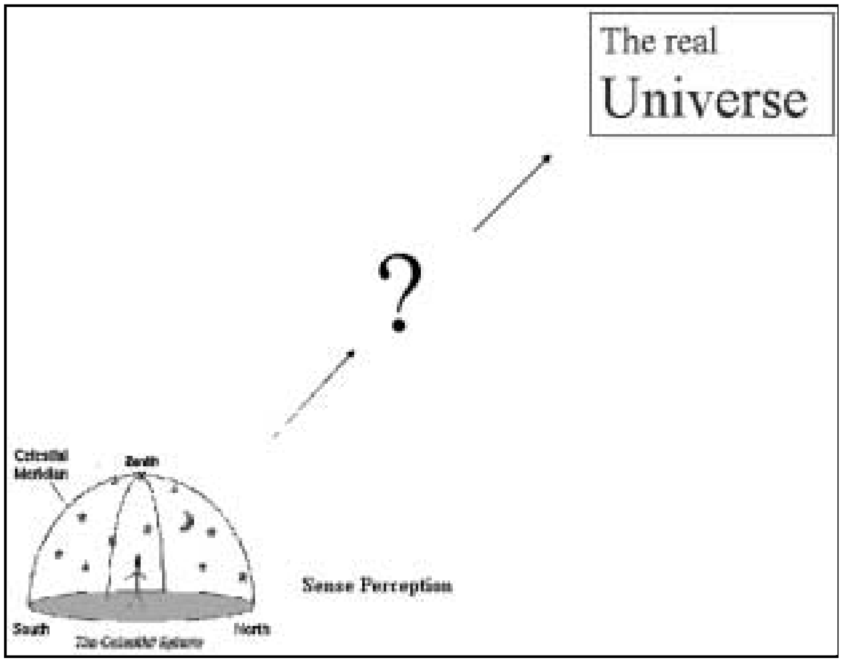
Full of paradoxes for 21st-Century astronomy. "There's no formula, no software, no procedure that would allow you to input sense perception, and get 'reality' as the output. The world doesn't work that way. To discover truth. you have to go outside the domain of formal procedures."

scientific instruments. We look at the scientific instruments and they do something; and we say, “Ah ha! There’s something out there.”

And also, we would not be talking about the Crab Nebula unless human beings, scientists, were actively looking for something, searching for anomalies. It didn’t come to us and hit us on the shoulder. It wasn’t something you stumbled over on a pathway somewhere, taking a walk. But scientists were actively looking. Something that, also, only man really does.

Thirdly, these scientific instruments, without which we wouldn’t be talking about the Crab Nebula—the telescope and other types of instruments form a kind of extension of our own sense organs. Their construction, however, embodied principles of design, physical principles that man has progressively discovered and mastered for practice, over a long history of scientific discoveries. No animal is able to do that.

FIGURE 2



But there’s more. We’re going to do something with these observations, that no animal does. We’re not going to just do what most scientists do, trying to just interpret their measurements on the basis of what they *learned*, on the basis of textbook knowledge—just as animals react to sense perceptions according to preprogrammed instincts. We’re not going to do that. We are going to be uniquely human. We’re going to use these observations to deliberately generate paradoxes. And, on the basis of those paradoxes, we’re going to locate and discover, through a process of reflection using human reason, something flawed or incomplete in our thinking—not just in some detail, but about the whole way we have thought about the world up to now. And by doing that, we then generate a new idea, a new axiomatic conception, which actually changes, implicitly, everything about the way we think and we deal with the Universe.

Finally, if we can prove the validity of this hypothesis—by demonstrating that this new way of dealing with the Universe provides us with a growing power to sustain human life, as demonstrated in economic development and so forth—then we have demonstrated scientific truth.

Another thing enters into this. The process of reflection called human reason, which permits us to generate new scientific conceptions, involves a very special sort of relationship of ourselves to other human beings, which is uniquely human: a very intimate, very profound relationship with people who are not alive any more in the biological sense. Great scientists, great thinkers, great creative personalities of the past, with whom we carry out a kind of Platonic dialogue of reflection on the way we think about the Universe. And these creative personalities make a kind of “second celestial sphere”—not the ordinary celestial sphere with the stars we see with our eyes, but a “sphere” that is populated by creative human personalities which form, in a sense, our intellectual Universe. Those are the “monads/stars” with whom we carry on a sort of Platonic dialogue, through which we increase our powers to develop human existence.

From Sense Perception to Knowledge

Now what I’ve presented here, in a very condensed way, is an ordered, multi-step process, going from sense perception to scientific knowledge. It goes from the sense perception to scientific instruments that extend the powers of perception; from the design principles of the scientific instruments; to paradoxes, which, ironically, show that there is something implicitly flawed or incomplete in those same design principles; and from there, to a dialogue inside the individual human mind, in which we converse with the other creative personalities, living and dead, to generate a new hypothesis. Finally, from the generation of a new hypothesis, via the communication of the new idea to other human minds, and its assimilation into the productive practice of society, to an increase in the per-capita power of society to sustain human life, demonstrating the validity of the new hypothesis as a genuine advance in human knowledge.

Let’s look more carefully at the different phases of this process. And start very, very simply, with the realization that our senses do not tell us the truth. They couldn’t; it’s not that they want to lie to us. They are not *able* to tell us what the real

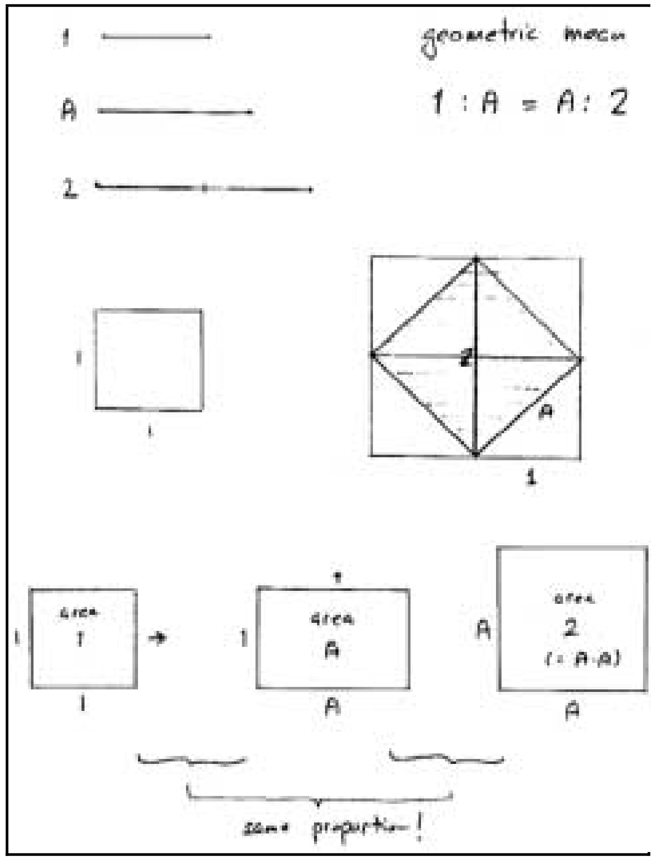
Universe is. For example: Objects that are far away from us, look smaller. Are they really smaller? They *look* smaller. So, by this simple sort of paradox, we see that vision doesn't tell us the true size of objects. More importantly, we see things happening, but we don't see their *causes* with our eyes or the other senses. That, we have to use our minds for.

Figure 2 shows the general problem posed by what I have just said. In the lower corner is the notion of sense perception, as it occurs in astronomy: the so-called celestial sphere, with the stars and other astronomical objects we see with our eyes. In the upper corner of the diagram, is the real Universe, that we don't see directly. The question is, "How do we get from sense perception to the real Universe? What kind of a process is that?" This is exactly the subject of epistemology, as Plato develops this in his famous "Allegory of the Cave," and in all of his dialogues, where he speaks of the realm of sense perceptions as a kind of shadow of reality.

This takes us to the central focus of the Classical Greeks' work on *geometry*. Many people think, "Oh yeah, Greek geometry is about straight lines and circles and points and triangles, and so on." That's not quite true. The real subject of the geometry of the Platonic tradition is epistemology, the question of how the human mind can come to know reality. I shall demonstrate that to you in a moment.

The geometry I am talking about is the geometry Lyndon LaRouche calls the "pre-Euclidean geometry"; the geometrical method that was brought in from Egypt, and developed by Thales and Pythagoras and their successors up to the time of Plato, but which was lost when the teaching of geometry became dominated by the influence of Aristotle.

FIGURE 3
Doubling of a Square



The Significance of Geometrical Means

One of the central topics of investigation of this Classical geometry, was the construction of what were called "means between extremes," such as the geometrical mean, the arithmetic mean, the harmonic mean. At first glance, these means have to do with numbers and line segments. For example: You take two numbers—2 and 8. How can you get from 2 to 8 by some kind of lawful progression? Well, one way to do it, is via the so-called geometrical mean, which is 4. To get from 2 to 4 is by doubling. And to get from 4 to 8 is by doubling again; so you have the same relationship; 4 mediates, so to speak, the transition from 2 to 8.

Now it's interesting to note, that at least in the languages that I know, the word "mean" signifies not only something which is in the middle between two things, but also an instrument or power by which you do something. So it is in German with the word "*Mittel*," in French with "*moyen*," in English "mean," in Russian "*stredstvo, sredneye.*"

Now, I want to illustrate this connection using some geometrical problems most of you are familiar with.

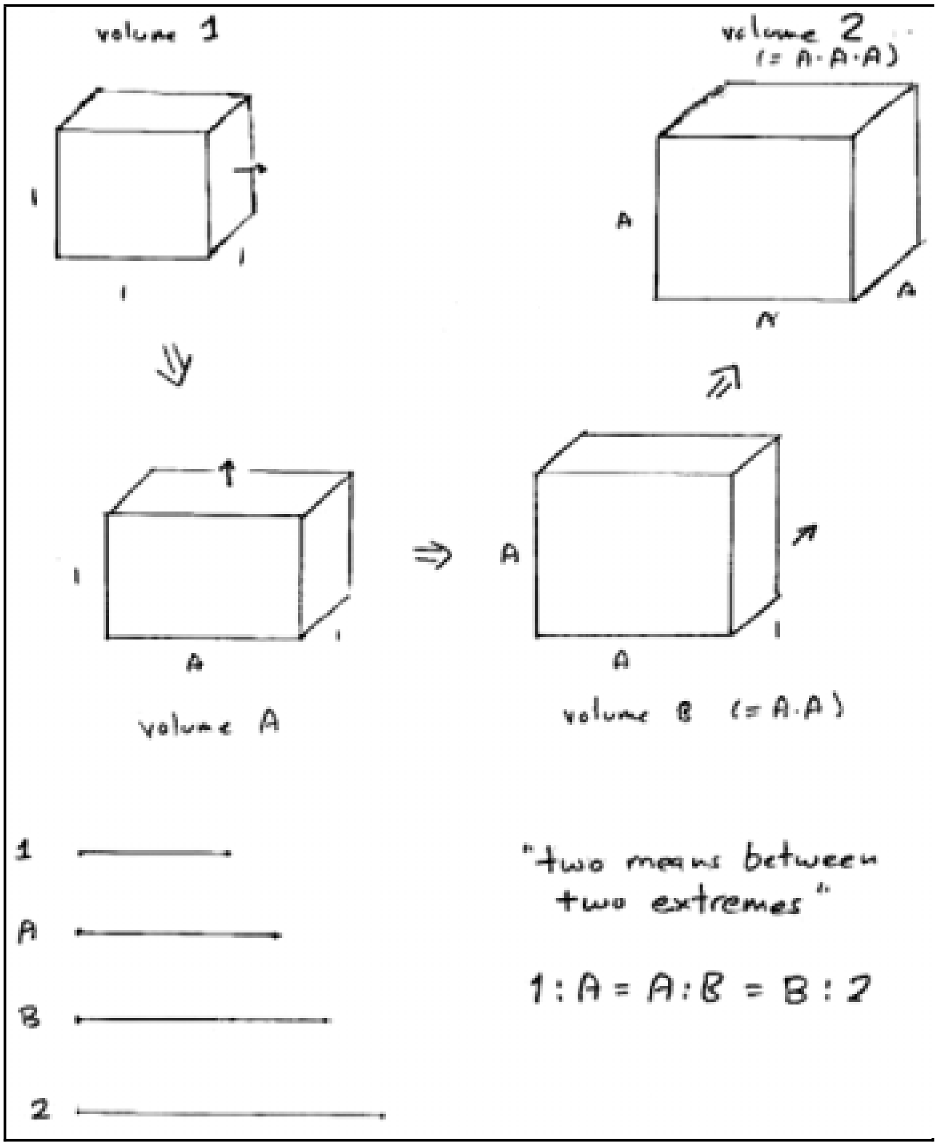
Figure 3 shows the problem of doubling a square. Given a square: You want to construct a square with exactly double the area. The Greek geometers discovered that this problem can be solved, if you can construct, between a length 1 and a length 2, an intermediate length called the geometrical mean: a length A, for which the ratio 1 to A equals the ratio of A to 2. In fact, if you look at the familiar solution for doubling the square, by means of diagonals, you can see geometrically that the diagonal of the original square is actually the geometrical mean between 1 and 2. This is apparent from the similarity of the two triangles ABC and ACD.

Another way you can understand the geometrical mean is to ask, "How do you go from the original square to the larger one?" Imagine you found the right length, A, for the side of the larger square. You take your square and you first stretch it in a horizontal direction to get a rectangle with sides A and 1. And then you stretch it again in the vertical direction to get the square with sides A and A. Evidently, both transformations increase the area by the same proportion. The area of the rectangle is the geometrical mean between the area of the original square and the area of the second square.

Doubling the Cube

Now let's look at the famous problem of doubling a cube (**Figure 4**). On the left, I have a cube whose side is a unit

FIGURE 4
Doubling of a Cube



length. Now suppose, hypothetically, that I have found a way to construct a cube with twice the volume; i.e., 2 cubic units. How could I get from the first cube to the second cube? Assuming I have somehow constructed the side A of the second cube, I could do the transformation in the following way: I start with the original cube, and I extend it in one direction, pulling it out, so to speak, lengthwise, so it has one side equal to A, while the other two sides remain of unit length. That will increase the volume by the factor A. Secondly, I now extend it vertically, by the same factor, to get a "box," two of whose sides are of length A, and the other of unit length. And finally, I stretched it in depth, by the same proportion, arriving at the second cube. So the transformation from the first to the second cube involved three "stretchings"—from the first cube to a box, from that to a second box, and then to the final cube, in such a way that the volume was increased by the same proportion in each step.

Investigating the matter along these lines, the Greeks concluded that the problem of doubling the cube, is equivalent to that of finding *two* means between the two extremes 1 and 2; i.e., two magnitudes A and B with the property, that $1:A = A:B = B:2$. These magnitudes are volumes of the two "boxes" we just interposed between the two cubes. In fact, the first box has volume A and the second box has volume $B = A^2$.

Now, it turns out that actually doubling a square, or even doubling a line, requires actually doing something which is not part of just the world of straight lines. To double a line, you must use rotation. To double the square we have to get the idea of a diagonal, which is, again, in a different realm, from that in which the problem is originally posed. That is why people tend to be surprised and delighted at the solution, and why Plato emphasized it in his *Meno* dialogue. Now, in both these cases—doubling the line and the square—the solution could be constructed, or at least seemed to be constructable, on the basis of ordinary procedures of geometry, with ruler and compass. Although actually, the idea behind the doubling of the square, what Plato highlights in the *Meno,* is not part of the procedures of geometry.

In the case of doubling the cube, however, it turns out that there is no construction at all within the procedures of geometrical construction laid forth by Euclid. You cannot double a cube using Euclidean procedures. That was known to the Platonics, known to Archytas; and it's a very crucial point. The problem of doubling the cube belongs to a higher "power." You have to go outside the bounds of formal geometry and its procedures, and generate a completely *different kind of idea*—an idea which is not simply geometrical in the ordinary sense, but involves a general notion of creation or generation.

This is most powerfully demonstrated by the construction by Archytas, a friend of Plato's, for how to double a cube. Archytas' astonishing construction actually generates the two means, A and B, between 1 and 2, using the intersection of three *surfaces of rotation:* a cylinder, a torus, and a cone (**Figure 5**). I can't go now into the details of Archytas' work; you can read about it in "Why Modern Mathematicians Can't Understand Archytas," *New Federalist*, May 26, 2003; and "Archytas' Musical Construction," *New Federalist*, June 23, 2003. But it should be clear that this construction is located, implicitly, in a completely different domain than ordinary Euclidean geometry. The surfaces are not static objects, but rather embody principles of generation, of action. You're in a different world.

So, although the original cube, and the one with double the volume, both ostensibly belong to the realm of ordinary Euclidean geometry, to actually construct the relationship between the two, we had to go outside the domain of Euclidean geometry. We had to go through a kind of thinking which is implicitly non-visual.

This means that the idea of simple, linear extension in space, and with that, the simple Euclidean notion of space itself, is not a true one. It's not the real Universe. There is no simple, linear action in the real Universe, allowing you to go from a cube to its double. Accordingly, there is no simple procedure to go from sense perception to knowledge about the real Universe. There's no formula, no software, no procedure that would allow you to input sense perception, and get "reality" as the output. The world doesn't work that way. To discover truth. you have to go outside the domain of formal procedures. And one crucial element of that is, you have to look at sense perception—the sensorium, so-called—as something *created*, not as something which is "simply there."

FIGURE 5

Solution by Archytas, Collaborator of Plato

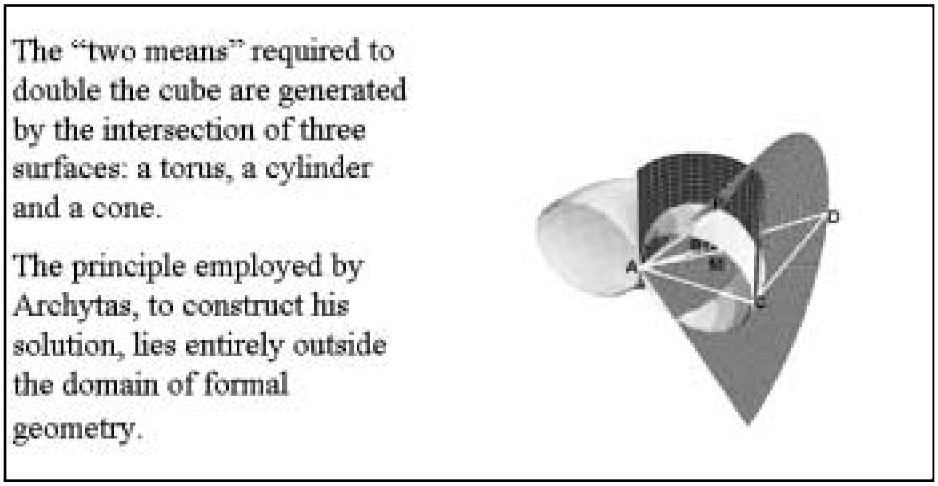
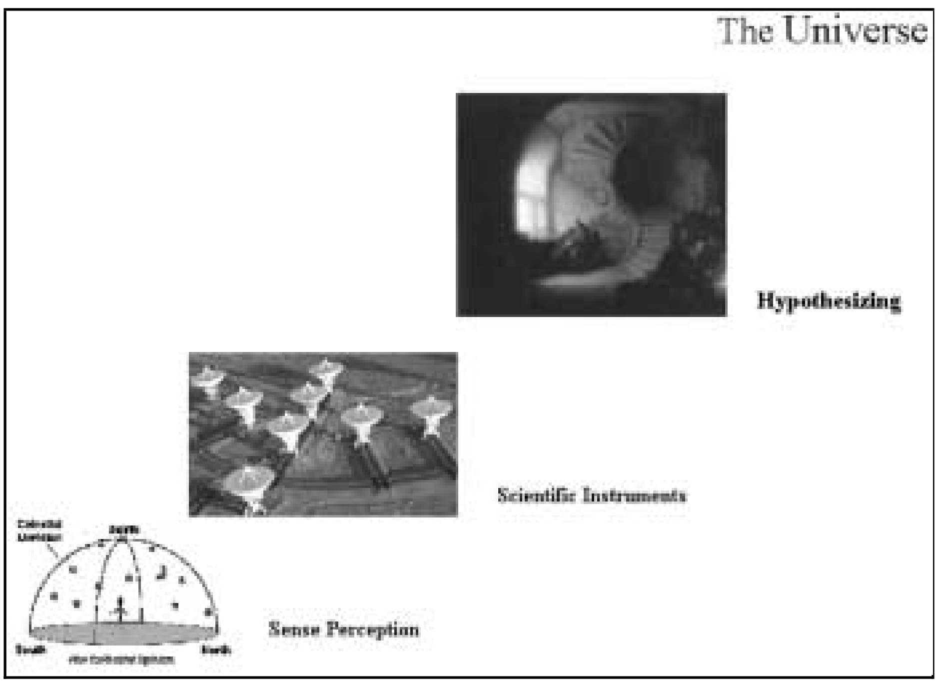


FIGURE 6

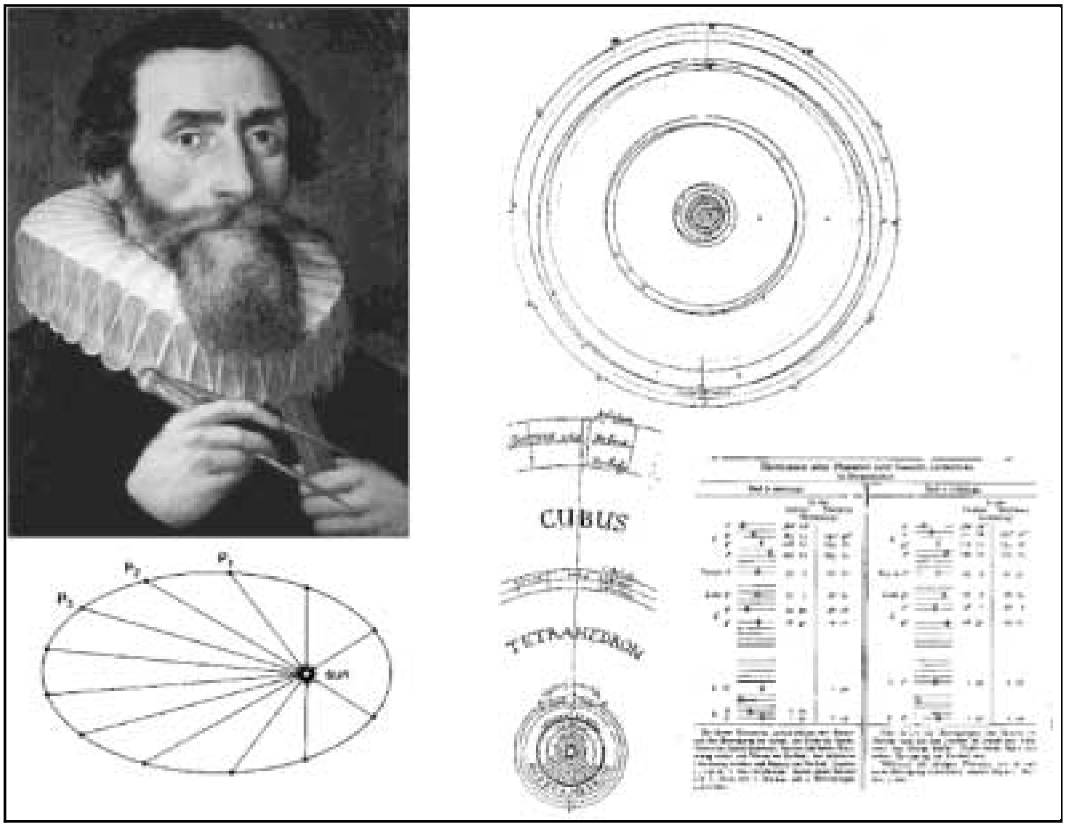
Cusa's 'Four Unities' for Astronomy



In summary, I want to emphasize three conclusions to be drawn from the work of Archytas and the Classical Greek investigation of "means," which shows what the pre-Euclidean geometry is *really* about.

Firstly, that there is no simple, deductive, or formal relationship between sense perception and the real Universe. There is a lawful relationship, but not formal.

FIGURE 7
Kepler's Discovery of Order of the Solar System



"Kepler demonstrated that the Solar System constitutes a single, unified, harmonically organized system—a kind of organism—in which each orbit has a pre-determined, lawful position within the whole. That conception, which Kepler developed in his New Astronomy *and* World Harmony, *is his original conception of 'universal gravitation.' "*

Secondly, to understand that relationship, you have to conceptualize a process of continuous creation or generation of the Universe.

And, thirdly, it concerns the hypothesis, that the process of going from sense perception to knowledge about the real Universe involves, somehow, two "means"—two additional species intermediate, so to speak, between our sense perception and the principle of creation of the Universe itself, mediating their relationship.

The Four Unities

Plato develops the concept of "two means" between sense perception and knowledge, in many places in his dialogues, including the Sixth Book of the *Republic,* where he discusses the different levels of hypothesis in terms of geometrical proportions. It was exactly this Classical, Platonic conception, most powerfully expressed and developed in the work of Nicolaus of Cusa, that launched the 15th-Century Renaissance. In his *Docta Ignorantia,* (*Learned Ignorance*) and most explicitly a companion writing entitled *De Coniecturis,* (*On Conjecture*, or *On Hypothesis*), Nicolaus of Cusa develops this notion of what he calls the "four unities." **Figure 6** gives an image of Cusa's four unities as they might be express in respect to human astronomical discovery.

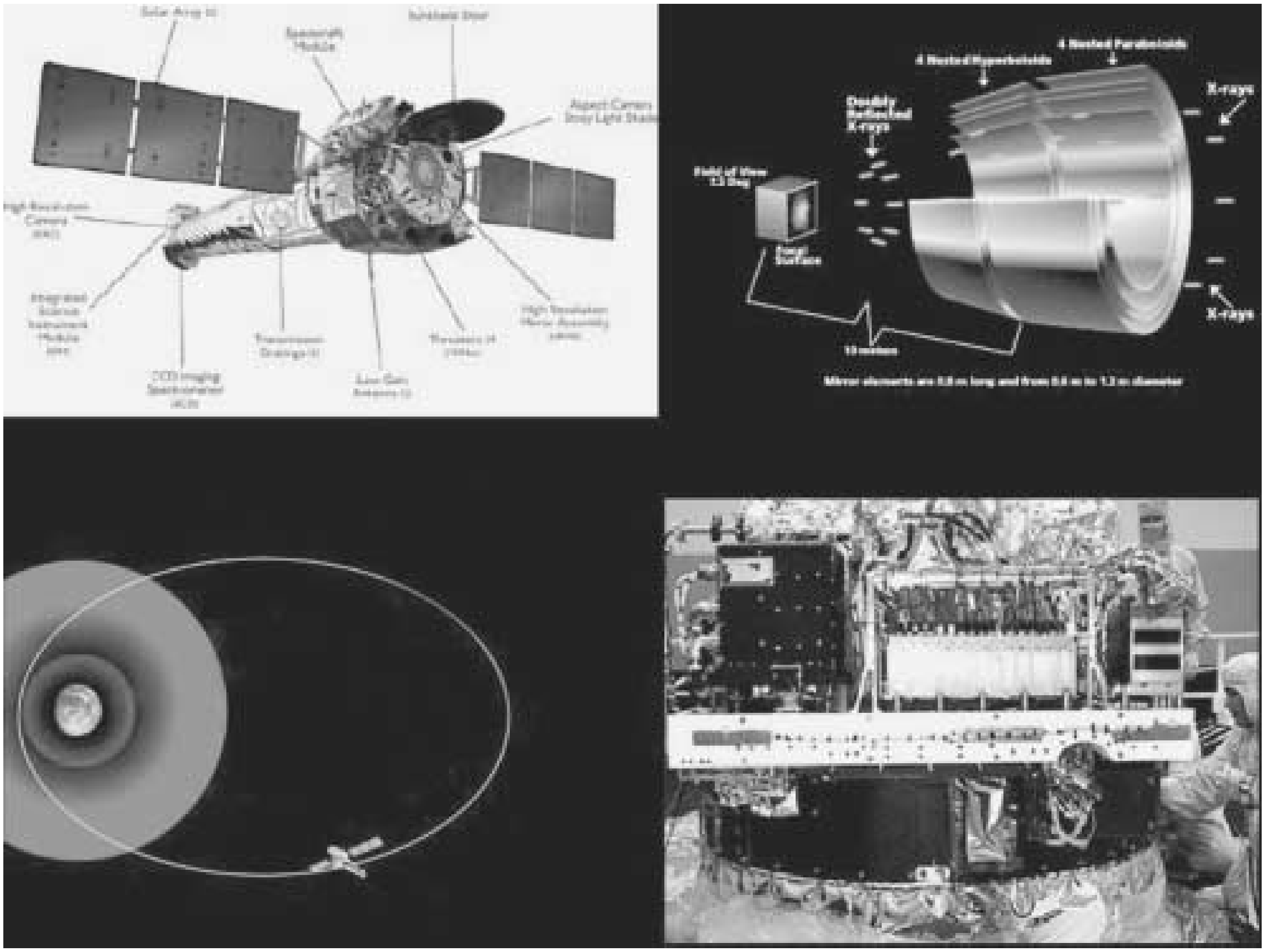
Below we have sense perception, and at the top the universal principle of creation. Between these, Nicolaus of Cusa distinguished two mediating faculties. One, he called the faculty of understanding (German, "*Verstand*") and the other he called reason (German, "*Vernunft*").

Let us look closer at these "four unities." Starting at the top we have, first, the Universe itself, considered not as an aggregate of objects, but, simply as a single principle of creation—a single idea, in the same way we were talking about the way a great work of music is the expression of a single idea. So the visible Universe and everything else is the expression of a single, grand principle of creation. That principle of creation is the "real Universe."

Next we have human creative reason, which is generated out of that great principle of creation of the Universe, and of which the human mind is a kind of expression. And we participate in the process of development and elaboration of the visible, through the discovery and "activation" in expanding human practice, of a growing array of universal physical principles.

Then we have a second, "lower" mean, Classically referred to as "understanding," which corresponds more or less

FIGURE 8
The ‘Chandra’ X-Ray Telescope



to what most people mean by “reasoning” or “logical” thinking. This is the sort of thinking process by which we elaborate already-known principles, into a growing system of knowledge and practice, somewhat analogous to the way a mathematician deduces a growing array of theorems from some given set of axioms. The level of understanding is exemplified by an engineer designing scientific instruments, and other forms of technology, on the basis of principles he had previously assimilated. The understanding is that by which we, most of the time, interpret sense perception, the fourth level.

Note the ironic relationship between these four unities.

For example, sense perception, by itself, cannot identify what is happening to it. The eyes say, “Flash, flash, flash, flash,” but do not by themselves identify an object. That requires a higher power of the mind. Our touch perception says, “Hurt, hurt, hurt. Feel good; hard; soft,” but does not by itself identify what it is we are touching.

So, it’s the understanding—an elaborated, evolving array of knowledge—by which we interpret sense perception, and by which also a scientist, seeing his instruments going, “Bup, bup, bup, bup, bup,” says, “Aha, this is the Crab Nebula.”

But although understanding can interpret, combine and compare, it can never go outside the limits of the basic concepts and assumptions that it has learned from reason.

Only reason—only the principle of reason, or that faculty of reason—can actually go beyond any system of elaborated knowledge, by the method of Platonic hypothesis: by discovering paradoxes, hunting them down, forcing them out, and on that basis, generating a new conception which changes the way we think about the Universe.

But, also, human reason is not the Universe itself. Beyond that, is a universal principle of creation which is the source of human powers. So the human reason is not everything. That means also that process of discovery is unending. The joy of discovery never ends. So we are in the best of all possible worlds.

So, by this, Nicolaus of Cusa actually defined, for the first time, the method of modern experimental science as a kind of a flow, a double relationship, among these four unities.

Kepler's Discovery of Universal Gravitation

Johannes Kepler's revolution in astronomy, particularly in his *New Astronomy* and *World Harmony,* demonstrates Cusa's method in action. We look up at the sky, the celestial sphere. The celestial sphere has a very specific geometry, based on circular rotation. The instruments Tycho Brahe used to make the measurements were based on the conception of angular (circular) displacement as the elementary form of action. In fact, we do observe the stars coming up in the East and setting in the West, making circular motions in the sky. The Sun's motion is a little more complicated: there is a yearly cycle and a daily cycle. But all seems to be derivable from just circular rotation, by different combinations.

But, now you discover the bizarre motion of the planets (called in German "*Wandersterne,*" or "wandering stars") relative to the simple circular motion of the stars. Most paradoxical of all is the motion of Mars, with its looping motion. Kepler was able to demonstrate that the observed motion of Mars is incompatible with the assumption, that circular rotation is the fundamental form of action in the Universe. The Mars motion cannot be accounted for on the basis of a combination of simple rotational processes, like the gears of a machine. You can approximate it, but the approximations break down. It's a different kind of process.

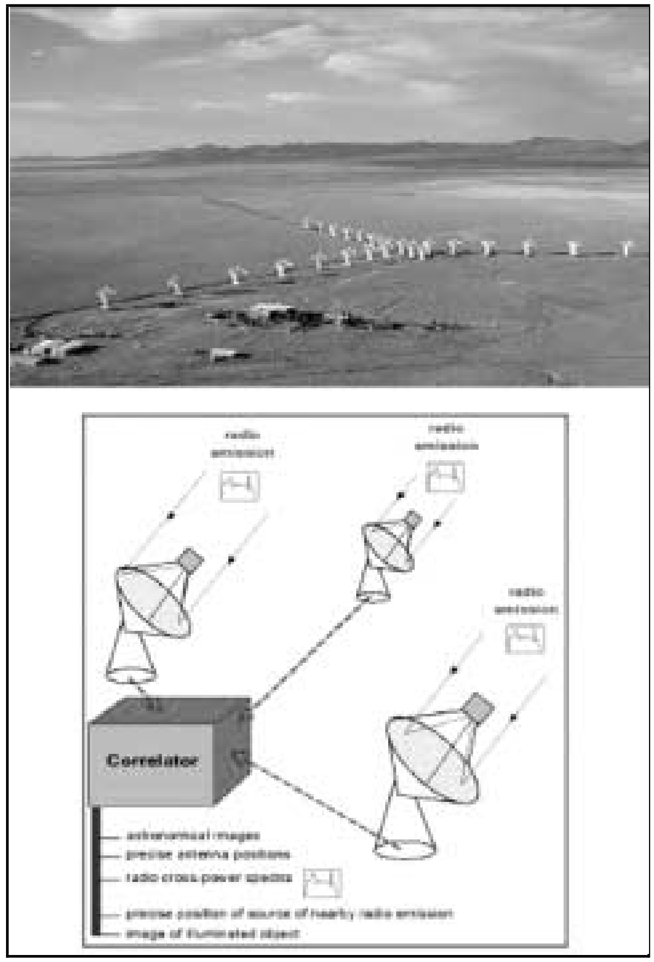
And out of this, Kepler conceived that there is a very different sort of principle, *guiding* the planet along its pathway, and which involves a constantly changing *curvature,* as expressed (in part) by an elliptical form of the orbit, as referenced to the Sun.

But, more than that. Kepler demonstrated that the Solar System constitutes a single, unified, harmonically organized system—a kind of organism—in which each orbit has a predetermined, lawful position within the whole (**Figure 7**). That conception, which Kepler developed in his *New Astronomy* and *World Harmony,* is his original conception of "universal gravitation." It's not a force; it's not the mechanistic bowdlerization produced by Newton later; it's a principle of composition of the Solar System.

I think it is very important, that Kepler did this at the historical moment he did, and not just for science. For, think of the disaster European civilization went through during his lifetime, the Thirty Years War, and the wars that went before that. Kepler's work was key to rebuilding European civilization after that holocaust, by instilling a sense of confidence in the creative powers of the human mind, to lift civilization again out of barbarism.

Now, the mathematics of Kepler's time was totally inadequate, to elaborate Kepler's new principle into a comprehensive mathematical physics. Therefore, a new type of mathematics had to be created; and this was actually done, particularly through the work of Fermat, Pascal, Leibniz and Bernoulli. This was the birth of what came to be known as the infinitesimal calculus.

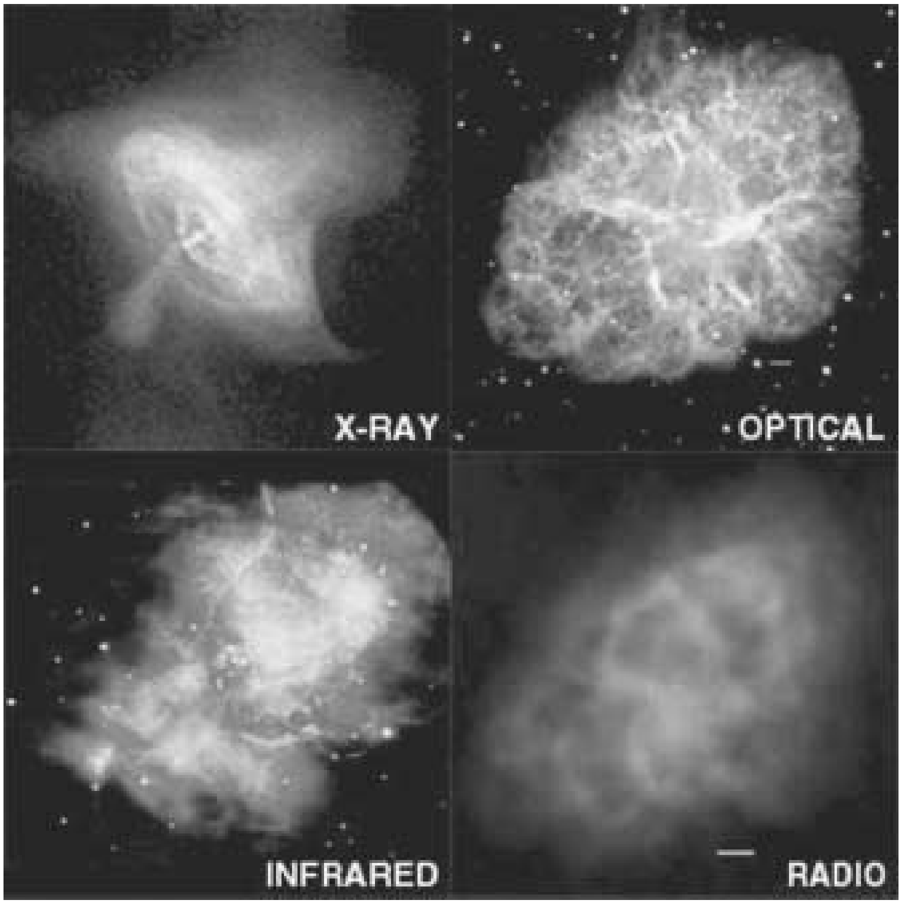
FIGURE 9
Interferometry With an Array of Telescopes



The Paradoxes of the Crab Nebula

Now we come to the present time, and back to the image of the Crab Nebula. In the meantime, the revolution which Kepler unleashed, led via the work of Leibniz and his collaborators, into an explosion of scientific and technological progress, whose effects continue until today. The instruments which produced the strange images I'm about to show you, are based on design principles that were discovered through Kepler's work and what came after that. Those instruments are an inseparable feature of the form of modern, scientifically driven, industrial society, which was established in the United States, in France, in Germany, in other nations, in the 18th and

FIGURE 10
Crab Nebula Viewed With Four Types of Radiation



"What is it that is doing these different things to our various instruments? We begin to realize, that the Crab Nebula is not a simple object, of the sort our naive sense-perception would lead us to think."

19th Centuries. That is the industrial society that is collapsing around us now, but fortunately there's still some remainder of that—expressed not least of all in the technology of space travel; in the extraordinary astrophysical instruments which have been put up in orbit around the Earth. Take, for example, the orbiting x-ray telescope Chandra, which uses some very remarkable new types of optics to focus and detect x-rays (**Figure 8**). This Chandra telescope had to be put into orbit in an elliptical orbit to take it away from the radiation belt of the Earth, which is very noisy.

Here you have another method of astrophysical observation called interferometry (**Figure 9,** left). You build a whole array of instruments; in this case, radio telescopes. You correlate the signals from those telescopes. The astronomers detect certain patterns of correlation between those signals, and say "Okay, now I'm looking at the Crab." So this kind of observation is a rather elaborate kind of interpretation of signals coming from a whole array of instruments.

Another example is a type of astronomical observations that hardly existed 50 years ago: gamma-ray astronomy (**Figure 9,** right). It's an astronomy based on the detection of extremely high-energy electromagnetic waves arriving toward the Earth from space. Some of these gamma rays have wavelengths about 1 trillion times shorter than those of visible light—trillion electron-volt gamma rays. When they encounter the upper layers of our atmosphere, they generate a whole cascade of different types of radiation, including flashes of light called Cerenkov radiation, which can then be detected by special instruments.

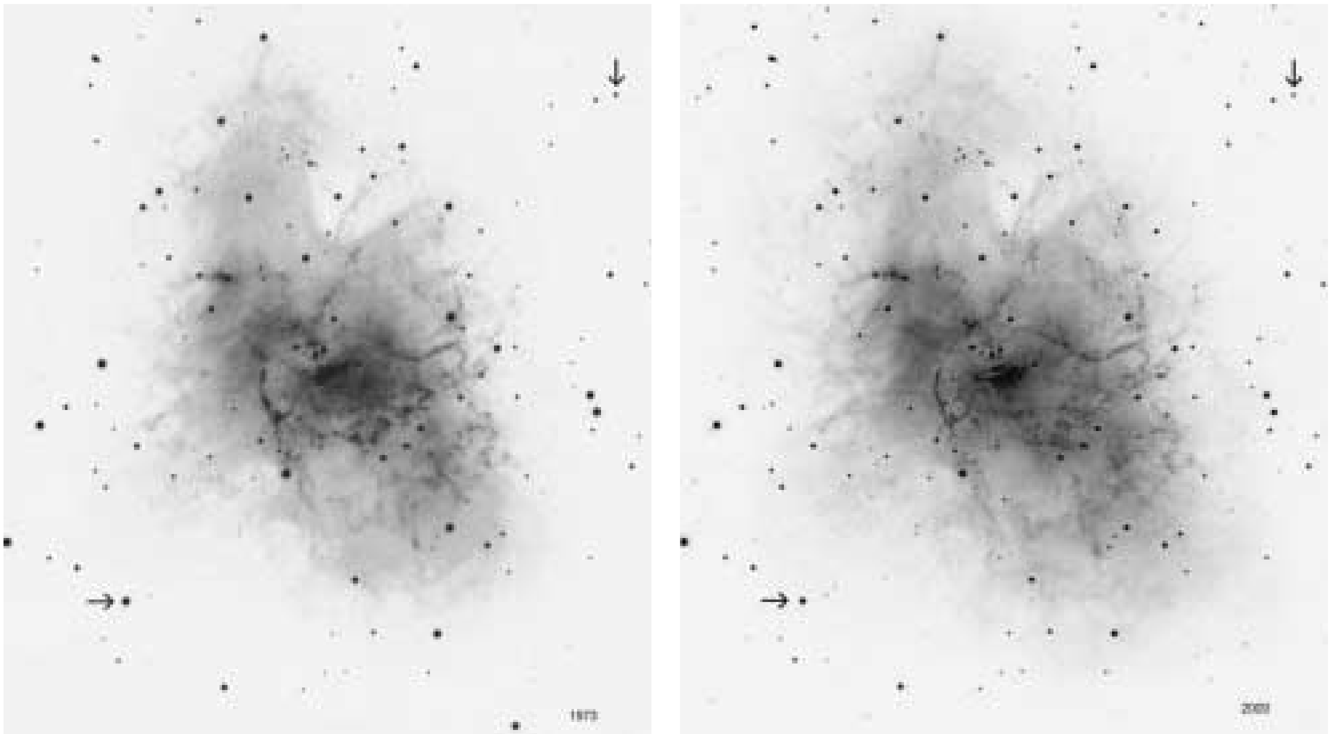
These few examples exemplify a whole orchestra of different types of instruments, now used to observe the Crab Nebula. Something already very far from simple sense perception.

Now, we point all these various devices at a location on the celestial sphere, where in 1731 the first astronomer noticed a diffuse luminous cloud, a "*nebula,*" which later became known as the "Crab Nebula." **Figure 10** shows images generated by four different types of instruments, operating in four different wavelength ranges of electromagnetic radiation. We have our x-ray telescope that shows us the image in the upper left-hand corner. A telescope operating with visible light gives us the image at the upper right. An infra-red telescope produces the quite different image at the lower left. And finally, a radio telescope array gives the fourth image, again very different, shown in the lower right-hand side.

Now, comparing these images should shake us up a little bit. Here we have four totally different pictures of what is presumably one and the same object. So, what *is* the object? What is it, that is doing these different things to our various instruments? We begin to realize, that the Crab Nebula is not a simple object, of the sort our naive sense perception would lead us to think.

Now let us look at another juxtaposition of images of the Crab—this time, two visible-light images, taken at different *times* (**Figure 11**—note that the images are negatives, with light and dark reversed.) The first picture was taken in 1973;

FIGURE 11
Crab Nebula Expands Over 27 Years' Time



"Comparing with the background of stars, we find that the Crab has grown*!—with an average rate of expansion of about 0.2 seconds of arc per year."*

the second, 27 years later, in 2000. Go back and forth between the two. Comparing with the background of stars, we find that the Crab has *grown!*—with an average rate of expansion of about 0.2 seconds of arc per year. (A second of arc is a 60th of a minute of arc, which in turn is a 60th of a degree.) Indications of this expansion were first noted by a recent comparison with photographic plates taken back in the 1920s.

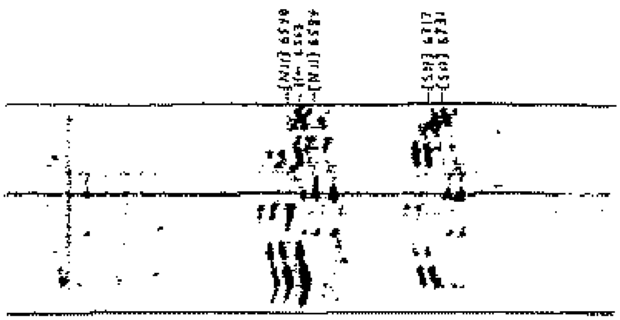
If you extrapolate backwards, assuming a constant angular rate of expansion, and assuming the Crab began as a very small object, you can make a very rough guess about how long ago the expansion would have started. You end up with an estimate of about 850 years, which would put the "birth" of the Crab Nebula, in its present phase at least, at around 1150 AD. Now around the year 1054, Chinese astronomers recorded the sudden appearance of a very bright, star-like object, in the general region of the sky where we now find the Crab. For three weeks, the "star" was visible even during the day, after which it gradually became weaker, until finally disappearing from the night sky. Astronomers now believe they know something about the sort of event that the Chinese observed in 1054: It is assumed to have been an explosion of a star, called a "supernova explosion"; and the Crab Nebula is supposed to be the "remnant" of that cataclysmic event.

Paradoxically, the approximately 100-year discrepancy in the extrapolated date, compared to the Chinese observation, seems to imply that the Crab's expansion has *accelerated* with time—a conclusion which is supported by some other indications, as well.

Next, we look at the so-called spectrum of the Crab Nebula (**Figure 12**). This is not a photographic image in the ordinary sense, but is generated when we run the light, coming from the Crab Nebula, across something called a diffraction grating, which splits the light into different wavelengths. The vertical axis in the spectrum corresponds to a position along the major axis of the Crab. We see clearly, that the distribution of wavelengths *changes*, depending upon what position along the Crab's axis we take the light from. People may remember from studying in chemistry laboratory, that every chemical element, when it's heated up, or otherwise excited, gives off light at very specific wavelengths, characteristic of the element. These appear as lines in a so-called spectrum. But in the Crab we find, that certain groups of lines, typically found in laboratory spectra of certain elements, appear "doubled" into two copies. One set is shifted toward lower wavelengths, and one is shifted toward higher wavelengths.

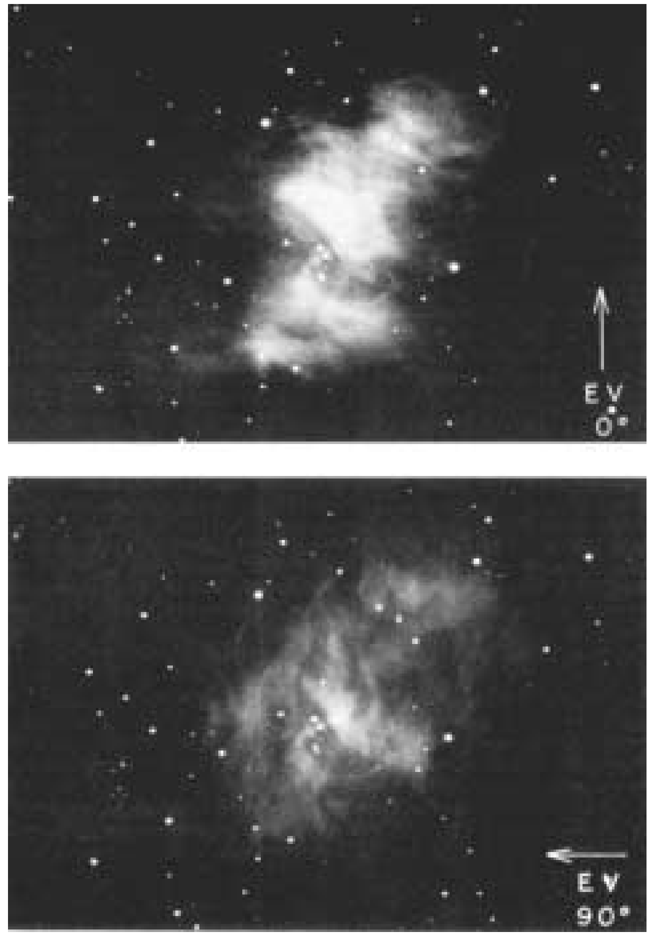
Quite anomalous, at first sight. What is going on? If we

FIGURE 12
Crab Nebula's Necklace-Shaped Emission-Line Spectrum



"The vertical axis in the spectrum corresponds to position along the major axis of the Crab. We see clearly, that the distribution of wavelengths changes *depending upon what position along the Crab's axis we take the light from."*

FIGURE 13
Two Views of 'Crab' Polarized 90° Apart



The great difference in brightness indicates the Crab Nebula's radiation emissions are strongly polarized along one axis in space.

look at this on the level of understanding, in terms of known principles associated with the generation and propagation of light, then we arrive at a fairly definite conclusion: We say, well, the Crab is expanding. If something is moving towards you very fast, and it emits light at a certain frequency, when the light arrives to you it will be slightly shorter in wavelength. It's called a blue shift. But if something is moving away from you very quickly, the light arriving to you will be shifted down in frequency, to a longer wavelength. That's called a red shift. That would account for the "doubled" appearance of familiar sets of spectral lines.

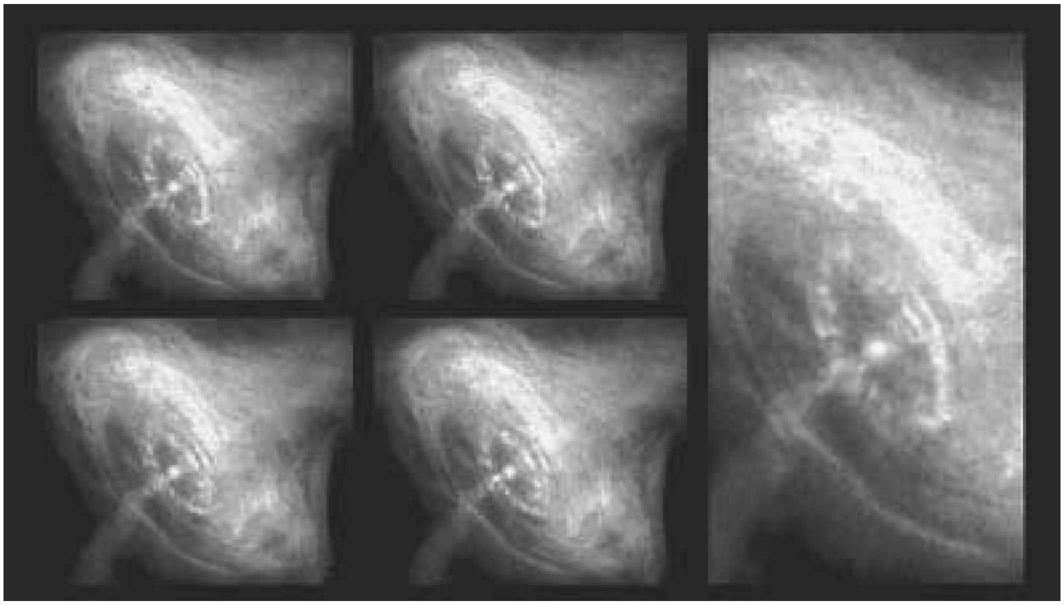
Again, applying known physical principles on the level of the understanding; and measuring the amount of the shifts of wavelengths upward and downward in comparison to the standard, Earth-bound laboratory values; you can derive an estimate of the *speed* of motion of the expanding outer shell of the Crab. Present estimates are in the range of 1,300 kilometers per second. From this, in turn, using simple geometrical principles, you can get a rough estimate for how large the Crab Nebula is, and how far distant it is from us. We come up with this estimate, that the Crab is about *ten light years* in diameter! A gigantic object, at least compared with our Solar System. I'm not saying this estimate is *true* in some absolute, objective sense.

This conclusion, however, is not an "objective fact," but an interpretation reached by our understanding, by applying known principles and assuming, for example, that the characteristics of space and time, of the propagation of light, etc., do not change in the vicinity of the Crab, nor over the entire distance to the Earth.

As we juxtapose more different sorts of observations, the paradoxes posed by the Crab become more and more powerful. **Figure 13** shows visible-light telescope images, taken with a polarizing filter which lets through only light waves having a certain axis of orientation in space. As we rotate the filter (in Figure 13, only two positions are shown), the image changes. In particular, the Crab is weak in one orientation and relatively bright in another. This indicates that all the light coming from different parts of this (presumably) gigantic object, has a common, dominant orientation. Astronomers conclude that the whole Crab Nebula is strongly magnetized—another reflection of its coherence and unity.

In **Figure 14** we have a close-up image of the core region of the Crab, made by the orbiting x-ray telescope Chandra. Here you see something very, very different. In addition to the visible-light range of the electromagnetic spectrum, the Crab emits most strongly in the range of x-rays—a very powerful, much shorter-wavelength form of radiation. A smaller, but significant part of Crab's radiation is in the form of gamma rays, including ultra-high-energy rays whose wavelengths are a trillion times shorter than those of visible light. These

FIGURE 14
Pulsing Motion of the Crab Nebula



"Just the inner 'ring' around the pulsar, where the most dramatic changes appear to occur—changes on the time-scale of days, or perhaps even hours—is already one light-year across."

gamma rays from the Crab constitute a significant part of the total cosmic radiation arriving at the Earth. These gamma rays are far beyond the wavelength range of the gamma rays produced by known nuclear-reaction processes like nuclear fission or fusion.

Pointing various instruments at the dot-like region in the middle of the Chandra picture, we pick up intense pulses of radiation, ranging over nearly the entire electromagnetic spectrum, but exactly synchronized at a rate of 30 pulses per second. The presumed source of the radiation, is a tiny, rapidly rotating star called a "pulsar," having highly anomalous physical characteristics.

Now, see: The Chandra actually made a series of seven x-ray images, between November 2000 and April 2001, once about every 20 days. These were put together to make a kind of a movie, which I'll show you now.[1] (Note: The pulsing you are seeing is not the pulse of the pulsar; it's just because the series of seven pictures has been "looped" to produce a longer film.)

What we see is really quite astonishing, very paradoxical, from the standpoint of conventional notions of physical causality. The object is rapidly changing. But at the same time, it is supposed to be immensely large. If you compare the pictures, you see that the changes are occurring in an apparently synchronous manner all over the object, producing the effect of waves propagating at a prodigious velocity. And yet, the object is so large that it would take light about ten light-years to go from one end to the other! Just the inner "ring" around the pulsar, where the most dramatic changes appear to occur—changes on the time-scale of days, or perhaps even hours—is already one light-year across.

This is highly anomalous. How does each part of the Crab know what the other parts are doing? There's a correlation that seems to be virtually instantaneous, and surely faster than the velocity of light. But the speed of light is supposed to be some kind of a limit, isn't it? Indeed, if the Universe were organized on the basis of the propagation of effects through space, then we would expect, that the larger an object is, the slower it should change; because it would take more time for effects to propagate. And yet the Crab, this vast object, is changing extremely rapidly, far more rapidly than our own, exceedingly peaceful Solar System. The Crab doesn't seem to pay any attention to the so-called limit of the speed of light.

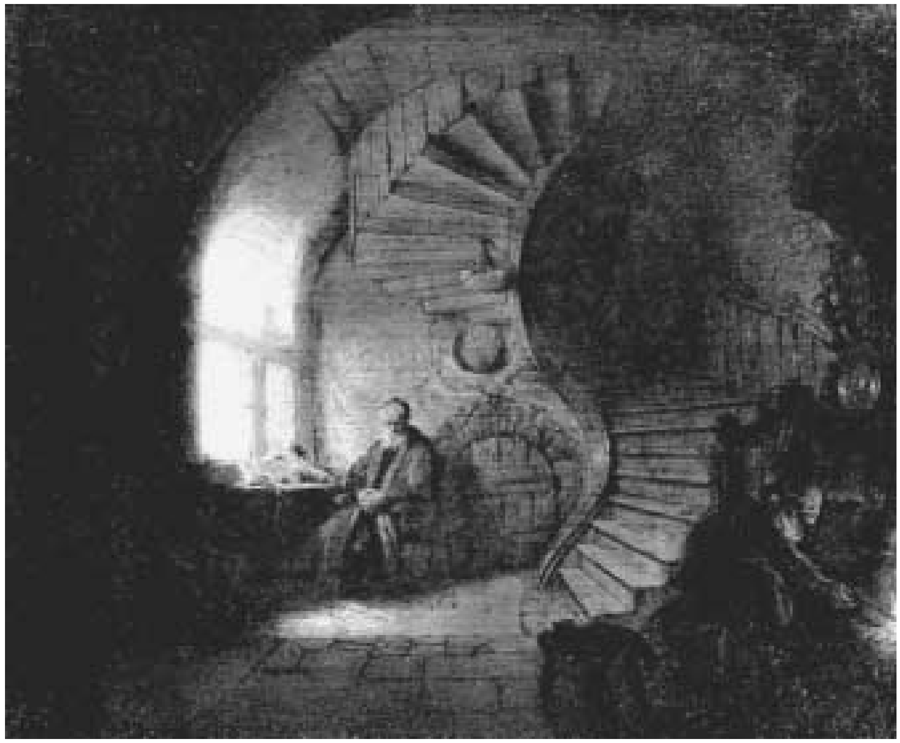
The Domain of Reason

So, we have an object, a "something" out there, now shown to be both highly organized and rapidly changing, in a manner that has hardly any resemblance to what the astronomers had earlier predicted and believed, on the basis of "standard theories." It is producing powerful, coherent pulses of radiation of different sorts. It displays correlations between events in very distant locations.

Now let us move to the second, and higher mean between sense perception and the Universe—the domain of reason. This domain of reason is something very special and also very terrifying for some people. I showed Rembrandt's painting (**Figure 15**), just to give a certain sense of part of this. Reason

1. The movie may be downloaded at the Chandra site: http://chandra.harvard.edu/photo/2002/0052/movies.html).

FIGURE 15
Rembrandt's 'The Philosopher'



is something that occurs entirely within the sovereign processes of a single individual human mind, in an individual soul. Secondly, reason, by its characteristic, tries to focus on the essentials. It doesn't want to be distracted. It doesn't introduce arbitrary things. What does it do? It does, what Helga described in her discussion of Herbart: Reason changes the relationships of the *Geistesmassen* [thought-objects, or thought-masses] in our soul.[2] It doesn't mean discovering a fact, getting some idea in the usual sense. Rather, your entire mind is changed by this process of reason. You change the substance of your mind. This is the realm of true freedom. This is what you can read in the passage of *I Corinthians,* 13 that Lyn often cites. You are face to face with the question of truth.

So, in this mode, we are not trying to "explain" the Crab Nebula. We are not making theories about the Crab Nebula. In the domain of reason, we don't make theories. In fact, if you can explain something on the basis of a theory, you can be sure that it doesn't exist in the real Universe. It's the anomalous nature of the Crab Nebula, which points to something actually existing behind the images we have seen. That's what Leibniz called substance. It's like Lyndon LaRouche. He is a walking anomaly. Furthermore, what we are looking for here, is a universal principle. It's not about the Crab Nebula per se. The Crab Nebula serves as a *Motiv* that a Classical composer employs in a musical composition, to convey an idea. So, we are not sitting and thinking about the Crab. We are thinking about the way we think about it! That is a characteristic of reason.

The first stage of this appears to be very negative, in a way Nicolaus of Cusa emphasized in what he called "negative theology." We first say, "Look, present-day physics, in terms of its fundamental assumptions, doesn't work." There are useful things in it; our technology is based on it. These wonderful astronomical instruments were based on real discoveries. But nevertheless, our present-day physics is defective, in two ways. Firstly, it's incomplete, as any knowledge is. Secondly, it has been crapped up. It has been pumped full of nonsense. It has been corrupted. In fact, as Lyn put it recently, science has been killed. This level of reason that I am talking about, the Platonic process of hypothesizing, has essentially stopped. Almost nobody is doing it.

Just look at almost any research paper in astronomy, or astrophysics. What are they doing? They are interpreting evidence on the basis of existing knowledge and "accepted standards" of reasoning and argument. They may come up with alternative theories, where one says it's this, another says it's that. They may fight over such alternative theories. But all the theories are ultimately based on the same fundamental assumptions. There's no actual hypothesizing going on.

On top of this, we have the way science was destroyed through empiricism—first in the form of Aristotle, and then upgraded into a streamlined, "turbo" form, with Paolo Sarpi and Descartes, leading to Newton and so forth. You can find evidence of this kind of corruption all over astrophysics today. Typical is near-universal acceptance of the notion of increasing entropy as a fundamental law of the Universe: the idea that the Universe is essentially running down as a whole. This notion was promoted by Kant, Laplace, Clausius, Lord Kelvin and others, as the thesis of a supposedly inevitable "heat death" of the Universe. And it comes out, for example, in the prevailing "line" concerning the Crab Nebula, repeated again

2. Helga Zepp-LaRouche's presentation in Frankfurt on Aug. 16 and her keynote to the ICLC/Schiller conference in Reston, Virginia on Aug. 31 both dealt with Friedrich Herbart's notion of the *Geistesmassen.* One of these will be published in a forthcoming issue. Readers can view her Aug. 31 keynote at www.schillerinstitute.org/conf-iclc/2003/labor_day/program.html.

and again in textbooks and research papers alike: "You had a star there, it collapsed and exploded. Boom! A supernova explosion. And what was left over after the star blew up, is the Crab Nebula." Thus, nearly everywhere, in almost ritual fashion, the Crab Nebula is constantly referred to as "supernova remnant." A remnant! Not a process of development.

But let's use reason. Let's examine this way of thinking. Let's ask ourselves, "What is the actual source of these kinds of conclusions, of this kind of idea? Did the idea of universal entropy come from observations? Or from some other kind of real evidence? If we critically examine where certain ideas and ways of thinking actually come from in science, we often find that they did come from a process of discovery. The idea of universal entropy did not come from some scientific discovery. It was actually introduced from the outside, as an ideological perversion of science. Discarding this, let us turn back to the Crab Nebula. It's not slow, not a dying remnant. It's behaving like a very peppy, very busy process, busy doing all kinds of things, changing very rapidly. It's going somewhere. It's evolving toward some kind of result.

Kepler already had a notion of the Solar System, implicitly, as an evolutionary process. Right now, our Sun is a wonderfully peaceful star. At first glance, looking up at the sky, the heavens appear very peaceful, very tranquil. But the more closely you look, the wilder, the more potentially violent the world of the stars turns out to be. For example, the visible Universe has innumerable variable stars, many of which can suddenly increase their light output by many times for a few hours, then go back again. Some pulse regularly. Some do it once in a while. If our Sun did anything like that, we'd all be gone. Fortunately, our Sun is very happy. Because it has its Solar System. It has its children going around it. So, it can have a peaceful old age in happiness.

But the Crab is changing very rapidly. And, as I mentioned, it's obviously not organized by signals or some kind of effects going from one place to another. That may be happening, as an effect, but this very rapid change suggests the idea of a *change of curvature* of an entire process as a whole. There is something behind the paradoxical, apparently contradictory features, revealed in the various images we have seen. You have a process of change which is a trajectory of evolution, of development. What is determining the correlation of events is not propagation, not chains of cause and effect of the sort present-day physicists are accustomed to thinking about; rather, the determining process is changes in the entire geometry of the process.

From the standpoint of "isochronic" changes in curvature of an entire process, on the scale of many light-years, we may begin to see the significance of the ultra-high-energy radiation from the Crab in a new light. What is "high-energy radiation?" What does it really mean? This cosmic radiation is beyond the range associated with ordinary nuclear reactions, with transmutations of elements from one position in the Periodic Table to another. What is going, on, is more like the generation of an entire periodic table.

To elaborate the concept of a trajectory of development as an *ordered process of changes of geometry*, is something that ordinary mathematical physics can't handle. It doesn't have anything that works for that. Thus, we need a reference-point and "seed crystal" for a way of thinking about this kind of critter. An indispensable reference-point, is Lyndon LaRouche's method in physical economy; a method whose mathematical side takes us into Riemannian geometry, as Lyn has characterized this, and also as understood from the standpoint of what Helga has presented about Herbart. This takes us into the elliptical and Abelian functions, which Gauss, Abel and Riemann developed out of the impulse of Kepler's work, as a notion of the primacy of axiomatic changes in the geometry of an entire process, relative to the apparent interactions of an assembly of elements.

Look at this not in terms of mathematics per se, but from the standpoint of Archytas and Plato: What is its physical significance? What does it mean ontologically? It is from this standpoint, that we may take the first steps, toward unleashing a new revolution in physics. Something akin to what Kepler did, almost singlehandedly, with his *New Astronomy.* And this will be, we can be sure, very beneficial for mankind. Because in the coming period, we're going to have to put the world economy through a rapid succession of changes having an axiomatic-geometrical character. We're not just building things here and there. When you talk about a global infrastructure system, you're talking about something which is *planetary,* in the sense that Vernadsky used the word, "planetary." You can't just look at an isolated part of the Earth. You have to look at how the entire planet is organized: its weather, its climate, its water system, and so forth. That means not making silly computer models based on interactions of parts, like the so-called climate models, which are all total nonsense, as Crab Nebula should teach us; and as Vernadsky taught us. As in the process of evolution of the biosphere, it is the changes in geometry that determine the apparent interactions of the elements, and not the other way around.

Perhaps the Crab Nebula is something a bit like what Lyn hypothesized as the early phases of creation of our Solar System, as an "exuberant," rapidly rotating young star "spun out" a plasma disk, generated the elements of the Periodic system, and organized them into planets. Certainly it's something in that direction.

Put this in a larger context. The more you study the heavens, using these developing arrays of instruments, the more densely populated it becomes, with anomalous astrophysical objects—objects that announce themselves as packages of anomalies. We seem to be looking at a Universe which is not just standing there; not evolving just on huge time scales like millions or billions of years; but there are also very rapid evolutions going on. So, we get a sense of what Lyn talked about in his three-by-three matrix of experimental science.

We have a Vernadskian Universe, which has the three groups of principles. The one is associated with non-living processes, the second with living processes, and the third with those involving the action of reason. But there is also a second sort of division of domains of experimental investigation: We can investigate physical principles in terms of their manifestations on the microphysical scale going down to the atomic, and the sub-atomic levels; we can look at them on the scale of our ordinary sense perception; and finally, their manifestations on an astrophysical scale. This combination of three groups of principles, and three distinctions of scale, forms a three-by-three matrix of experimental domains. Looking at the Crab Nebula and some other astrophysical objects from this standpoint, we come to a very fascinating question: To what extent might the anomalous characteristics of these objects constitute manifestations of a universal *principle of life,* operating on the astronomical scale of organization of the Universe? And what about the possible astrophysical manifestations of the principle of human reason? A principle which is always there in the Universe.

This brings us, in a sense, to the astrophysics of the human mind, and to the notion, that the Crab Nebula and other anomalous objects are not really just "out there" many light-years away, but are expressing principles which are operating *everywhere* and at *every time* in the whole Universe, and which are therefore also directly "here" with us.

This inquiry inevitably leads to the necessity of continuing the process that Nicolaus of Cusa laid out, involving both of the abovementioned "double means." On the one side, we stand at the threshold of new revolutions in the technological infrastructure of astrophysics. So far we've remained limited to the Earth and its immediate environment. To really investigate the Crab Nebula and other astrophysical anomalies, we must deploy arrays of such instruments far away from this noisy Sun, away from the noisy Earth. This means mankind must move to more remote regions of the Solar System—beginning with the orbital region of Mars—deploying there successive generations of astronomical instruments, based on new physical principles that we shall discover as we go along.

A first step is to develop the necessary logistical base in space, starting from the setting up of production centers on the Moon and the establishment of cities on Mars—permanent human settlements, that will carry on the task of deploying and servicing networks of astronomical instruments, operating in the region of the Mars orbit and beyond. On the other side, it's time to liberate science from the prison of empiricism, and to unleash an era of Reason, an era of development of human creative powers unlike anything history has seen.

That gives you a concept of a trajectory for mankind. Mankind needs this kind of conception, which Lyn has given to us, and it's crucial to the youth movement. To the extent young people today really get serious about taking up the intellectual and moral challenges set forth by Lyn, I am certain, that we shall indeed have that great Renaissance, upon which the survival of human civilization now depends.