Nitzotzot Min HaNer

Judaism and Science

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1. Overview

This edition of Nitzotzot Min HaNer has been written with sufficient care that we believe the novice to science will find the entire article a fairly easy read, while those who have a background in this issue will be more engaged by the last sections, beginning with Section 5 - Conflicts and Compatibilities, but especially the last 3 sections.

We begin by showing that science has been highly successful in improving mankind's lot in multiple ways, including his quality of physical life and his life span. Science, in other words, commands our respect because it works. But science has gone further – it has affected our thinking by radically changing our relationship to time and other things and by introducing many words into our common vocabulary. Science has been so powerful, in fact, that it has taken over from philosophy all the major questions about the beginning and the end of the universe, how and when life began, and what defines death.

In principle, Judaism is pro-science – it is a part, not only of our physical realities, but often of our halachik realities as well. Having said that, there are certainly conflicts between the Torah position and individual theorems of science. Even theories that are touted as great reconciliations with religion, such as the Big Bang, are not flawlessly in

harmony with Judaism. But the remarkable thing is that science, in almost every area, seems to be moving closer and closer to what Judaism has been saying all along.

As laymen, we sometimes pay more respect to a scientific theory than the scientist himself does. For the scientist, a theory is simply the best possible current explanations, usually among many, for as broad a group of phenomena as possible. Theories can contradict, and can be weaker or stronger. No theory is considered by scientists as infallible. This reinforces the idea that science is in constant movement forwards, and, since that direction is towards Judaism, we need not feel that we have to resolve all conflicts right away. We can wait, patiently, until science gets closer, and ultimately see all these conflicts resolved.

However, there are two more serious areas of conflict between Judaism and science. The first has to do with the fact that science is essentially a secular paradigm. Many scientists comfortably believe in G-d – but they would never dream of invoking Him as a part of their scientific explanations. G-d is outside of the acceptable parameters of science. Formally, science is neutral vis-à-vis religion. But the idea that all of nature would be discovered, without seeing G-d permeating every element, is highly problematic as we shall show.

The second problem is the fact that science moves so rapidly, that it tends to create facts on the ground without a full exploration of the moral and ethical implications it brings. Ethicists are always playing catch up with science, always coming from behind. In some scientific circles progress is welcomed as always being good, although many have recognized the seriousness of the current situation.

Our belief is that, in the Messianic era by the latest, science will undergo a radical revolution – a paradigm shift – which will bring G-d into the picture, will subject itself to Torah ethics, and allow science to bathe in its true glory, as a handmaiden of the Torah.

2. The Great Success of Science

Science, and in particular, twentieth century science, has changed our whole way of life. We live in houses that are heated and cooled, lit up at night, and wired to alarm systems. We turn on taps and get running water and flush toilets which connect to sophisticated sewerage systems; we drive in cars, watch TV and receive e-mails; we buy in huge supermarkets and cook in microwaves; we use our credit cards and make electronic transfers - indeed it is difficult to think of much of anything that we do which was not given to us by modern technology.

More than just saving us from going to the well for our water and using candles by night and donkeys by day, science has given us a new lease on life itself. In the USA between 1900 and 1998, the life expectancy increased from 47 years to 78 years. The average person has 31 extra years with which to fulfill his life's task. Truly remarkable! Many whose lives were measured in minutes and hours would today live long and healthy lives. Infant mortality (below one year of age) in the USA declined from 100 per 1000 births (10%) in 1915 to 11 per 1000 in 1984.[1]

[1] Figures from Dennis Flanagan's *Flanagan's Version*, Vintage Press, pp. 26-28

Horrible diseases, which over the centuries took hundreds of millions of lives, are now under control. One of the ghastliest of them all, smallpox, was totally eradicated from the face of the earth.

The more scientifically advanced a country, the better its standard of living. In these countries people eat better, have better sanitation, higher income, and generally live healthier, more comfortable lives. If we believe in science it is because we see that it works; not just by sending someone to outer space, but in tangible ways that seemingly improve our lives every minute of the day: telephones access us to almost anyone, roads are better paved and greengrocers store fresh produce from all ends of the globe.

Our world is full of the glories of scientific invention -we wake up in the morning, and turn on the electric kettle; we drive to work, catch the elevator, and turn on the computer. Our counterparts a century ago would not have done a single one of those things.

But what most of us fail to even be aware of is how science has changed our whole way of relating to the world. We are not aware of how even our daily speech has dramatically changed in the last century. After the invention of electricity, for example, effective people became “dynamos", a thrill gave one a "charge" and personalities could become "overloaded" or "burnt out".[1]

Our whole way of relating to time, changed dramatically. Up to the 1820's a day was divided into 12 daylight hours, each day having a different measure of hour. It was American railroads, with their need for exact scheduling which imposed modern time on mankind. No-one today can imagine how revolutionary such a change was. It engendered huge resistance at the time. Banks in Louisville, Kentucky stuck to sun time for another 30 years. A school board in an Ohio town decided to run the schools on Eastern Standard Time, in defiance of the city council which kept the rest of the town on sun time. A debtor in Boston reset his watch to the new eastern time and thereby missed his court appearance before a judge who stubbornly persisted in using local time and declared the man delinquent; the state supreme court overturned the decision.[2]

The presumption is that all of this had been good for mankind. But it was that same science that produced the atom bomb, chemical weapons, global warming, and wholesale destruction of the environment. Possibly the greatest physicist of our time, Stephen Hawking, was prompted to wonder: “It has certainly been true in the past that what we call intelligence and scientific discovery has conveyed a survival advantage. It is not clear that this is still the case: our scientific discoveries may destroy us all[3].” No-one is suggesting that we go back to donkey carts and candles. But it is clear that science is a mighty force which needs to be understood and directed. It is clear too that the scientific community itself cannot handle this challenge. In fact, being a great scientist is in no way a moral advantage. “Scientists themselves show no correlation between their greatness and their ethical behavior. Some like Einstein and Sacharov, used their fame to try to promote what they saw as ethical behavior in the world. But others were simply rascals. Heisenberg worked on an atom bomb for the Nazis and Newton was callous and

[1] Electrifying America, David Nye, reviewed by Claude Fisher in Science, May 17, 1991

[2] *Keeping Watch, A History of American Time*, by Michael O'Malley, reviewed by Patricia Cline Cohen, in Science, May 17, 1991

[3] Stephen Hawking, *A Brief History of Time*, pg. 12

vindictive. After his breakdown in 1693, he discarded academic pursuits for more heavy-handed work as a private investigator and prosecutor who was feared by many[1].” The power of science, where it should be going and who should be its leaders, is the subject of this essay.

3. Science as the Leader of Civilization

In the 20th Century, science became not just another endeavor of the Western world - it became the defining characteristic of our civilization. The sciences in general, and theoretical physics and cosmology in particular, have captured as theirs for the answering, all the ancient questions of the philosophers - where does life begin and end; when did the universe begin and when will it end; how is matter created and destroyed; what are the ultimate principles by which the universe runs?

In 1988, the Harvard naturalist Edward Wilson published a book by the queer name "Consilience: The Unity of Knowledge". His was an attempt to show the complete unity of all knowledge, in particular the knowledge of human affairs, under the umbrella of the scientific endeavor. Politics, economics, society, the individual - all will only make ultimate sense when reduced to biology - genetics to be specific - and genetics will only ultimately make sense when reduced to physics. Only then will we be able to link all the insights of diverse fields into a coherent whole that will explain all of human behavior. Why do people love, and why are there wars; why do we dream and why do we have self-awareness; why are we greedy capitalists and why are we creative; why are we moral and why do we believe in G-d - all must yield to the might of a science-based ‘consilience’.

Wilson has not been welcomed by all scientists in the scientific mainstream. His is too much grandeur and not enough hard science to back it up. But what Wilson wants to do explicitly, has indeed already taken place, without the conscious awareness of the human race as a whole. Science has, if not taken over all areas of knowledge, defined and shaped them, and set the standards by which they will all be judged.

This is true not only of philosophy, but of art as well. This is not to say that the painting of a picture or the composition of a piece of music has become more scientific, although this may be true. My suggestion is more radical. In the 20th century, it appears that there has been a collapse of the sense of aesthetics which always informed the formal world of culture. Simple rules like symmetry, counterpoint and harmony are no longer obviously present in works where the subjective and interpretive responses of the viewer are the only way in which one can make any sense at all of what is being communicated.

Yet these principles of aesthetics, so orphaned by the world of art, have been adopted by a new parent, the world of science. In an astonishing unfolding, many great scientific discoveries of the 20th century were made by adherence to just those principles of symmetry, beauty, unity and simplicity.

[1] Michael White, in *Isaac Newton: The Last Sorcerer* 1997

4. Judaism is Pro-Science

Judaism is pro-science. The great conflicts of science and religion were with the Church, not with Judaism. Thus when Galileo supported Copernicus's opinion that the sun and not the earth was at the center of the universe, he was forced by the Church to withdraw his views. Given the choice of publicly retracting or of being killed, Galileo chose life[1]. Giordano Bruno (1548-1600), who refused to retract, was burned to death[2]. In 1997, the Pope apologized for this position of the Church, a position which may have contributed to the loss of control of the government and the people by the Church. On the day that Galileo died, Isaac Newton was born and the scientific revolution begun by Copernicus was complete.[3]

Judaism by contrast has always related to science in a positive way. For example, it obligates us to use most up to date medical procedures[4]. If medical science says this year that it is life threatening for a patient to fast of Yom Kippur, then it is a mitzvah for him to eat. This is so even if last year's medicine said that it was ok to fast, and if next year

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[1] Until Copernicus, Aristotle and Ptolemy reigned supreme. The Church and science agreed: the earth was the center of the universe; the planets, the sun and the stars all revolved around the earth in eight spheres made of an immutable substance; their movements were circular. Copernicus, followed by Tycho Brahe (1541-1601) and Johannes Kepler (1571-1630), challenged this doctrine, introducing a sun centered universe. For over a century, the church fought this doctrine, seeing it as a challenge to man's centrality in the world. Copernicus escaped the more radical persecutions that would inflict Bruno and Galileo later on. This was partially because his doctrine was still considered weak, not being able to explain why, if the earth moves, we do not fall off it (gravity was unknown), why the position of the stars does not appear to constantly change and why there is no detectable wind induced by the motion. Nevertheless, theologians tried to prevent publication of Copernicus's "The Revolutions", John Calvin pointed out that the Bible says that the world cannot be moved, and Martin Luther condemned Copernicus.

In 1616, the Church decreed that Copernicus is "false and erroneous" and banned his writings. The Church view continued to be the Aristotelian one that the world was the center of the universe, that it did not move, and that the sun rotated the earth. In 1632, Galileo was tried by the Roman inquisition for espousing the Copernican theory of the structure of the universe, thereby violating the decree of 1616. He was not given a copy of the charges against him, nor was he allowed someone to defend him. He was given the choice of publicly retracting or of being killed. In a decision that some have criticized as damaging the cause of science, Galileo chose life. He was forced to state that "I abjure, curse and detest the aforesaid errors and heresies." Aged seventy, he was confined to his villa under strict house arrest for the remaining days of his life.

[2] Bruno was originally ordained as a priest, but led a troubled life with the church. Although excommunicated twice, he still managed to become one of the greatest scientists of his age. In 1593, he underwent the beginnings of a seven year trial by the Roman Inquisition who demanded that he retract his Copernican views. He declared that he had nothing to retract and was burned to death 9 days later.

[3] Culled from *The Science Class You Wish You Had ...* by David E. Brody and Arnold R. Brody

[4] אברהם בן הרמב"ם; מאמר על אודות דרשות חז"ל (בעין יעקב הקדמה)... :לא נתחייב מפני גודל מעלת חכמי התלמוד שנטען להם ונעמיד דעתם בכל אמריהם ברפואות ובחכמת הטבע והתכונה (ע"ש)...

See חזון איש in his אמונה ובטחון (פ"ה) who shows, in considerable detail, that the sages and others who lived in their time knew an enormous amount of medical and other scientific knowledge. Much of this knowledge was subsequently lost. Some of it was rediscovered by modern science and medicine. Other areas seem to elude us to this day.

things will change again, as is quite common in medicine[1]. We use contemporary scientific knowledge for halachic decisions even though we know that the knowledge will date. Halacha in fact demands a certain knowledge of science or access to those with knowledge[2].

The Kuzari[3] describes the amazing detail which the Sages had of the physical world. They had a precise understanding of the relationship of the cycles of the moon to that of the sun, many centuries ahead of Western knowledge of the subject. This required knowledge of mathematics as well as of the exact appearance of the constellations in what parts of the sky at particular times of the year, and where the moon would be seen in relation to these. They could tell, without internal examination, whether a particular type of blood was coming as a menstrual flow or was coming from another source. They could do this merely by looking at a spot of blood. They knew which diseases were fatal to an animal and which were not, and they had detailed biological understanding of exactly how different animals would inflict damage through clawing. There are many other examples.

All of this required keen scientific eyes to see order, patterns and laws. The physical world is world of הכרח, therefore the השגחה is seen through the order. The use of אלוקים throughout בראשית means that the world was created according to set patterns or laws = מדת הדין. This underlies the whole possibility of science, which relies on the fact that the world is consistently logical.

Avraham Avinu went further - discovering the whole Torah by intuiting the underlying spiritual implications of the world around him. Theoretically speaking, we could all be like Avraham Avinu and discover Torah through deep contemplation of the physical world[4]. However, this approach is simply too inaccessible to be a reliable method of discovering what G-d wants of us[5]. Therefore, when the Torah was given, we began to rely primarily on knowledge of Torah to know and have a relationship with G-d. Unusual people are able to work in the reverse: they are actually able to discuss the

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[1] A medical student told me that his class was told that, by the time they graduate, half of what they were taught in medical school would be out of date. The trouble is, he said, there was no way of knowing which half would be right and which half wrong.

[2] See also *Challenge*, A. Radkowsky pp. 77 (bottom)-79, p. 88, paragraph beginning "We know..."

[3] מאמר רביעי. כח-לא

[4] משך חכמה על שמות פרק כד פסוק יב: והתורה והמצוה אשר כתבתי להורתם - אשר כתבתי לא יתכן על התורה והמצוה, ועיין רשב"ם, ונראה דאלמלא נתנה תורה היו למדין צניעות וכו' גזל מנמלה וכו' (גמ' עירובין ק סע"ב), לכן אמר אשר כתבתי בספר הטבע אשר יצרתי שזה ספר של השי"ת היוצרה ע"ש עוד

[5] רמב"ן, דרוש תורה תמימה :"חכמי הגויים אינם יודעים ביצירה מה שיודע קטן בישראל. ודבר ברור הוא שרוב תועלת שאר החכמות אינה אלא להיות סולם לזו ולחכמה שקורין הם ידיעת הבורא..."

physical world by study of the Torah. This is called the study of מעשה בראשית[1], but this too is not a reliable method on a broad basis[2]. Hence the need for science.

5. Judaism and Science – Conflicts and Compatibilities

In his book on religion and science, the great paleontologist Stephen J Gould stated that there was no tension between the two because they existed on two different planes, or magesteriums as he called them[3]. The magesterium of science deals with the physical word, whereas the magesterium of religion deals with the spiritual and moral plane.

There is a certain truth to this. The Maharal explains that the Sages never attempted to give scientific, medical or biological explanations to things. They were only interested in giving the inner spiritual content of the situation[4]. Scientific laws are explanations for what happens in the world. Behind these explanations of "what" are reasons of why, the underlying spiritual reality of things[5]. Ultimately, this inner content is not only in complete harmony with the outer, scientific reality, but it is the reason behind the reason[6].

At the same time, there is definitely information in the Torah which tells us about the physical world. We know, for example, that the world had a definite beginning, that there were six days of creation, and that after the flood, G-d fixed six seasons. Science also lays claim to interpret these events, even if they are not yet sure of all of the facts. Before the Big Bang theory, for example, the 19th century scientific theory of the static universe (claiming that the universe had always existed) was definitely in conflict with the Torah's view that the world was created from scratch[7]. For the same reason, there are definitely

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[1] חגיגה יא: אין דורשין בעריות בשלשה ולא במעשה בראשית בשנים ולא במרכבה ביחיד אלא אם כן היה חכם ומבין מדעתו

מאירי: ריש פ"ב דחגיגה: וענין מעשה בראשית הוא ידיעת חכמת הטבע ונכלל בה ידיעת שני עולמות ר"ל עולם היסודות ועולם הגלגלים.

רמב"ם: (הל' יסודי התורה פ"ד ה"יא): ...ולמה אין מלמדין אותו לרבים לפי שאין כל אדם יש לו דעת רחבה להשיג פרוש ביאור כל הדברים על בוריין.

ועיין עוד ברמב"ן בראשית א: א

[2] כוזרי: Our faith comes from the fact that the Jewish nation collectively witnessed the event at סיני, and not from the fact that there was a מעשה בראשית, to which there were no witnesses.

[3] Stephen J. Gould, *Rocks of Ages: Science and Religion in the Fullness of Life.*

[4] מהר"ל, באר הגולה (באר שישי עמ' קו): ח"א באו חכמים לדבר מן הסיבה הטבעית כי קטון ופחות הסיבה הטבעית כי דבר זה יאות לחכמי הטבע או לרופאים או לחכמים. אבל הם ז"ל דברו מן הסיבה שמחייב הטבע

[5] ר' חיים פרידלנדר, שפתי חיים (אמונה ובטחון ח"ב דף תמט): חכמי הטבע אינה עוסקת בלמה, התחום שבו היא עוסקת הוא המה

[6] מהר"ל (שם סו): שאמרה תורה על אות הקשת (בראשית ט: יד-טז): את קשתי נתתי בענן והיתה לאות ברית ביני ובין הארץ ... והיתה הקשת בענן וראיתיה לזכור ברית עולם וחכמי הטבע נתנו סיבה טבעית לקשת כמו שידוע אבל הדבר הוא כך שהסיבה אשר נתנה התורה הוא הסיבה שלכל דבר יש סיבה טבעית המחייב אותו, ועל אותה הסיבה הטבעית יש סיבה אלוקית, והוא סיבת הסיבה, ועל זה דברו חכמים. כי לאדם על צורתו ומספר אבריו יש סיבה טבעית, כי אין ספר שיש לדבר זה פועל טבעי, ומכל מקום יש לאותה סיבה סיבת אלוקית, שעל סיבת הסיבה אמר (בראשית א כג): ויברא אלוקים את האדם בצלמו בצלם אלוקים ברא אותו.

[7] This does not mean that the Big Bang theory solved all contradictions between Judaism and science in this area. But it was a giant step in the right direction.

things about the theory of evolution as it stands now which contradicts the Torah position, as it is interpreted by the major Mefarshim[1].

On the other hand, science has plenty to say about ethical and spiritual issues, as we shall show later. Science posits a secular paradigm and, by its very nature, creates facts on the ground which in turn determine ethical positions on the most major of issues.

So Torah and science do relate and can be in conflict.

Yet, the amazing thing is that while there are definite areas of incompatibility between modern science and Judaism, science has moved very rapidly in the direction of Judaism over the last century. What little incompatibility is left is getting smaller and smaller. This is quite remarkable. A hundred years ago or more, a Jew would have been faced with huge contradictions between Judaism and science. His belief in Torah would have gone

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[1] What would a Torah-true 'Theory of Evolution' look like? Certainly all the Gedolei Mefarshim point out that only three times does the word ברא - a creation ex-nihilo – appear in the Bereishis story, once at the beginning, once at the point of transition form plant to animal life (the תנינים), and once with the creation of the soul of man. According to the Ramban and perhaps the Gra, only the first ברא is referring to creation ex-nihilo. The rest of the creation was an evolutionary development from the initial elements, sometimes in several or perhaps many stages. However, to this must be added seven qualifications:

1-*That the theory accommodates the fact that some things required a creation ex nihilo.*

2-*That the first day not be regarded as more primitive than subsequent days; on the contrary - it was higher spiritually than the other days***.**

3-*That all evolutionary developments be recognized as only taking place because of G-d's Providential input***.**

4-*That the time taken be reconciled with the literal Biblical text.*

5-*That the creation process be regarded as the most perfect for the purposes for which the world was made.*

Although evolutionary developments can take place after the six days of creation, these represent retrogressive steps. This does not mean that the world was created objectively perfect; on the contrary, there was a certain imperfection built into the creation to allow for free choice and to allow man to partner G-d in completing the creation. But, what it does mean is that the world was completed to perfection for its designated task.

6-*That the world and its entire species be regarded as essentially co-operative and not in competition.*

Even where one species lives off another, the latter is to be regarded as essentially serving the former. This is in opposition to Darwin's principle of the survival of the fittest, even after the many recent modifications to this principle.

It is true that, other than man, at one level, species were produced essentially to reproduce. But this does not require that we evoke a principle of survival of the fittest, which implies that species are in competition and opposition with each other. The *Daas Tevunos* says that the creation with all its species is essentially in co-operation, and all of creation combines to fulfill their common purpose.

A leading micro-biologist, Lynn Margulis has proposed a system of the advancement of organisms by cooperation and symbiosis. Her idea that parts of the cell were once free-living organisms has today won widespread scientific acclaim.

7-*That man be regarded as the pinnacle of creation, the purpose for which the creation was made.*

In purely evolutionary terms, man may not be the best adapted, i.e. the most successful, to his environment; bacteria do a lot better.

against thousands of years of scientific progress. Today, Arachim-like seminars use archaeology, physics, astronomy and other areas of science as outside proofs for the authenticity of the Torah!

Until the twentieth century, scientists thought the world to be completely deterministic, i.e. every effect has a clear cause which in turn is the effect of a previous cause, and so on ad infinitum. As expressed by the nineteenth century Frenchman, Laplace, if we could know everything that had happened in the world until now we could predict everything that would happen in the world from now on. The fact that we cannot do this, so it was believed, is a function of the impossibility of our knowing all the variables, a technical problem, rather than something fundamental. This made belief in השגחת הבורא more difficult. For, if everything is predetermined, what place is there for Providence to interfere with the process?

But, with the introduction of quantum physics, probability replaces certainty as the accepted idea in science. We can no longer know for sure what reality is; for example, we can no longer say where an atom is. What we can know are the various options of where it might be and the likelihood (probability) that it indeed might be there. This is not just because we do not have good measuring instruments, or because our measuring instruments are somehow faulty. This is because uncertainty is actually built into the universe.

Heisenberg's famous Uncertainty Principle (we can know either the position of an electron or its speed, but not both at the same time) was a precursor to this. If all we can say about something is that it exists as a probability, then matter itself is not as solid as we think it is[1].

When the universe was considered to be completely predictable, as scientists thought for thousands of years, there seemed to be no place for G-d's Divine Providence. Perhaps G-d created the world and then withdrew. Today, remarkably, with the collapse of the scientific world of certainty, there is no longer a contradiction between science and G-d's Providence. The laws of science only represent the range of options which G-d normally uses to run his world. Which specific option He chooses, when He chooses to use the natural order, cannot be pre-determined.

The same is true of our freedom of choice. If the world is pre-determined, then our choices are an illusion. But if the world is indeterminate, then there is place for choice.

Now let us take this idea a little further, the idea, held by some scientists, of an observer-centered universe.

A fascinating experiment in interference was first performed by Earnest Young in the seventeenth century. Young sent a band of light through a screen which had two slits onto a second screen. This second screen showed a series of dark and light bands. The dark bands show where two bands of light woven had interfered with each other, arriving at the screen out of step. The light bands showed just the opposite, i.e. where two bands of light reinforced each other. This can only happen if two sets of light are going through both slits simultaneously. But the same results are found even where the light is sent only

[1] Heisenberg went on to say that particles do not really have substance, only mathematical form and therefore do not have the quality of being but only a possibility of being or a tendency for being. [*Physics and Philosophy*, p.60].

one photon at a time. The only explanation for this is that each photon must be going through both slits at the same time!

More amazingly, if someone were to try to measure which slit the photon was going through, the photon landed out going through whichever slit was measured. In some way, the measuring of the slit causes the photon to go through that slit, and that slit only. This led scientists to realize that observation actually causes a change in matter.

Many scientists claim that it is the mind itself which causes this change. The fact that I choose to observe at one point or the other, 'collapses' the particle out of its previous state and cause it to go through this hole and not both holes or the other hole exclusively. This not only opened the way for belief in freedom of choice, a fundamental tenet of Judaism, but also to the idea that our choices actually shape the universe, a very Jewish idea[1]. The term, an observer centered universe, was coined[2].

These are but a few examples of many in the gradual reconciliation of science with what Judaism has been saying for thousands of years!

But there is something even more remarkable. The progress of science is based on certain beliefs about the world. I call them beliefs because they are not scientifically provable. Yet they are the underlying bread and butter which provide the direction which propels the fundamental direction in which science is going. For example, scientists have been searching for a theory which will combine all of the basic four forces of matter (the strong, weak, electromagnetic and gravitation forces[3]) into one force. Now there is nothing in science which says that there has to be one force instead of four. There is nothing scientifically wrong with there simply being four forces rather than one. There was no reason for scientists to conduct a search that has involved tens of thousands super-colliders that run in the billions, and a massive effort that has taken most of the century. Why could they not have simply accepted that there were four forces rather than one? However it is a deep belief of science that the more a theory will give a comprehensive, total explanation for all of nature, i.e. the more unifying it is, the truer the theory is. This is simply a religious belief shared by all scientists and is highly consistent with a belief in

[1] A whole sefer, the Nefesh HaChaim, is dedicated to this idea.

[2] Filiz Peach quotes leading physicist David Deutsch in Philosophy *Now*, (December 2000/January 2001) as saying the following:

The arguments that humans *don't* have a fundamental role in the scheme of things, which used to seem so self-evidently true, have all fallen away. I mean, it is no longer true that human beings are necessarily destined to have a negligible effect on physical events, because there is the possibility that humans will spread and colonize the galaxy. If they do, they will necessarily have to affect its physical constitution in some ways. It is no longer true that the fundamental quantities of nature – forces, energies, pressures – are independent of anything that humans do, because the creation of *knowledge* (or 'adaptation' or 'evolution' and so on) now has to be understood as one of the fundamental processes in nature; that is they are fundamental in the sense that one needs to understand them in order to understand the universe in a fundamental way. So, in this and other ways, 'human' quantities – human considerations, human affairs and so on – *are* fundamental after all.

[3] Gravity is the only force which works on the macro-world, the world larger than atoms. The other three forces work on a micro-level. Electromagnetism is well known. The Strong Force holds atoms together. The main expression of the weak force is radiation. Scientists have already combined three of the four forces, i.e. the three micro-forces, to form a Grand Unified Theory, at least at a mathematical level. They are now working on combining these three forces with the fourth force, gravity.

an Ultimate Creator[1]. As Timothy Ferris put it, "Science from the beginning incorporated [the] idea that the universe really is a uni-verse, a single system ruled by a single set of laws. And science got that idea from the belief in one God[2]."

Few scientists, even those who are investing massive amounts of time, money and effort to unite these forces, ever stopped to think that such a belief would only make sense in a Monotheistic world. If there is one G-d Who is the source of everything, then all things ought to be traceable back to a point where they are all one. But if there was no One Creator of everything, what's wrong with four forces rather than one.

The reason that science is getting so close to a Torah viewpoint in our age is because we are in the pre-Messianic era. This is the time when the most powerful Galus ever to exist on earth, Edom, was destined to present the closest, most powerful alternative to Torah, and science is at the center of this.

6. Science is Intrinsically a Secular Paradigm

The German philosopher Karl Jaspers claimed that science failed to give man a comprehensive view of the world[3]. While it is true that science never spelled out a philosophy of man, science is based on a very definite world view, as we shall explain.

Paul Johnson writes in his introduction to 'The History of the Jews' that he came to write about the Jews because he kept on bumping into them in his travels of world history. Indeed, it is difficult not to bump into the Jews on any point in the time-line. But there is more to it than that. World history and Jewish history are one, not merely two overlapping or even interacting histories.

Science itself might have come to the same conclusion, but it did not. Therein lies the greatest source of tension between Judaism and science. Science takes us ever so close to tying up the creation back to the Creator. But just at that point it stops and claims that that is all there is to it. Science separates itself from religion at the very point where it ought to

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[1] Though scientists do not readily make that connection.

[2] Timothy Ferris (author of *The Red Limit - The Search for the Edge of the Universe*, Bantam, 1981) wrote, produced and narrated a PBS science special: "The Creation of the Universe." : The search for, and the belief in the possibility of finding, a unified field theory "testifies to the triumph of the old idea that all creation might be ruled by a single elegantly beautiful principle."

Ferris states: "Religion and science are sometimes depicted as if they were opponents, but science owes a lot to religion. Modern science began with the rediscovery, in the Renaissance, of the old Greek idea that nature is rationally intelligible. But science from the beginning incorporated another idea, equally important, that the universe really is a uni-verse, a single system ruled by a single set of laws. And science got that idea from the belief in one God...

"The founders of modern science -- Kepler and Copernicus, Isaac Newton and even Galileo, for all of his troubles with the church -- were, by and large, profoundly religious men.

"I'm not saying that you have to believe in God in order to do science. Atheists and agnostics have won Nobel Prizes, as have Christians and Jews, and Hindus, Muslims and Buddhists. But modern scientific research, especially unified theory, testifies to the triumph of the old idea that all creation might be ruled by a single and elegantly beautiful principle" (PBS science special: "The Creation of the Universe")

[3] Cit., 465, Baumer, *Modern European Thought*, MacMillan.

be calling on an understanding of G-d to complete the explanation which it had begun. As such it is a secular, humanist endeavor.

Science discovers the Big Bang, but will then try desperately to avoid saying that that means that G-d created the world[1]. Scientists uncover the anthropic principle, that nature seems to have direction and purpose towards life[2], but will not say that some Being therefore designed it that way.

There is no question that the world-view, the paradigm of science, holds that it is unscientific to bring G-d into the picture. Even a religious scientist, and there are lots of them, would not dream of talking about G-d in a scientific paper.

Thomas Kuhn of MIT wrote his famous *The Structure of Scientific Revolution* about 45 years ago. In it he claimed that science moves very slowly for long periods of time until there is a sudden revolution during which the scientific community changes paradigms. A paradigm is a way of looking at the world, a way of filtering information.

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[1] See Robert Jastrow's, *God and the Astronomers,* who writes of the fierce resistance of the scientific community to the discovery of the Big Bang, because of its religious implications. But even those who embraced the Big Bang were careful to avoid spelling out its religious implications.

[2] See *Nature's Destiny*, by Michael Denton.

Nature turns out to be very exactly tuned - change any law of nature even slightly, or change the initial conditions and it becomes impossible for life to have emerged at all. Denton shows that water, oxygen, minerals and many other things are perfectly suited in multiples of ways for the task for which they fulfill. In fact it is impossible, in each case, to even imagine a theoretical substance which might do a better job.

Critics argue that the universe is bound to look as if it were designed for our existence because we could only be here if the universe were adapted for our existence. That would be a good argument if the cosmos was adapted to some degree for life. But it appears that the cosmos is optimally adapted for life - that every constituent of the cell and every law of nature is uniquely and ideally fashioned to that end.

More than that, it is not only this or that variable that makes this argument so impressive. It is the accumulation of all the variables, all being there in exactly the proportion that they need to be, the lack of any one of them rendering life impossible.

This has led many leading scientists to claim that the world was "designed" for life (e.g. Ernest Sternglass) even if they are careful not to say that G-d was behind that design.

This includes energy levels of the carbon atom; the rate at which the universe is expanding; the four dimensions of space-time, carbon, DNA, proteins, even the exact distance between stars in our galaxy.

These arguments are not, of course absolute proof that G-d made the world. We could always say that all of this is only by chance. Nevertheless, as more and more exact conditions emerge, this argument does become increasingly more powerful. Even hardcore evolutionists are increasingly subscribing to the anthropic principle. One such person is Conway Morris, professor of evolutionary paleobiology at the University of Cambridge and one of the leading evolutionists in his field. In his book, *The Crucible of Creation: The Burgess Shale and the Rise of Animals* (Oxford University Press, 1998), he argues that if the tape of life were rerun form the Cambrian time, we would get almost exactly the same outcome as we have today. "I believe it is necessary to argue that within certain limits the outcome of evolutionary processes might be rather predictable." And this for a theory, which started out saying that everything, is a function of random, chance events!

The issue is not whether we can come up with a scientific explanation for what took place. The fact that all these factors are so precise and perfect for the world we need, support the fact that this was a planned and guided event; the fact that this plan followed principles, intelligible to us up to a point, is only to be expected from what we know of how the Almighty made His world.

Since facts are always seen through paradigms, there is no such thing as a completely objective fact. When operating in a certain paradigm, the scientific community only sees certain types of questions or unsolved scientific problems as legitimate areas of scientific concern and therefore they are only going to get certain types of answers. Eventually, someone comes and manages to break out of that paradigm, like Newton and Copernicus in their day and as did Einstein, breaking out of Newtonian ways of looking at the world. Usually, this person is very young, not yet set too deeply in the existing paradigm. Very often, the older scientists never fully accept the new paradigm - they simply have to die out to allow for the new paradigm to take root.

The roots of this G-d exclusion paradigm go back to *Migdal Bavel* and *Dor Haflaga.* The people at that time said: *Come, let us build us a city and a tower, whose top may reach to heaven; and let us make us a name, lest we be scattered abroad upon the face of the whole earth*[1]. A great city with a great tower in the middle to maintain the unity of the human race! What could be wrong with that? The Mefarshim explain, however that the tower was being built as an instrument to conquer and bring under the control of man every aspect of the creation. Then they would be able to prevent G-d from using the heavens as an instrument for implementing His decrees against the earth[2]. "Remove Divine Providence from the equation," they said, "and we can then use science and medicine to give us a more secure, healthy, wealthy and happy existence." The way the Kabbalists describe such a thing is the attempted separation of the last Sefira, Malchus, through which all *hashpaos* from above must ultimately pass from the other higher Sefiros in order to control and use the former[3]. The discoveries of דור ההפלגה and of contemporary science are of tangible benefit to mankind. But they can also become a Tower of Babel, used as an instrument to lead people astray.

Although the name אלוקים was consistently used in the story of Noach, the Chumash now changes to use the 4 letter name of G-d[4]. For the generation of Noach was guilty of moral depravity (theft) and sexual immorality – both interpersonal transgressions requiring G-d's attribute of Justice to respond. But, in the case of the Tower of Bavel, the problem was realizing that all forces extended back to G-d's ongoing creative Will, and that He cannot be excluded for a moment, from the running of the world if it is to survive. Here is was necessary to mention G-d's ineffable Name, not His attribute of Justice, to show that all extends back to Him[5]. It is G-d's attribute of Justice which defines all the laws of nature, and so it required something above that level to show man that there really was a limit to how far a man-centered universe could go[6].

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[1] יא (ד) ויאמרו הבה נבנה לנו עיר ומגדל וראשו בשמים ונעשה לנו שם פן נפוץ על פני כל הארץ:

[2] גור אריה יא א: לאו כל הימנו וכו' בואו ונעשה עמו מלחמה. פירוש כי זה המגדל היו בונים להיות דבקים עם מערכות עליונים, שהיו עושים בפעולות הידוע להם לבנין ההוא, ובבנין ההוא נכנסו למעלה להיות עם המערכות העליונים, וזהו המלחמה שעושים עם העליונים, כי היה כל פעולתם לבטל כמה דברים הבאים בגזירות ה', וזה שהיו אומרים לא די שיבור לו העליונים להיות גזירתו על התחתונים גזירות, בואו ונעלה השמים בפעולתנו להתחבר עם מערכות השמים ונעשה עמו מלחמה לבטל מעלינו הגזירות שהם באים על התחתונים:

[3] שעור דעת ח"א עמ' רסח

[4] רמב"ן, יא ב: והסתכל כי בכל ענין המבול הזכיר אלוקים ובכל ענין הפלגה הזכיר השם המיוחד

[5] רמב"ן שם: כי המבול עבור השחתת הארץ, והפלגה בעבור שקצצו בנטיעות

[6] שעורי דעת ח"א עמ' רסז: כי בלבול השפה נעשה על ידי ההנהגה היותר עליונה, הנהגת שם הוי', שהיא למעלה משם אלוקים. שם אלו'ים מורה על ההנהגה התמידית המסודרת ומגבלת במערכות הטבע ... בהנהגה התמידית של שם אלוקים נדמה להם כי יש ביכולת בני האדם על ידי כח הבחירה שנתן להם להשתמש בכחות הבריאה שלא כחפץ

Rashi brings another, fascinating interpretation to the words דברים אחדים: The people of that generation had calculated that the world has a major collapse, as in the case of the flood, every 1656 years. The tower was an attempt to build some kind of an alternative, heavenly system to beat the natural cycle as they perceived it[1]. This second approach amounts to the same thing as the first. As the Ramban explains it, they wished to cut off G-d connection with the world (לקצץ בנטיעות)[2] in the belief that this would allow them to discover and harness all the scientific forces that would be needed for them to solve every sort of human misery.

Not naïve to the scope of the job at hand, they realized that only if there was a United Nations far more powerful than the one we have today, was there any hope of bringing the necessary resources to bear in resolving the issues of illness, poverty, war and natural disaster[3]. The idea of a world capital with its gigantic tower, a monument to human possibility, etched in every mind was just the solution for this challenge[4]. Of course, a tower of this size was not just meant to be an empty monument. It's multi-purpose structure would serve as a center of science, a giant lightning rod[5] , and a potential launching pad for future lunar expeditions[6].

The truth is, says the Shiurei Daas, that despite the massive advances of contemporary science and its revolutionary impact on us, we have revealed but a drop in the vast ocean that is G-d's world of nature. There may be hundreds of scientific laws which scientists have yet to discover; perhaps far more is hidden than has been revealed. It is possible, that had the generation of Dispersion created the mechanisms for long term, international scientific cooperation, we would have been much further in our progress than we can imagine[7]. This is especially true because those early generations had a much deeper understanding of certain types of forces than we have today[8]. The problem was not the

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ההשגחה ... ואמנם הם לא ידעו ולא הבינו כי עצם ההנהגה הוא צמיד בידו של הקב"ה ולא נמסרו מוסרות ההנהגה לכחות הבריאה התחתונים

[1] רש"י יא א: ודברים אחדים (ס"א דברים חדים) אמרו אחת לאלף ותרנ"ו שנים הרקיע מתמוטט כשם שעשה בימי המבול בואו ונעשה לו סמוכות (ב"ר):

גור אריה יא א :אין צריך לפרש כי על ידי מגדל היו רוצים לעלות השמים, אלא מפני כי המגדל הזה במה שהיה "ראשו בשמים" (פסוק ד) - הוא דוגמא משמים, שהמגדל הוא נבדל מן הארץ בגבהותו כמו השמים - להיות רוצים להתנגד אל השם יתברך, כי האדם ראוי שיהיה למטה והוא יתברך למעלה, וכאשר עשו להם מגדל לדוגמא - היו רוצים בפעולתם הזרות לכנוס בדברים השייכים לעליונים בהוראות המגדל הזה שהוא נבדל מן המטה, ודבר זה הוא התנגדות אל השם יתברך, והוא המלחמה:

[2] רמב"ן יא ב: כי הוי קוצצים בנטיעות

[3] שעורי דעת ח"א עמ' רסה: עלה בדעתם שצרכים למצא עצות ותחבולות למען תשלט ביניהם אחדות גמורה ושתהיינה כל משפחות הארץ מאורגנות ללחום בכחות משותפות עם פגעי העולם.

[4] שעורי דעת ח"א עמ' רסו: הבה נבנה לנו עיר ומגדל וראשו בשמים שישמש להם בתור מרכז וסמל להתאחדות

[5] ר' בחיי

[6] יהונתן אייבשיץ, תפארת יהונתן

[7] שעורי דעת שם עמ' רסה: הלא גם בדורות האחרונים ראינו כמה המצאות חדשות שעשו מהפכה ... עד שקודם התגלותם קשה היה לשער ולהאמין כי נמצאים כחות כאלו בטבע, ואמנם כל מה שנתגלתה לנו עתה אין זה אלא טפה מן הים מול סתרי הטבע שעדיין לא נתגלו לנו ולא ידענו אודותם ואלמלא היו בני אדם בכל הדורות באחדות גמורה בשלום ושלוה והיו עובדים כל אחד במנוחה במקצוע שלו לתועלת האדם , מי יודע כמה כחות נפלאות הטמונים בחיק הטבע היו יכולים למצא ולהשתמש עמהם להנאות העולם וכתריס נגד הפורעניות השונים.

[8] שעורי דעת ח"א עמ' רסו

עיין בחזון איש, אמונה ובטחון, שני הפרקים האחרונים

desire to know more and to organize accordingly; it was that when G-d "came down" to look[1], He saw a rebellion, not a scientific venture[2].

But here's the rub – the people themselves were not fully conscious of this rebellion. They didn't see themselves as anti-G-d but rather just pro-science, not realizing that the science they proposed made G-d inadmissible. They felt this was for the good of mankind, not seeing that they were seeking for a level of control that contradicted G-d's Hashgacha[3]. This, says the Shiurei Daas, is why the verses do not explicitly mention any sin[4].

This is exactly the same as science today. The secular bias is not deliberate, except for some evolutionists[5]. Rather, it exists as the natural framework with which scientific eyes view the world. Because of this, at some stage in the future, perhaps only in the Messianic era, we will require a paradigm change, so that the natural filter for information accommodates G-d. Kuhn points out that the new paradigm may use the same words as the old, but it often means something completely different, making the old and new theories non-comparable. A scientist in the post-Messianic paradigm of science will see G-d written in every theory. [6]

The truth is that we already had such a scientist – Avraham Avinu. Avraham Avinu did not just look at the world of nature and see G-d. He went much further, harmonizing his entire being with what he saw. This allowed him to intuit all of the Torah and its Mitzvos, since the Torah is but a higher level of the creation-reality[7] and therefore completely in harmony with the inner logic of creation.

Perceptive scientists throughout the ages have at least achieved Avraham Avinu's basic conclusions. They have marveled on how remarkable it is that higher, more abstract forms of thinking are in harmony with the physical world around us. Carl Gustav Jacobi, the 19th Century Prussian mathematician, remarked that "it is a remarkable fact that when

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[1] יא (ה) וירד ד' לראת את העיר ואת המגדל אשר בנו בני האדם:

[2] שעורי דעת ח"א עמ' רסו: הבורא ב"ה ראה וידע, שבבקשת האמצעים האלה טמון רגש רע החפץ להשתחרר מההשגחה ושלא להיות מוטל תחת הנהגת ד'

[3] שעורי דעת ח"א עמ' רסו: בבקשת האמצעים האלה טמון רגש רע החפץ להשתחרר מההשגחה ושלא להיות מוטל תחת הנהגת ד' ... אמנם זאת היתה כונה נסתרת שלא נגלתה בבהירות גם להם בעצמם

[4] שעורי דעת שם: ולכן בפשטות הכתובים ספרה לנו התורה המעשה הנגלית כפי שהביעו בדבריהם המפרשים שאמרו "ונעשה לנו שם פן נפוץ על פני כל הארץ".

[5] For example: Finally the evolutionary vision is enabling us to discern the lineaments of the new religion that we can be sure will arise to serve the needs of the coming era." (Julian Huxley, 1959)

[6] Kuhn subsequently modified his position considerably –'the new Kuhn', in which he questions whether science actually progresses in some objective sense when there is a paradigm changed. What we described above is the Old Kuhn which people usually mean when referring to him.

[7] הסתכל באורייתא וברא עלמא means that the logic of the world is in harmony with the logic of the תורה. Since man was also created from that תורה, the logic of man is similarly in harmony with the logic of the world.

The Maharal's opinion is that it was only Avraham Avinu of the Avos who kept the Torah. He gives two reasons for this:

תפארת ישראל למהר"ל פ"כ:אברהם אבינו היה מיוחד ביותר לקיים כל התורה, כי מעלת אברהם דבקה בחכמה עליונה ... [ו]התורה הוא השכל העליון ועוד ... כי מדת אברהם היא מדת התורה כי התורה נקרא תורת חסד דכתיב (משלי לא) ותורת חסד על לשונה, וזה כי התורה דרכיה דרכי נועם וכל נתיבותיה שלום, ואף כאשר תמצא בתורה מיתות וכריתות אין תכלית התורה רק להעמיד הטוב בעולם שלא יהיה נמצא שום רע.

man thinks in a pure system of abstract logic such as mathematics, that logic turns out to be consistent with the logic of the world[1]." Or, as Plato put it, "G-d ever geometrizes." [2] These scientists reached the most basic level of a Monotheist. But nowhere do we see that they were able to take these observations and turn them into a personal G-d who makes moral and spiritual demands of them. At most, this represents what Alfred North Whitehead called a "widespread instinctive conviction in the existence of an order of things"[3]. The G-d of the scientist is generally some great cosmic being, and the awe scientists feel when they look a little deeper seems to lead nowhere. A scientist can notice that the number pi, 3.14159… is not only yielded by the division of the circumference of a circle by its diameter, but it turns up in equations that describe subatomic particles, light and other quantities that have no obvious connection to circles. He can then conclude, as John Polkinghorne did, that human invented mathematics somehow tuned into the truths of the cosmos[4]. But, why don't scientists then take the next obvious step, which is to say that the reason that there is this harmony between our minds and the world is that they both come from the same Creator-Source. And that this Creator has a plan for us.

This is not to say that such a conclusion, obvious to a frum Jew, is easy to arrive at from the outside. Avraham Avinu, who discovered G-d by looking at nature[5], began his G-d search at the age of 3[6] but he was 40 - after an additional 37 years of total absorption and thought – when he reached a mature understanding and relationship with G-d[7]. It was only then that Avraham was finally willing to give up all idol-worship[8]. It was another 35 years, when Avraham was 75 years old, that he was first ready for G-d's command of Lech Lecha.

To understand what took him so long one has to look at the context in which Avraham made his discovery. The world that Avraham was born into had become completely idolatrous. The idolaters, praying to intermediaries, were able to show tangible results for

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[1] Jacobi commented, "The Great Architect of the Universe now appears as a pure mathematician."

[2] Quoted in the Time-Life book on mathematics p. 9

[3] Alfred North Whitehead, Science and the Modern World: "There can be no living science unless there is widespread instinctive conviction in the existence of an order of things"

[4] *Newsweek*, July 27, 1998

[5] רב צדוק הכהן, צדקת הצדיק ס' קפט: ב' מיני השגות אלוקות יש: א - מצד הבריאה מכיר שיש בורא וזה נקרא מעשה בראשית. ב - מצד ההנהגה וזה נקרא מעשה מרכבה איך הש"י רוכב על הברואים. והם ב' מדריגות דראיה וידיעה של אבות ומרע"ה הנזכר בזוהר וארא כג א ע"ש שהאבות השיגו מצד הברואים כמשאז"ל (בר"ר ר"פ לך לך) באברהם אבינו ראה בירה דולקת וכו' והיא נקרא ראייה דאתגליא ולכן נקרא אותו שם אצלם שם בכתוב המורה שאמר לעולמו די דרז"ל (חגיגה יב.) ופ' הרבי רב בונים זצ"ל שיש די בבריאה זו להכיר אלוקותו על ידו … וידיעה הוא בהנהגה כמ"ש הודיעני נא דרכיך וגו' ע"ש

[6] השגת הראב"ד הל" עבודת כוכבים פ' א: א"א יש אגדה בן שלש שנים שנאמר עקב אשר שמע אברהם בקולי מנין עקב. וכן בנדרים לב ע"א: בן ג' שנה הכיר אברהם את בוראו אמנם הרמב"ם כתב שב40 הכיר את בוראו והכסף משנה על הרמב"ם שם תירץ שבג' התחיל להכיר ובארבעים נשלם הבנתו.

רמב"ם שם הל' ג: כיון שנגמל איתן זה התחיל לשוטט בדעתו והוא קטן והתחיל לחשוב ביום ובלילה והיה תמיה היאך אפשר שיהיה הגלגל הזה נוהג תמיד ולא יהיה לו מנהיג ומי יסבב אותו כי אי אפשר שיסבב את עצמו ולא היה לו מלמד ולא מודיע דבר אלא מושקע באור כשדים בין עובדי כוכבים הטפשים

[7] רמב"ם הל" עבודת כוכבים פ' א: (ג) ובן ארבעים שנה הכיר אברהם את בוראו

[8] רמב"ם הל" עבודת כוכבים פ' א: (ג) ואביו ואמו וכל העם עובדי כוכבים והוא עובד עמהם ולבו משוטט ומבין עד שהשיג דרך האמת והבין קו הצדק מתבונתו הנכונה וידע שיש שם אלוה אחד והוא מנהיג הגלגל והוא ברא הכל ואין בכל הנמצא אלוה חוץ ממנו וידע שכל העולם טועים ודבר שגרם להם לטעות זה שעובדים את הכוכבים ואת הצורות עד שאבד האמת מדעתם.

their efforts; for they were tuning into real intermediaries used by G-d[1]. This is exactly why we turn to science. It delivers again and again. Avraham Avinu himself was brought up as an idolater like all those around him[2]. It required enormous courage and a radical breakthrough on his part for Avraham to see the world through different eyes. Perhaps too, the scientific paradigm of today may require similar courage to break through and see things with different eyes.

Scientific revolutions have happened before. Copernicus and Galileo led one that was rounded off by Newton. Einstein, Plank, Borne and Heisenberg led another one in the early part of this century. But, a scientific revolution which allows science to accommodate G-d is a revolution of a different order. It will require a change in the whole order of Western dominance, what we Jews call Edom. This is because science is so hugely dominant in the Western World and through there to the whole world in general.

We know that American culture is exported everywhere -its language, its denim-jeans, its movies and its Coca-Cola. But more than that, it exports the scientific paradigm. It is not capitalism or democracy which bestows the remarkable living standards of today's Westernized countries although certainly the former is a prerequisite and the latter a great facilitator. Ultimately, however, it is the ability to be at the cutting edge of modern technology that edges countries out of their millennia of poverty and into this remarkable new order[3].

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[1] רמב"ם הלכות עבודת כוכבים פ' א: (א) בימי אנוש טעו בני האדם טעות גדול ונבערה עצת חכמי אותו הדור ואנוש עצמו מן הטועים היה וזו היתה טעותם אמרו הואיל והאלהים ברא כוכבים אלו וגלגלים להנהיג את העולם ונתנם במרום וחלק להם כבוד והם שמשים המשמשים לפניו ראויין הם לשבחם ולפארם ולחלוק להם כבוד וזהו רצון האל ברוך הוא לגדל ולכבד מי שגדלו וכבדו כמו שהמלך רוצה לכבד העומדים לפניו וזהו כבודו של מלך כיון שעלה דבר זה על לבם התחילו לבנות לכוכבים היכלות ולהקריב להן קרבנות ולשבחם ולפארם בדברים ולהשתחוות למולם כדי להשיג רצון הבורא בדעתם הרעה וזה היה עיקר עבודת כוכבים וכך היו אומרים עובדיה היודעים עיקרה לא שהן אומרים שאין שם אלוה אלא כוכב זה הוא שירמיהו אומר מי לא ייראך מלך הגוים כי לך יאתה כי בכל חכמי הגוים ובכל מלכותם מאין כמוך ובאחת יבערו ויכסלו מוסר הבלים עץ הוא כלומר הכל יודעים שאתה הוא לבדך אבל טעותם וכסילותם שמדמים שזה ההבל רצונך הוא:

(ב) ואחר שארכו הימים עמדו בבני האדם נביאי שקר ואמרו שהאל צוה ואמר להם עבדו כוכב פלוני או כל הכוכבים והקריבו לו ונסכו לו כך וכך ובנו לו היכל ועשו צורתו כדי להשתחוות לו כל העם הנשים והקטנים ושאר עמי הארץ ומודיע להם צורה שבדה מלבו ואומר זו היא צורת הכוכב פלוני שהודיעוהו בנבואתו והתחילו על דרך זו לעשות צורות בהיכלות ותחת האילנות ובראשי ההרים ועל הגבעות ומתקבצין ומשתחוים להם ואומרים לכל העם שזו הצורה מטיבה ומריעה וראוי לעובדה וליראה ממנה וכהניהם אומרים להם שבעבודה זו תרבו ותצליחו ועשו כך וכך ואל תעשו כך וכך והתחילו כוזבים אחרים לעמוד ולומר שהכוכב עצמו או הגלגל או המלאך דבר עמהם ואמר להם עבדוני בכך וכך והודיע להם דרך עבודתו ועשו כך ואל תעשו כך ופשט דבר זה בכל העולם לעבוד את הצורות בעבודות משונות זו מזו ולהקריב להם ולהשתחוות וכיון שארכו הימים נשתכח השם הנכבד והנורא מפי כל היקום ומדעתם ולא הכירוהו ונמצאו כל עם הארץ הנשים והקטנים אינם יודעים אלא הצורה של עץ ושל אבן וההיכל של אבנים שנתחנכו מקטנותם להשתחוות לה ולעבדה ולהשבע בשמה והחכמים שהיו בהם כגון כהניהם וכיוצא בהן מדמין שאין שם אלוה אלא הכוכבים והגלגלים שנעשו הצורות האלו בגללם ולדמותן וגו'

וכעין זה פירש הרמב"ן, החינוך, הכוזרי וספר העיקרים.

[2] רמב"ם הלכות עבודת כוכבים א ג: ולא היה לו מלמד ולא מודיע דבר אלא מושקע באור כשדים בין עובדי כוכבים הטפשים ואביו ואמו וכל העם עובדי כוכבים והוא עובד עמהם

[3] It was once possible for an economy to do well based on its natural resources, or on farming. Thus countries like Argentina and South Africa had quite solid economies. But, today emerging economies only exist in countries which are moving into high tech. Although there are seemingly some exceptions to this, most notably China and the oil rich countries, a deeper analysis would show that they really prove the rule.

So here we are, with a G-d-excluding methodology that appears to produce endless good for mankind (atomic bombs aside). It is no accident, that it is just at this time that secular humanism, which places man rather than G-d in the center of things, has become the main source of ethics, law and even meaning. What chance for religion to really challenge that and come up with a better alternative.

When Laplace presented his work to Napoleon, Napoleon reputed to have remarked, "Monsieur Laplace, they tell me that you have written this large work on the system of the universe and you did not even mention its Creator." To this Laplace supposedly responded, "I had no need for that hypothesis."

But the world has come a long way since Laplace and his Napoleonic encounter. Recently, there have been many attempts to reconcile religion with science, not so much because of a change in attitude, but because scientific discoveries in the twentieth century seem to point in that direction. Fritjof Capra caused quite a stir when, in "The Tao of Physics", he showed the basic harmony that exists between modern physics and Eastern religions. Michael Behe (Darwin's Black Box) has made a powerful case for showing that biochemistry is leading us toward rather than away from the idea of a designer of the universe. These gentlemen have their point, but they miss the larger issue I wish to make here.

It is true, as we show elsewhere, that science is drawing closer to religion in general and Judaism in particular. The idea that matter can turn into pure energy has made it easier to conceive of a purely spiritual world. The indeterminacy of quantum physics allows for freedom of choice and moral responsibility; the Big Bang is a step towards (though not a complete harmonization of) the creation story. But the closeness only consolidates the position of science as the embrace of all reality. It may be, as Robert Jastrow suggests in *God and the Astronomers*, that the scientist will ultimately get to the top of the cliff and to find the theologian sitting there all along. But the scientist has no intention of joining the theologian, sitting side by side. The scientist sees the theologian as an extension of the cliff face which he must climb. He will keep on climbing until he is sitting, as he sees it, on top of the theologian as well. Of course he is gracious to his cliff, and he smiles kindly down on his theologian as well. All are welcome in the ultimate scheme of things.

But there is a different vision of things – one which we will witness in the Messianic era. Although it is possible, I do no not envisage the end of science, since I believe that there are enormous secrets still held in nature. I envisage the great scientists (then all non-Jewish) calling the Mashiach[1], telling them of a new breakthrough in superconductivity and receiving instruction on what the spiritual implications are and what to do with the discovery. Mashiach's job then will not be to teach the Jews – ולא ילמדו עוד איש את רעהו[2], the job of the Mashiach will be to teach non-Jews the Torah they need to know[3]. Perhaps

[1] Mashiach himself will have the status of a Melech. Pachad Yitzchak (שבועות לו) states that while דעת תורה on pure Torahdik issues was the domain of the Sanhedrin, it was the King who was in charge of דברי רשות, including הוראת שעה. (But the King, in turn, has to be appointed by the Sanhedrin.) This is why we wrote that the scientists will contact the Mashiach and not the head of the Sanhedrin.

[2] ירמיהו לא:לג

[3] שם משמואל (קרח ור"ח תמוז שנת תרע"ב): עד גמר התיקון שאז נאמר (ירמיהו לא) ולא ילמדו עוד איש את רעהו וגו' לאמור דעו את ד' כי כולם ידעו אותי למקטנם ועד גדולם, ובמדרש (ב"ר פ' צח) אין ישראל צריכין לתלמודו של המלך המשיח דכתיב אליו גוים ידרושו ולא ישראל.

science will be a part of that Torah.

During the Messianic Era, there will be no distractions from dedicating one's life to spirituality[1]. Each Jew will be capable of understanding the truth by himself[2] and will be able to understand the Torah at a much deeper level than we are able to now. If that is the case, then science will also not be a distraction, neither its technical innovations (think of cell phones, the internet, TV – all today questionable additions to the spiritual progress of mankind) nor its more substantive discoveries concerning the beginning of the world, of life and of man, the nature of consciousness, etc. But science will go further: it will actively serve spirituality, it will naturally flow from it, and provide yet another way of connecting to G-d.

7. Resolution of Conflicts between Judaism & Science

We have talked about the need for a paradigm change in science so that scientific discoveries flow naturally into G-d. However, until that time, we need also to deal with local conflicts – the conflicts of specific scientific theories. The Big Bang may bring us closer to Judaism than its predecessor, the Static Universe, but it still posits an infinitely dense particle of matter. It may mean, as Hawkins and Penrose claim, that time, at least must have had a beginning[3]. But it lends itself just as well to other scenarios. Scientists frankly don't know what happened before then, but certainly many of their speculations do not agree with Judaism[4]. Some have seen in the Punctuated Equilibria an evolutionary theory which is closer to Judaism than the Synthetic Theory, but it is probably closer to classical Darwinism than it is to Judaism. Einstein's theory of relativity makes it easier to reconcile the scientific age of the universe with the Six Days of Creation, but the multiplicity of explanations suggests that this reconciliation is not yet clear. It should also be stated that any resolution needs to be according to the main highway of the *Mefarshim* throughout the ages. This does not mean that no *chiddush* is valid. But there is something highly uncomfortable with an approach which requires us to leave aside the *Gedolei HaRishonim* and *Achronim* in order to accommodate a scientific theory.

Personally, I would prefer to leave such theories as contradictions. I can live the contradiction (as scientists themselves do with contradictory scientific theories), until one day science changes to reconcile itself with Judaism. The fact is that in almost every area science is moving closer to Judaism and this lends strength to this patience. The scientific endeavor itself is sufficiently robust that it continues to more closely approximate the truth. Scientists themselves have a healthy attitude towards the almost inevitability of certain theories changing with time.

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[1] רמב"ם הל' מלכים (פ' יב הל' א-ד): ולא יהיה עס' האדם אלא לדעת את ד' בלבד

[2] ר פרידלנדר (שם דף קלב): כיון שלעתיד לבא תהיה עבודת ד' אצלם בטבעם, גם יבינו מצד טבעם מעצמם את האמת. ע"כ וזה מה שאמר הנביא (ירמיהו לא לג): ולא ילמדו עוד איש את רעהו וגו'

[3] Stephen Hawking and Roger Penrose proved in the 1960s that time cannot extend back indefinitely. As you play cosmic history backward in time, the galaxies all come together to a single infinitesimal point. Each galaxy or its precursor is squeezed down to zero size. Quantities such as density, temperature and space-time curvature become infinite turning into a singularity. (Gabriele Veneziano, *Scientific American*, May 2004)

[4] See Gabriele Veneziano, *Scientific American*, May 2004.

Einstein's larger theory of general relativity is one of two macro-theories that describe all of matter. The other one is the quantum theory, which also has considerable theoretical and experimental backup. The theory of relativity describes reality at a macro-level, from the size of an atom up, while quantum theory describes what happens inside an atom.

The problem is that, although both theories are accepted they contradict each other[1]. Either one or both has to be modified or completely overthrown. As a result, the standard theory of matter is sure to change. Some have already questioned whether Einstein's gravity doesn't change at large distances[2]. Yet, just as sure as scientists know that, they continue to find proofs which confirm both theories[3]! For the time being, scientists are happy to regard both as true. Scientists comfortably live this contradiction, as they do many others.

It is the layman more than the scientist that gives science an aura of infallibility and makes the problem of any contradiction larger than it really is.

Few scientists would agree with Paul Feyerabend[4], a noted physicist, who claims that non-rational factors are dominant in science. But they do agree that the theories they propose are not meant to be claims of absolute truths about the world. What scientists purport to do is to provide theories which are the best explanation, amongst competing explanations, of the facts at hand. Scientists never claim that a particular theory is the final explanation of things (although they may dream of such a thing[5]), even where the theory is supported by experimental evidence.

Newtonian physics is a classic example. Today, we know that Newtonian physics is wrong. It has been replaced by Einstein's theory of relativity. Einstein proposed three proofs to decide between his theory and Newton's. One of them was how much light

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[1] Quantum theory radicalizes our assumptions about the relationship between observer and observed but pretty much buys into Newton's ideas of space and time. General relativity changes our notions of space and time but accepts Newton's view of observer and observed. This situation is deemed unacceptable by most physicists, and the solution is thought to lie in a unifying theory of quantum gravity, sometimes called a Theory of Everything. The idea is that ultimately everything, space and time, like matter and energy, come in quantized, indivisible units and that relationships, rather than things, are the fundamental elements of reality.

[2] See George Musser, *Four Keys to Cosmology* in *Scientific American*, February 2004.

[3] Quantum physics not only has many proofs, but we have many practical instruments based on this theory. The theory of relativity has been tougher to prove, though Einstein initially set out three tests, all of which relativity passed. The contraction and expansion of time is used in a practical way in GPSs, which if they were not refacted for the influences of gravity and speed, would be off by as much as seven feet a day.

Even Einstein's so-called fudge factor is turning out to be right. When Einstein first applied his general theory of relativity to the universe, he made a dramatic simplifying assumption: the universe, on average, was homogeneous (it had no lumps) and isotropic (it looked the same in all directions). He called this assumption the cosmological principle, and it underlies all modern scientific models of the universe. (See Michael A. Strauss, *Reading the Blueprints of Creation,* in Scientific American, February 2004)

[4] *Against Method*

[5] In 1996, John Horgan, created quite a stir when he wrote *The End of Science* (Broadway Books, 1996), claiming that science was about to solve all the major issues and after that there would be only riddles. However, most scientists agree that Horgan's exceptional optimism has not panned out. Many argued that his idea that certain major discoveries would resolve all the major issues of science was flawed to begin with.

would be bent by a large object. One of the world's greatest astronomers of the time, Sir Arthur Eddington, went out on a boat on a full solar ellipse to measure how much the starlight coming from behind the sun was bent by it on its way to earth. The amount of refraction turned out to be exactly as Einstein predicted.

But school children still learn more about Newton than Einstein. And every bridge, skyscraper and jet plane is built on the principles that Newton expounded. How can this be if Newton is known to be wrong. However, Newton is accurate enough that on small scales like skyscrapers, the margin of error does not matter. We might say that Newton was right enough for us. And that is why it took 300 years to show that there is a better theory which may, in turn approximate reality just a little better.

One of the things which Einstein's general theory predicts is a new way of understanding gravity, as curvatures in space rather than as a force which objects exert on each other. The attempt to prove Einstinian gravity goes on to this day. Although all experiments have been in favor, scientists are always discovering more accurate ways of proving the theory. Yet, as we pointed out above, Einstein's underlying theory of relativity may well have to go[1].

When a theory is first proposed, it is usually competing with many others. Often different scientists will cling to different theories. Even if scientists will do an experiment to prove one of these theories, this will usually not be decisive.

However, after experimental evidence builds up, there does come a certain point at which the scientific community accepts a particular scientific theory. Such is the case of the Big Bang. For 60 years after it was first discovered in the 1920's, the Big Bang was a disputed theory. A lot of scientists believed it, but others had good reason to believe that the world had always existed. By the 1980's, however, there were more than 6 proofs, coming from different areas, for the theory[2]. At that stage, no self respecting scientist, even those who were frightened of the religious implications of the Big Bang, disputed the theory. So the Big Bang is now a strong theory, but it is not invincible. And in fact it is undergoing modifications all the time.

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[1] In a choice between the correctness of Quantum Physics vs. Relativity, I believe most physicists today would vote for Quantum Physics

[2] Proofs came from:

a- The Red Shift (the Doppler Effect);

b-Radio waves which showed changes in universe;

c-Cosmic Background Radiation;

d-COBE, the satellite which confirmed much of the above/

e-Entropy, which should have led to increasing disorder in the universe. Since the universe is still highly ordered and was even more ordered in the past, it follows that the universe could not have existed for ever: otherwise it would have reached its state of maximum entropy a long time ago.

f-The composition of the Universe: Atom smashers which push subatomic particles to extremely high energies, produced results that allowed researchers to calculate that the early universe should have been about three-quarters hydrogen and one-quarter helium. When astronomers inspect the oldest stars and nebulae, they find them composed of almost exactly that mix.

Einstein's relativity theory seems as sure and confirmed as a theory. There are many proofs for and applications based on this theory. Yet most scientists don't expect it to be around in the next century, unless it can be modified and reconciled with quantum physics.

The truth is that one can always come up with competing theories to explain any set of phenomena. Scientists try to choose a theory that best fits the facts at hand. This theory may later be proven to be wrong, and it may even now contradict other accepted theories. But the scientist is not bothered by this because they have a great belief in their method. They are sure that the scientific method will ultimately prove which theories have to be abandoned or modified, but the process usually continues on an open ended basis. Theories are never finally proven. As Sir Karl Popper put it, theories can only claim that they have not yet been disproven.

Many people are under the mistaken impression that to at least one area, mathematics, a rigorous notion of proof does apply. Mathematics, after all, lends it self to a progression of logic, starting from assumptions and arriving at a conclusion. If the chain is correct, the proof is true. If not, it is wrong[1].

But even a mathematics proof is sometimes a fuzzy concept, subject to whim and personality. Almost no published proof contains every step; there are just too many. Reviewers rarely check every step, instead focusing mostly on the major points. In the end, they either believe the proof or not.

"It's like osmosis," said Dr. Akihiro Kanamori, a mathematics professor at Boston University who writes about the history of mathematics. "More and more people say it's a proof and you believe them."

Let us take as an example one of the longest-standing problems in the field — the most efficient way to pack oranges.

The packing problem dates at least to the 1590's, when Sir Walter Raleigh, stocking his ship for an expedition, wondered if there was a quick way to calculate the number of cannonballs in a stack based on its height. His assistant, Thomas Harriot, came up with the requested equation.

Years later, Harriot mentioned the problem to Johannes Kepler, the astronomer who had deduced the movement of planets. Kepler concluded that the pyramid was most efficient. That allows each layer of oranges to sit lower, in the hollows of the layer below, and take up less space than if the oranges sat directly on top of each other[2]. But Kepler offered no proof.

In 2002, Dr. Wu-Yi Hsiang of University of California at Berkeley claimed he had a proof[3]. But, because his earlier versions contained holes of logic other scientists felt Dr.

[1] This and the following paragraphs concerning mathematical theories was adapted from a NY Times article, *In Math, Computers Don't Lie. Or Do They?* By Kenneth Chang, April 6, 2004

[2] An alternative arrangement, with each layer of spheres laid out in a honeycomb pattern, is equally efficient, but not better.

[3] It appeared as a book (rather than in a peer-reviewed journal).

Hsiang could not fill, few bothered to even read let alone check Dr. Hsiang's thesis[1]. Dr. Hsiang's thesis may well be true but we will probably never know this[2].

In the belief that too much emphasis on details stifles creativity, mathematicians continue to debate how much rigor a proof requires. Major mathematical fields of the 1700's and 1800's like calculus and topology developed without rigorous proofs. "For quite some time in mathematics, arguments were basically descriptive," Dr. Kanamori said. "People would give what we would now call informal arguments."

In 1998, Dr. Thomas C. Hales, a professor of mathematics at the University of Pittsburgh, offered a proof for Kepler's proposal comprising hundreds of pages. But Dr. Hales's proof of the problem, known as the Kepler Conjecture, hinges on a complex series of computer calculations.

The first group recruited to review the proof spent six years on it, but gave up, exhausted[3]. Yet the proof was accepted by the mathematics community anyhow[4]. This requires faith that the computer performed the calculations flawlessly, without any programming bugs[5]. Yet, untested computer techniques are becoming more common in mathematics[6], further lowering the old barrier of checking everything before accepting a theorem as true[1].

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[1] "Hsiang has not such a good track record," said Dr. Frank Quinn, a mathematics professor at Virginia Tech. "I don't want to spend time proving it's wrong." Dr. Hsiang counters that his proof offers deeper insight and that others' understanding of his techniques is inadequate.

[2] Scientists justify this approach by saying that they do not have the time or the inclination to spend time disproving something they think is wrong.

[3] Everything checked by the reviewers, led by Dr. Gabor Fejes Toth of the Hungarian Academy of Sciences, turned out to be correct. But the prospect of reviewing every calculation proved too daunting.

[4] Eventually, the prestigious Annals of Mathematics Journal published only the theoretical parts of the proof, which were checked by hand. A more specialized journal, Discrete and Computational Geometry, published the computer sections.

[5] In 1976, Dr. Wolfgang Haken and Dr. Kenneth Appel of the University of Illinois used computer calculations in a proof of the four-color theorem, which states that any map needs only four colors to ensure that no adjacent regions are the same color.

The work was published — and mathematicians began finding mistakes in it. In each case, Dr. Haken and Dr. Appel quickly fixed the error.

[6] Mathematicians like Dr. Larry Wos of Argonne National Laboratory use "automated reasoning" computer programs: they enter axioms and the computer sifts through logical possibilities in search of a proof. Because of the huge number of possibilities, a human still needs to tell the computer where to search.

"The human mind will never be replaced," Dr. Wos said, but the advantage of computers is their lack of preconceptions. "They can follow paths that are totally counterintuitive," he said.

The software also fills in the tedious work giving the mathematician more time to contemplate other problems, and it generates as much or as little detail as a mathematician desires, telling you how each step was obtained. In 1996, Dr. Wos and a colleague, Dr. William McCune, used the software to prove a previously unsolved problem known as the Robbins Conjecture.

In a 2003 book, "Automated Reasoning and the Discovery of Missing and Elegant Proofs," Dr. Wos described new proofs and more elegant versions of known proofs discovered by computers.

When you get to something like evolution, the barrier is lowered even further. The very nature of the proof which is being attempted, something which happened in the past, requires a weaker standard. But critiquing evolution does not mean that, as a scientist, one ought to reject it as a theory. It may have lots of problems and still be the best theory around. Either paleontologists will plug the holes one day by modifying the theory or finding more evidence, or have to reject the theory altogether. But for the time being, it is scientifically valid to accept evolution as the reigning theory. Laymen tend to ask, "How can there be so much wrong with evolution and yet the scientific establishment still hold on to it? It must be because of a radical, secular bias." And then they say, "And how can they believe in something just because they don't have something better to believe in?" But this misses the point of how a scientific theories work. We can say that evolution is a weak theory or a strong theory; we can look at Lynn Margolis[2] for some competing theory. But as things stand today, if we do not believe in evolution, it is because it contradicts elements of the Torah, not because it is scientifically invalid.

Sometimes there are as many as ten or twenty competing theories, all of them with some problems and all of them with some proof. Take superconductivity. Superconductivity means that a material conducts electricity without resistance. Almost all of the electricity gets passed through the material and almost none is lost in the form of heat. But superconductivity requires very cold temperatures, well below zero to work. Scientists believe that this is because at these temperatures, the electrons all align in neat rows and therefore do not bounce around. But superconductivity has also been discovered in ceramics at much higher temperatures. No one theory conclusively explains why, and there are many tens of competing explanations as to why this is so. Perhaps one day one of these theories will emerge as the accepted one amongst scientists, but for the time being, you can take your pick.

Up until now we have been suggesting that it is the amount of proof which is the determinant of how accepted a theory is. But proof, though important, is not the only thing that determines the acceptability of a theory. There are also things like the unity which the theory brings, its mathematical beauty and its simplicity. To say that the more beautiful (mathematically) a theory is the truer it is an axiom of science and cannot be proven. Yet, there is no question that these kinds of criteria play a significant role in determining which theory gets the chop and which gets the final nod of approval.

Quantum physics gave a boost to this belief. In his book, The Tao of Physics, physicist Fritjof Capra wrote:

Intel, the microchip giant, uses proof-checking software to check algorithms in its chips, in the hope of avoiding glitches like one in the original 1994 Pentium that caused numbers to divide incorrectly.

Current software, however cannot handle anything nearly as complex as the Kepler Conjecture.

[1] The Annals has decided that computer-assisted proofs have merit, but the journal will accord them a lower status than traditional proofs, regarding them more like laboratory experiments that provide supporting evidence

The above paragraphs, concerning mathematical theories was adapted from a NY Times article, In Math, Computers Don't Lie. Or Do They? By Kenneth Chang, April 6, 2004

[2] Lynn Margolis' proposal is that organism's operate in wholistic and cooperative fashions.

> *Subatomic particles [in fact] have no meaning as isolated entities ... Quantum theory thus reveals a basic oneness of the universe. ... We cannot decompose the world into independently existing smallest units. ... Nature does not show us any isolated 'basic building blocks', but rather appears as a complicated web of relations between the various parts of the whole." (page 78)*

Another one of the beliefs of science, closely linked to the first, is the fact that, "as we examine nature on deeper and deeper levels, she appears ever more beautiful, revealing hidden symmetries where none were imagined to exist[1]; Why should that be?[2]" But physicists don't just notice a correlation; they use beauty as an active criterion to measure truth. H. Bondi describes Einstein's attitude to an 'ugly' equation:

> *"What I remember most clearly was that when I put down a suggestion that was most cogent and reasonable, Einstein did not in the least contest this, but he only said, Oh, how ugly." As soon as an equations seemed to him to be ugly, he rather lost interest in it and could not understand why somebody else was willing to spend much time on it. He was quite convinced that beauty was a guiding principle in the search for important results in theoretical physics[3].*

This is almost a mystical approach to things. Whereas we can understand why scientists associate truth with unity, it is harder to understand how a theory can be accepted based on how beautiful it is. Although man has always tried to connect truth with beauty, from a purely secular point of view, scientific theories might just as soon be ugly as beautiful. It would be nice if they were beautiful as well, but to say, as Paul Dirac often did, that, "It is more important to have beauty in one's equations than to have them fit the experiment[4]," is to go very far indeed. It is to use aesthetics as a driving force; to presume that not only is nature, at the fundamental level, beautifully designed, but that *aesthetic imperatives of contemporary physics make up a system of aesthetics that can be rigorously formulated*[5].

Science has never proven that truth is dependent on beauty. This too is a part of the religion of science. The physicist A Zee calls a spade a spade when he declares:

> *Some physics equations are so ugly that we cannot bear to look at them, let alone write them down. Certainly the Ultimate Designer would use only beautiful equations in designing the universe! We proclaim: Let us worry about beauty first and truth will take care of itself.*

Paul Davies goes even further: "Forces are simply nature's attempt to maintain various abstract symmetries in the world"[6]

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[1] Simple symmetries are seen everywhere in nature. Anything which is shaped in a circle or a square, snowflakes, reflections are all symmetrical. But, it was the discovery of deeper symmetries in nature which helped to unlock many of the secrets of higher physics.

[2] A Zee, *Fearful Symmetry*

[3] In A Zee, *Fearful Symmetry,* p. 3

[4] Paul Davies, *Superforce*, pg. 54

[5] A Zee, *Fearful Symmetry,* p. 3 – 5

[6] *Superforce*, Davies, p. 7; see also p. 112-116)

The discovery of these hidden symmetries is that it is all the more remarkable given that, on the surface, everything in nature seems to demand the opposite, that things be slightly asymmetrical. …

Simplicity is another way of measuring truth. For practical reasons, scientists are always looking to explain things according to the simplest formula possible. This allows complex things with many variables to become easily manageable and usable. In fact Newton and Einstein came up with formula that are less than half a line long, and that can be taught to a school child. The greatness of their theories included the fact that they were so elegant and simple.

A perfect Creation, with its symmetry untainted, would have led to matter and antimatter in precise balance and a mutual annihilation when in the very next instant they recombined: a precisely symmetrical universe would have vanished as soon as it had appeared. Such a uniform cosmic soup could hardly have led to the asymmetrical universe that we are a part of today where antimatter appears to be all but absent.

However, another theory states that the two were indeed made equally in the Creation. Soon afterwards something interceded; the symmetry between matter and antimatter was slightly lost, with the result that after the great annihilation, a small proportion of the matter was left over. Those remnants are what have formed us and everything around us as far as we can see. We are the material rump of what must have been an even grander Creation.

Scientists also see the need for asymmetry in the four forces …. [and] in the atoms, the building blocks of all of life. Life appears to thrive on mirror asymmetry …. The deeper one looks, the more asymmetry becomes apparent and seemingly necessary for anything `useful' to have emerged. And yet, seemingly deeper still, everything emerges symmetrical once more.

The focus of much current research is to understand how nature hides symmetry, producing structured patterns out of underlying uniformity.

Scientific American, July 2002 *Uncovering Supersymmetry*, By Jan Jolie:

Symmetry principles occur through physics, often in ways that one wouldn't expect. For example, the law of conservation of energy can be derived from a symmetry principle involving the flow of time. The equations governing elementary particle physics are fundamentally based on symmetries.

Einstein's theory of special relativity is a theory of the symmetries of empty space and time. Effects such as length contraction and time dilations, which flatten fast-moving clocks and make them run slow, are operations of the symmetry group, similar to rotating your point of view in space, but with time as par of the "rotations." The fundamental forces are dictated by symmetries called gauge symmetries. Conservation of electric charge is a consequence of yet another symmetry.

Supersymmetry is a remarkable symmetry. In elementary particle physics, it interchanges particles of completely dissimilar types, the kind called fermions (such as electrons, protons and neutron), which make up the material world, and those called bosons (such at photons), which generate the forces of nature. In quantum physics particles are divided into bosons and ferrmions.

…. Fermions are inherently the individualists and loners of the quantum particle world: no two fermions ever occupy the same quantum state. Their aversion to close company is strong enough to hold up a neutron star against collapse even when the crushing weight of gravity has overcome every other force or nature. Bosons, in contrast, are convivial copycats and readily gather in identical states. Every boson in a particular state encourages more of its species to emulate it. Under the right conditions, bosons form regimented armies of clones, such as the photons in a laser beam or the atoms in superfluid helium 4.

In the mirror of supersymmetry, standoffish fermions look magically like sociable bosons, and vice versa. Figuratively, you might say it is a symmetry that lets you compare apples and oranges. Hold up an apple to the supersymmetry mirror, and its reflection looks and tastes like an orange.

In the 1980s nuclear theorists predicted that a different form of supersymmetry could exist in certain atomic nuclei. Nuclei with even numbers of protons and neutrons and those with odd numbers.

Supersymmetry opens up a new class of possible relations among particles. These relations result in far greater computational power for analyzing or predicting a system's behavior.

However, there is no reason to expect that everything in the universe can be reduced to simple formulae and that because a scientific theory is simpler than another, that it is therefore more true. From a purely scientific point of view, there is no rational reason why the world should be explained according to simpler rather than more complicated formula. Yet scientists believe just that.

In the time of the great astronomer, Copernicus, there was a great showdown between him, as a scientist, and the church, which sought to silence his views as being contradictory to church doctrine. Up until then, the Church had accepted Ptolemy's ingenious but very complicated system of calculating planetary motion[1], which was presumed to be circular. Copernicus had proposed a much simpler heliocentric system of planetary motion. In response to Copernicus, the Church argued with Copernicus that the fact that his theory was simpler (and more elegant) was no indication that it was more true. But the belief of the scientific community in the principle of simplicity won out in the end over that of the church.

Beauty, unity and simplicity all represent underlying beliefs or axioms of science. "Science", said the mathematician-philosopher, Bertrand Russel, "has never cared to justify its faith or explain its meaning[2]." The enormous success of science over the last 150 years has emboldened the scientist to believe that his creed truly is correct.

8. Science as the New Ethics

We are much beholden to Machievelli...that if something has been invented then we must use it. We don't stop to think of the possible consequence of its use. (J.B. Priestley)

Scientists exceed their mandate, and can even be dangerous, when they try to deal with the why[3]. Firstly, science, by its very nature, lacks a certain perspective. As Will Durant put it: "The scientist is as interested in the leg of the flea as the creative throes of a genius...." Scientifically speaking, they may of equal interest. In human values, they are worlds apart.

Yet, the very pace of science has meant that, by default, science has become the great moral arbiter of its own discoveries. 20th century science charged ahead so quickly, that its de facto control created a sort of de juror reality. It operated on the assumption that since science meant progress, every discovery was automatically for the good of mankind. It was dead wrong[4]. The moral and ethical issues which emerged from the new

[1] It involved a system of circles and sub-circles, with different radii, tilts and different amounts and directions of eccentricity.

[2] *The Will to Doubt*, p. 65

[3] שפתי חיים שם: אוי ואבוי הוא כאשר חכמי הטבע חורגים מגבולות וממגבלות חכמתם, ומנסים להסביר את הלמה, כי אז הם בודאי שוגים, וטועים, מפני שהלמה - סיבת הסיבה היא רוחנית

[4] R.G. Collingwood (Autobiography): "The gigantic increase in man's power to control nature had not been accompanied by a corresponding increase in his power to control human situations" (Baumer, *Modern European Thought*, pg. 466)

Aldous Huxley felt that science actually made things worse: "Man's very victory over nature constituted an important causative factor - in the progressive centralization of power and oppression and in the corresponding decline of liberty during the twentieth century." (Above Cit.)

science were rarely anticipated. They were almost always only brought up after the fact. To their credit, in the last twenty years, many American colleges have introduced medical and other ethical courses. Many hospitals now have an ethics committee. However, these are limited to responses to given realities; science, with virtually no constraints, first discovers a particular area and only then does the ethicist deal with it.

Take the atom bomb. The dropping of the bomb led to much discussion about whether nuclear power for military ends is good or bad. Some of the most eloquent and vociferous opponents of the atom bomb became those who were involved in the Manhattan project (the American WW2 initiative to make the atomic bomb) to begin with, including Robert Oppenheimer, who headed the project. It was he who said in retrospect, "The physicists have known sin; and this is a knowledge which they cannot lose" (lecture, 1947). But at the time of its development a certain dynamic was taking place, a dynamic which is insightful about the momentum of science in general.

Victor Weiskopf writes of his participation in the Manhattan Project: "Today, I am not quite sure whether my decision to participate in this awesome and awful enterprise was solely based on the fear of the Nazis beating us to it. It may have been more simply an urge to participate in the important work my friends and colleagues were doing. There was certainly a feeling of pride in being a part of a unique and sensational enterprise. Also this was a chance to show the world how powerful, important and pragmatic the esoteric science of nuclear physics could be."

After the defeat of Germany, the single, most powerful reason for working on the bomb had been removed. But work continued because, "By then we were too involved in the work, too deeply interested in its progress, and too dedicated to overcoming its many difficulties ... the thought of quitting did not even cross my mind." (After the war, Weiskopf did quit working on the project.)[1]

It has become popular to talk of the twentieth century scientific revolution as having been concentrated in the first decades of the century. Enter quantum physics, enter relativity, enter most of the major practical innovations which affect our lives so greatly today. The truth be told, that science has increased its revolutionary momentum over time. The whole area of biochemistry for example, only really took off from the 50's onward.

Until that time, there was precious little understanding of how organs of the body worked at a chemical level, let alone of whole organisms. To explain the exact transmission of vision, for example, from the time a photon first hits the eye to the time when the fired nerve returns to its normal state was something that early 20th century science did not even dream of being able to do. In fact the tendency was to grossly underestimate the complexity of all living organisms. The questions were not even asked. Very small creatures were not even thought to have discreet internal structures. We might say that in this regard there has been a paradigm shift of sorts. We now expect to find complexity; we ask the right sort of questions and we therefore get the right sort of answers. But the ethical implications of all of this has barely been touched.

Perhaps most dramatic is our assault on both ends of life. It is not always realized that the American average life span of 78 for men and 80 for women is as much a function of the lives we save of people in their first year on this earth, as it is of people in their 70th

[1] The Joy of Insight, Passions of a Physicist, Basic Books.

or 90th. It is estimated that over 80% of all medically related costs (including especially research) goes into these extremities.

The attempts of ethicists to keep pace with these events have been hopeless. As science reached toward the top of any hill, ethicists only began climbing from the bottom. This is not because of any failure on their part. More recently, the reaction time to issues has gotten faster. The U.S. made great strides when it reacted promptly to the recent cloning in Scotland. But cloning has been around for ages; scientists just happened to get it right at a much earlier age, something they were bound to do sooner or later. In other words, it was only when science was again at the top of the hill that such responses were forthcoming.

Not only are responses by the non-scientific community reactive rather than proactive but such responses are to the credit of big government and not to the world of philosophers and thinkers. However, democratic, capitalist governments will at best act as honest brokers guiding processes that ultimately must be controlled and directed by others. At best, bodies like the NIH are scientists monitoring other scientists to create acceptable, not ideal standards. Any suggestion of a "non-professional" monitoring the corporate body of science, even in essentially non-scientific ethical areas, such as criteria for publishing results or preventing fraudulent claims is fiercely and successfully resisted by the scientific community.

The situation that has emerged is aptly described by the Jewish medical ethicist and biologist Rabbi Dr. Moses Tendler: "By default, society has assigned the physician the role of theologian and moralist - a role for which he has no competence. The fear of sickness and death, aided by the intentionally cultivated aura of mystery and the deep respect of the laity for scientific achievement, has resulted in this unwritten election of the medical community as arbiter of the most fundamental truths of Torah morality and of Western Civilization."[1]

In truth a doctor is as qualified to pass judgment on when life begins and ends as a chef is on which foods are carcinogenic or a computer programmer about which way the PC market is about to go. All are likely to sound intelligent; none have more than an educated layman's chance of being right.

Thinking rigorously ethically is a highly specialized business. The great posek has invariably spent 40 to 50 years of his life preparing just for this. He has focused on a body of Divinely given information, the Torah, which anticipates all these questions to begin with. One has only to page through an Igros Moshe to see that all the new ethical issues have already been in the Torah, in principle form, from the outset. The posek has been preparing himself personally to reflect the values he adheres to at the highest of levels.

He is aware of every variable that impacts on his decision. He knows that what he thinks about the centrality of the family, the value and the purpose of life, the right to self-determination and G-d are not only going to influence his answers, they will determine the very questions that get asked. And those questions will already point us toward a particular answer. As the sages put it, `The question of a wise man is half the answer.'

Even if we ignore the fundamental difference of a Torah answer to a man-given one, the average medical ethicist has but a fraction of the preparation that we are talking about.

[1] Challenge, Feldheim

For many, this comprised of one under-graduate course, and that's it. And therefore, in the main, these people are lightweights against the inexorable march of scientific progress. There is not a single one who can claim a towering moral prowess which will prompt any major scientist to consult with him in advance, to set the parameters of research and anticipate its ethical implications.

The idea that the moral implications of science be dictated by the fact of science is a fundamental flaw of Western reality. The classic view of science as a morally neutral force is simply no longer tenable. Fifty odd years ago, Will Durant was able to say that "science tells us how to heal and how to kill; it reduces the death rate in retail and then kills us wholesale in war; but only wisdom...can tell us when to heal and when to kill."[1] But Science did not wait for wisdom to inform it.

What this leads to is a sort of trance of action inherent in the nature of scientific progress. "We are much beholden to Machievelli," J.B. Priestley said,"...that if something has been invented then we must use it. We do not stop to think of the possible consequences of its use."

Of course, many Western scientists, together with the politicians, were aghast at some of the more morally repugnant uses to which Nazis and Communists had applied the new technology. Scientists as a whole are interested in doing the right thing. But this misses the point. The real issue was that "the gigantic increase in man's power to control nature had not been accompanied by a corresponding increase in his power to control human situations,"[2] nor to act more morally. Alduous Huxley pointed out that man's very victory over nature constituted an important causative factor in the progressive centralization of power and oppression and in the corresponding decline of liberty during the twentieth century.[3]

And there things lay. On the one hand we never expected, and therefore never demanded, that science deal with the whole world of feelings, purpose and values[4]. But nor did we expect its de facto dictation of these very things with which it claimed to have nothing to do.

We are not suggesting a conspiracy of scientists making a takeover bid of the world. It is the scientific endeavor per se which imposes this reality. For example, the ability to end an individual life has never required much help from the scientific establishment. We have always known how to insert poisons into living bodies, to turn people into just so much rotting flesh. It is hardly cutting edge technology to put up a drip and engage in an act of euthanasia a la Kevorkin. It requires infinitely greater expertise to save the life of someone in critical condition rather than ending it. We can therefore expect that the medical establishment would move in the direction of saving lives rather than ending it. Ending the life of fetus in a way that is painless and relatively dignified for both mother and fetus is more medically challenging than ending the life of a critically ill adult, especially an adult that is on life-sustaining machinery. Therefore the medical establishment is more likely to invest in learning how to do abortions than how to do

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[1] *A History of Philosophy*

[2] Baumer, *Modern European Thought*, MacMillan, 466, quoting R.G. Collingwood, Autobiography

[3] Above cit.

[4] Based on Sir Arthur Eddington: "Physics dealt, by choice, only with measurable quantities. But there was the whole world of feelings, purpose and values." (Above Cit. 471)

euthanasia. That the medical challenge rather than the ethical prioritization should determine these goals is inherent in the nature of the scientific enterprise. Even where humanitarian efforts are undertaken in areas such as finding a cure for AIDS is a function of the occasional successes of forces outside the scientific community indicating a priority.

The medical establishment is certainly not morally neutral. It does distinguish the ethical difference between conducting an abortion vs. conducting a euthanasia. This is why abortionists still retain their medical licenses while Dr. Kevorkan had his revoked. But this moral sensitivity is a secondary and not a primary determinant of research and other priorities.

Outside of medicine, conventional wisdom has it that the scientific endeavor is essentially morally neutral. Atomic power can light up dark homes, or flatten and darken 100,000 lit ones. Society decides whether evil ends or good ones are what is in mind. I have tried to show that this is not so. The scientific exercise produces moral facts on the ground, facts which would require an exceptional effort on the part of society to counter.