בס"ד

GENESIS & THE BIG BLUFF

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A comprehensive critique of *Genesis and the Big Bang* by Dr. Gerald Schroeder, and an introduction to the Torah and science interface.

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INTRODUCTION

In 1994, Dr. Gerald Schroeder published *Genesis and the Big Bang*. In this book, he claimed to have discovered harmony between modern science and Biblical tradition. The book was regarded in academic circles as an important milestone in the study of the intersection of religion and science.

Subsequently, Dr. Schroeder became an influential figure within the Jewish outreach (*kiruv*) movement. He regularly publishes articles in Jewish magazines, Torah websites host his audio lectures (*shiurim*) and he has presented seminars in a number of countries. He also lectures on behalf of a world-famous outreach organisation. Even though Dr. Schroeder has published a number of books since *Genesis and the Big Bang*, his reputation rests mainly on it.

Since *Genesis and the Big Bang* was published about fifteen years ago, one may wonder whether a critique is needed now. I believe that it is. A key thesis of *Genesis and the Big Bang* is that traditional Jewish teachings can be reconciled with some sort of evolutionary process (see the section entitled *GOD & EVOLUTION* below). Much has happened in the world since the publication of *Genesis and the Big Bang.* Numerous new discoveries have been made since 1994 in a variety of biological fields which are relevant to this discussion. The debate over the teaching of evolution in biology classrooms has become much more acrimonious since 1994. The United States has been convulsed by the debate over introducing supplementary material into classrooms which is critical of the current scientific paradigm. This controversy has not left the Torah world unscathed. In the past few years, a number of books were published which generated furious debate in the Torah community.

This essay was written with this background in mind. It has two major objectives. The first is to serve as a comprehensive critique of *Genesis and the Big Bang*. It is my opinion that Dr. Schroeder presents a distorted picture of the Torah outlook on several issues, particularly biological evolution. I present copious evidence for this below. For the benefit of readers who are able to follow the original sources, I have cited them not only in English translation, but also in the original Hebrew and Aramaic.

In addition to serving as a critique, I believe that this essay constitutes a brief and readable introduction to the religion and science debate in general, and to the Torah and science discussion in particular. Years of experience in teaching this material, as well as correspondence with a broad spectrum of people, have taught me that such an introduction is sorely needed. Among Torah scholars, knowledge of science is often rudimentary. The intersection of Torah and science has long been the unloved stepson of many rabbis, even the small minority who specialise in Jewish philosophy (*השקפה*). Among secular Jewish readers who are attracted to books on science and evolution, knowledge of relevant Torah sources is abysmal. Invariably, these readers are not in a position to critically assess the claims of writers such as Dr. Schroeder. This essay can serve the useful function of introducing interested parties to some of the contentious issues and key sources. It can also serve as a guideline as to the type of questions that should be posed to anyone who makes claims about the intersection of Torah and science.

I tried to make this essay as concise and as simple as possible, for the benefit of the vast majority of readers who are neither scientists nor Torah scholars. Nonetheless, it was imperative to make the critique comprehensive, in order to avoid superficiality.

In order to make this essay accessible to as many people as possible, I have used standard English monikers. Thus, *Maimonides* for Rambam (רמב"ם), *Nahmanides* for Ramban, *Laban* for Lovon (לבן) etc.

THE BIBLE & HEREDITY

On page 142 of *Genesis and the Big Bang*, Dr. Schroeder takes up a fight against Ernst Mayr, one of the greatest biologists of the twentieth century. This is done in the context of a discussion of *Lamarckism*. Jean-Baptiste Lamarck (1744-1829) was a biologist who is credited with the idea that an organism can pass on characteristics that it acquired during its lifetime to its offspring (this process is also known as *heritability of acquired characteristics*). The essence of Lamarckism is that an organism's experiences or behaviour during its lifetime could lead to adaptations which are then inherited by its offspring. The standard example referred to in this context is the neck of the giraffe. According to Lamarckism, giraffes stretching their necks to reach leaves high in trees would strengthen and gradually lengthen their necks. These giraffes would have offspring with slightly longer necks. Extrapolated over eons, the process would result in giraffes possessing the prodigiously long necks we observe them to have. This is how Lamarck himself explained the process[1]:

> The giraffe lives in places where the ground is almost invariably parched and without grass. Obliged to browse upon trees it is continually forced to stretch upwards. This habit maintained over long periods of time by every individual of the race has resulted in the forelibms becoming longer… and he neck so elongated that a giraffe can raise his head to a height of eighteen feet without taking his forelibms off the ground.

Lamarckism is generally discredited today. Modern biologists believe that adaptations are due to genetic mutations (which are then acted upon by natural selection). These mutations are not believed to be influenced by the way an organism lives.

What provoked Dr. Schroeder's ire is Mayr's contention that the Bible supports Lamarckism. This, Mayr says, grew from the fact that it was commonly accepted, until modern times, that the behaviour of organisms (including human beings) could influence the biological characteristics of their offspring.

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[1] Jean Baptiste de Lamarck, *Zoological Philosophy*, translated by H. Elliot (1809; translated and reprinted London: Macmillan, 1914), page 122.

Mayr cites the case of the patriarch Jacob attempting to influence the pigment patterns of the wool of the sheep entrusted to him by his father-in-law, Laban (Genesis 30 and 31). According to the agreement between Jacob and Laban, these unusual sheep would belong to Jacob; those with regular colouring would belong to his father-in-law. Before the agreement was to take effect, Laban removed from the flocks all of the existing sheep with these unusual marks, leaving only those with pure white wool. The Torah relates the strategem used by Jacob to ensure that the sheep would nonetheless bear young with unusual speckled or streaked wool. Just before the mating season, he took branches from a number of types of trees. He peeled the bark off them, and placed them near the watering troughs where the sheep would drink. When the ewes came to the troughs, they were startled by the sight of these peeled rods. The rams then copulated with them. As a result of this strategem, many streaked and speckled sheep were born, enriching Jacob.

Mayr wrote that this description is an outgrowth of the belief in Lamarckism, which was popular in ancient times (long before Lamarck formulated it rigorously). The fact that the ewes *saw* speckled or streaked rods contributed to the fact that they gave birth to speckled or streaked offspring. Dr. Schroeder claims that Ernst Mayr distorted the meaning of the Biblical passage. He writes:

> Regarding the concept of the inheritance of acquired traits, Mayr writes, "It was a universal belief, grounded firmly in folklore (one expression of which was the biblical story of Jacob and the division of striped and speckled livestock)." Mayr interpreted this biblical episode as only a reader having a preconceived notion of the facts could so interpret it.

According to Dr. Schroeder, it was something else altogether. Through fourteen years of observation (while he was tending Laban's sheep as a labourer, prior to their wealth-sharing agreement), Jacob noticed that "within the potential of the white animals was the ability to produce speckled and spotted progeny." Jacob relied on this and trusted that *some* speckled and spotted lambs would be born even within his lily-white flock. But if so, what

was the purpose of the peeled rods? Dr. Schroeder continues (page 143)[2]:

> Nowhere is it stated that the color of the rods affected the color of the offspring. Rashi (on Genesis 30:38) explains the purpose of the rods for those readers not able to catch the subtlety: "When the female animal [bending forward to drink and therefore raising her hind quarters] saw the rods [reflected in the water], she was startled backwards, and the male [standing behind her] copulated with her."… The effect of the rods was to increase the rate of copulation of the selected males with the selected females.

Let us examine Rashi's comment *in its entirety*:

> הבהמה רואה את המקלות והיא נרתעת לאחוריה והזכר רובעה ויולדת כיוצא בו.

> The ewe would see the rods and recoil backwards and the male would copulate with her and it would give birth *in the rod's likeness*.

Rashi, in the part of his commentary omitted by Dr. Schroeder, clearly states that the ewes would give birth to speckled and spotted lambs, in the likeness of the rods to which they were exposed. Now, Rashi rarely provides original explanations in his Torah commentary. Invariably, his comments are culled from the Talmud or midrashim. In this case, his comments are taken verbatim from Midrash Rabbah. For those readers who are not able to catch the subtlety, the classical commentator on the midrash, *Eitz Yosef*, clarifies matters[3]:

> ונרתעת לאחוריה מפחד המקלות והזכר רובעה ויולדת כיוצא בו והיו עקודים וטלואים ממראה המקלות המפוצלות. שעל ידי הרתעתן ממראיתן נשאר המראה בדמיון בעת ההרבעה ועל ידי זה נוצר הולד עקוד וטלוא שהדמיון פועל בעת ההריון…

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[2] The parenthetical comments are in the original.

[3] בראשית רבה, סדר ויצא פרק ע"ג [ל,לג] פירוש עץ יוסף ד"ה ונרתעת לאחוריה.

> The ewe would recoil out of fear of the rods and the ram would copulate with it, and it would subsequently give birth to lambs that were speckled or spotted, as a result of the peeled rods. Because of the recoil which came as a result of the appearance of the rods, the image of the rods remained in their imagination at the time of mating. Through this, the lambs were born spotted or speckled, because the imagination has an effect at the moment of conception…

Immediately after making the comment about the rods quoted above, the midrash proceeds to provide an example of the relevant phenomenon[4]:

> מעשה בכושי אחד שנשא לכושית אחת והוליד ממנה בן לבן. תפס האב לבן ובא לו אצל רבי. אמר לו: שמא אינו בני? אמר לו: היה לך מראות בתוך ביתך?
> אמר לו: הן! אמר לו: שחורה או לבנה? אמר לו לבנה. אמר לו: מיכן, שהיה לך בן לבן.

> There was once an African man who was married to an African woman, and she bore him a white son. The father [suspecting his wife of adultery,] brought his son to Rabbi [Judah the Prince]. He asked the great scholar, "Perhaps he is not my son?" The rabbi asked him, "Did you perhaps have a statue[5] of a person in your home?" The man replied, "Indeed I did!" The rabbi asked him, "Was it a statue of a black man or a white man?" The man replied, "A white man." The rabbi said to him, "That is why you had a white son."

This is by no means the sole instance where the Talmudic tradition mentions the idea that mental images beheld during intercourse influence the appearance of the offspring. Consider, for example, the great Talmudic sage, Rabbi Yochanan[6]. The Talmud records

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[4] מדרש רבה, סדר ויצא פרק ע"ג [ל,לג].

[5] An alternative rendering of *מראות* is *portraits*.

[6] Babylonian Talmud, tractate Bava Metzi'a, page 84a.
מסכת בבא מציעא דף פד.

> רבי יוחנן הוה אזיל ויתיב אשערי טבילה אמר כי סלקן בנות ישראל מטבילת מצוה לפגעו בי כי היכי דלהוו להו בני שפירי כוותי גמירי אורייתא כוותי

that he was exceptionally handsome. He would frequently sit at the entrance to women's bath-houses, where they would immerse in a ritual bath (a *mikveh*) in preparation for resuming marital relations with their husbands after the separation mandated by the Torah as a result of menstruation. His objective? That the women emerging from the bathhouse should gaze at him prior to engaging in marital intimacy and thereby give birth to handsome children.

The primary commentator on these types of Talmudic passages (known as *aggadic* passages) is Rabbi Shmuel Eidels (1555-1632), known as Maharsha. He writes[7]:

> ביאורו כענין המקלות אשר פצל יעקב לפי שהטבע מוליד בהזדקקם לפי הציור בדמיונם בעת הריון כדאיתא במדרשות...
>
> The idea behind Rabbi Yochanan's conduct is the same as the idea behind the rods which Jacob peeled. When intercourse occurs, the image that women have in their minds can have an effect on their offspring, as is explained in various midrashim.

Here is another relevant Talmudic passage[8]:

> מעיקרא חשיבי דרומאי הוו נקטי בליונא דגושפנקא ומשמשי ערסייהו מכאן ואילך מייתו בני ישראל ואסרי בכרעי דפורייהו ומשמשי אמר ליה חד לחבריה הא היכא כתיבא אמר ליה (דברים כח, סא) *גַּם כָּל חֳלִי וְכָל מַכָּה אֲשֶׁר לֹא כָתוּב בְּסֵפֶר הַתּוֹרָה הַזֹּאת*
>
> Before the destruction of the Temple, Roman noblemen would hold signet rings with beautiful human forms engraved on them during intercourse. After the destruction of the Temple, [when Jewish slaves were

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> Rabbi Yochanan would sit at the gates of the *mikveh*. He said, "When Jewish women emerge from immersing, let them encounter me so that [when they resume marital relations and conceive children] the children will be as handsome as I am…"

[7] מהרש"א, חידושי אגדות מסכת בבא מציעא דף פד. ד"ה מסתכלין בי וניהוי להו זרעא דשפירין.

[8] Tractate Gittin 58a.

plentiful] they would bring [handsome] Jewish [prisoners], tie them to the bed and indulge in intercourse…

Rashi[9] explains that the idea here was, once again, to influence the appearance of the child conceived as a result of the intercourse. Even though this Talmudic passage describes the conduct of the Romans, it is clear that the passage reflects the belief of the Talmudic sages that this procedure had some basis in nature. What they loathed is the Romans' vulgarity, not their science.

Ernst Mayr was correct. The rods *were* supposed to influence the appearance of the lambs. In denying this, Dr. Schroeder may have been motivated by righteous indignation. After all, Ernst Mayr was one of the architects of the Neo-Darwinian Synthesis, for whom the Bible was, at best, folk wisdom and at worst, a collection of myths and superstitions. But righteous indignation does not grant one licence to distort the traditional sources.

The Talmudic sages thus accepted that *some* aspects of Lamarckism are true and even applicable to people. This is not to say, however, that Jacob's strategy should be viewed as a completely natural phenomenon. It is clear that it had a miraculous component. Indeed, when Jacob explains his conduct to his wives, he stresses the supernatural component of this episode[10]:

וַיְהִי בְּעֵת יַחֵם הַצֹּאן וָאֶשָּׂא עֵינַי וָאֵרֶא בַּחֲלוֹם וְהִנֵּה הָעַתֻּדִים הָעֹלִים עַל הַצֹּאן עֲקֻדִּים נְקֻדִּים וּבְרֻדִּים וַיֹּאמֶר אֵלַי מַלְאַךְ הָאֱלֹהִים בַּחֲלוֹם יַעֲקֹב וָאֹמַר הִנֵּנִי וַיֹּאמֶר שָׂא נָא עֵינֶיךָ וּרְאֵה כָּל הָעַתֻּדִים הָעֹלִים עַל הַצֹּאן עֲקֻדִּים נְקֻדִּים וּבְרֻדִּים כִּי רָאִיתִי אֵת כָּל אֲשֶׁר לָבָן עֹשֶׂה לָךְ

When the ewes were in heat, I saw in a dream that the rams that mounted the ewes were spotted and speckled. An angel of God told me in the dream, "…All the rams that mount the ewes are spotted and speckled, for I have seen everything that Laban has done to you."

This duality - that Lamarckism is a natural phenomenon, coupled with the fact that the incident with Jacob also involved a

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[9] ד"ה בליוני דגושפנקי.

[10] Genesis 31:10-12.

miraculous component - is emphasised in the commentary of Rabbeinu Bechaye[11]:

> והיה הענין הזה ליעקב דבר חכמה וסוד הטבע מעורב בנס, כי היה ענין טבעי מצד פיצול המקלות, ומצד אחר היה נס גמור שלא היו נולדים כפי האמהות אם שחורים שחורים אם לבנים לבנים. ואם תאמר שציור המקלות לעיני הצאן היה גובר על הטבע הפשוט, מכל מקום שיהיו כולם בגוון המקלות שהוא הציור ואין גם אחד שיהא בגוון האמהות אי אפשר זה בלא נס. וכן אמר יעקב *וֵאלֹהֵי אָבִי הָיָה עִמָּדִי*, בא ללמד כי לולא הנס וסיוע אלהי לא היה הענין נגמר בפיצול המקלות בלבד. וכן אמר עוד *וַיַּצֵּל אֱלֹהִים אֶת מִקְנֵה אֲבִיכֶם וַיִּתֶּן לִי*, יחס הענין לאלהים שעשה עמו להפליא.
>
> This episode was a mixture of the natural and the miraculous. It was a natural event in so far as the peeled rods are concerned. On the other hand, it was completely miraculous in that no lambs were born completely black or completely white… This is indicated by Jacob's words [Genesis 31:5] *And the God of my Father was with me*. Jacob taught us that were it not for the miracle and Divine assistance, the stratagem of the peeled rods by itself would not have sufficed…

Another classical commentator, Malbim, also emphasizes that this episode was a mixture of naturalistic and miraculous elements[12].

I have stressed above that, *contra* Dr. Schroeder, the Talmudic sages certainly accepted *some* form of Lamarckism. This hedging is necessary, because the sages' conception of this phenomenon may well have been different to Lamarck's version. All of the examples cited above – Jacob and the sheep, Rabbi Yochanan sitting at the entrance to the *mikveh*, the conduct of the Romans – revolve around the effect of the mother's imagination at the time of intercourse on the offspring's appearance. Whether this process can be extended to adaptations such as the elongation of giraffes' necks is a different matter. The Talmudic sages did not specify the precise parameters of this phenomenon. Clearly, not every incident of intercourse, whether involving animals or people, can be expected to produce precisely what the female beholds at the time.

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[11] Commentary of Rabbeinu Bechaye (1255-1340 C.E.) to Genesis 30:37.

[12] See his commentary to Genesis 30:38-39.

Ewes do not give birth to lambs with green wool just because they gaze at the grass during mating. One scholar who attempts to shed light on the matter is Rabbi Zvi Chajes (מהר"ץ חיות[13]).

He writes[14]:

> עיין במדרש רבה פרשת ויצא פע"ג. ואל יפתוך המתלוצץ בכזביו שאם ההבטה בשעת חימום וקבלת ההריון ממש יש בו, מדוע לא מצינו שהצאן יהיה להם מראה ירק, כצבע אשר רואים כל היום בשעה שרועים על פני השדה? אכן בזה לעגה לו, כי עיקר הפעולה שעושה אז ההבטה רק מפני שפועל על כח הדמיון ונתפעל רק מדבר זר חדש ונפלא. אבל מענין אשר רואה כל היום לא יעשה פעולה בנפש, ורק דבר מתמיה וחידוש מסבב ענינים החדשים הללו בהולדה.
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> … Why do we not find that sheep have green wool, like the colour of the grass on which they graze all day long? [The answer is that] This phenomenon [i.e. Lamarckism] acts on the imagination, and is activated only by strange, surprising sights. Things that the animal sees all day long do not affect it – only things which are startling.

Whether the explanation is as *per* Rabbi Chajes – that only exceptionally startling and surprising sights induce a Lamarckian phenomenon – or some other explanation, is less important. What *is* important is the fact that Dr. Schroeder omitted the last, crucially relevant part of Rashi's commentary, as well as all of the numerous relevant rabbinical sources[15].

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[13] The acronym for *מורינו הרב רבי צבי הירש חיות*. Rabbi Chajes (1805-1855) was born in Brody, and was for many years the rabbi of Zolkiev. His glosses to the Talmud are printed at the end of each tractate of the Vilna edition. His other writings are collected in *כל כתבי מהר"ץ חיות*.

[14] כל כתבי מהר"ץ חיות, חלק א, עמוד רטז בהערת השוליים.

[15] In this context, it is worthwhile pointing out Dr. Schroeder's criticism of others' research (page 81 of *Genesis and the Big Bang*):

> At times the temptation is to use only the agreeable information and neglect those data that seem to contradict a preconceived notion of the truth.

Another important point in the context of this discussion is Dr. Schroeder's point of departure, which is that the current scientific consensus is unassailable. He therefore assumes that the ruling paradigm, which rejects Lamarckism in favour of the Darwinian view of heredity, must be correct.

But there is mounting scientific evidence that *some* aspects of Lamarckism are true. In January 2009, for example, Newsweek Magazine ran an article about emerging evidence for Lamarckism. Its science correspondent, Sharon Begley, reported that:

> Some water fleas sport a spiny helmet that deters predators; others, with identical DNA sequences, have bare heads. What differs between the two is not their genes but their mothers' experiences. If mom had a run-in with predators, her offspring have helmets, an effect one wag called "bite the mother, fight the daughter." If mom lived her life unthreatened, her offspring have no helmets. Same DNA, different traits. Somehow, the experience of the mother, not only her DNA sequences, has been transmitted to her offspring.

Begley continues by pointing out that this constitutes heresy for Darwinian biologists:

> That gives strict Darwinians heart palpitations, for it reeks of the discredited theory of Jean-Baptiste Lamarck… With the success of Darwin's theory of random variation and natural selection, Lamarck was left on the ash heap of history. But new discoveries of what looks like the inheritance of traits acquired by parents - lab animals as well as people - are forcing biologists to reconsider Lamarckism.

After reviewing the evidence for laboratory mice and other animals, Begley discusses the evidence that some form of Lamarckism is applicable to human beings:

> But preliminary evidence suggests that Lamarckism acts in people, too… Similar to the lab mice, the experience of the parents is visited upon the children and even the grandchildren. If the results hold up, says [Emma] Whitelaw [a researcher at the Queensland Institute of

> Medical Research], "it would signal a paradigm shift in the way we think about the inheritance" of traits.

Similar evidence was reported in February 2009 by *Technology Review*, published by MIT[16]. It describes research published in the *Journal of Neuroscience* and in *Biological Psychiatry*. The MIT report states that,

> The results of both studies are likely to be controversial, perhaps resurrecting a centuries-old debate. "It's very provocative," says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern Medical Center, in Dallas. "It goes back to two schools of thought: Lamarck versus Darwin."… [Lamarckism] was largely abandoned as Darwin's, and later Mendel's, theories took hold. But the concept of Lamarckian inheritance has made a comeback in recent years, as scientists learn more about epigenetics. "I didn't set out to come up with findings that support neo-Lamarckian inheritance," says [David] Sweatt [a neuroscientist at the University of Alabama at Birmingham]. "But the research now makes it more plausible that these things may be real and may be based in molecular mechanisms." … Sweatt and others say that this type of inheritance may in fact be much more common than expected.

In its January 18, 2010 issue, TIME magazine ran a lengthy article about the new field of epigenetics. The article defines epigenetics as the study of changes in gene activity that do not involve alterations to the genetic code but still get passed down to at least one generation. These patterns of gene expression are governed by the cellular material – called the epigenome – that sits on top of the genome (hence the prefix *epi-*, which means *above*). These epigenetic "marks" instruct the genes to switch on or off. It is through epigenetic marks that environmental factors like diet, stress and prenatal nutrition can make an impression on genes that is passed from one generation to the next.

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[16] This is available at:

http://www.technologyreview.com/biomedicine/22061/

The article cites a new book, *The Genius in All of Us*, by science writer David Shenk. Shenk claims that epigenetics is helping usher in a "new paradigm". He calls epigenetics "perhaps the most important discovery in the science of heredity since the gene."

In the next paragraph, the magazine goes on to say that,

> Geneticists are quietly acknowledging that we may have too easily dismissed an early naturalist who anticipated modern epigenetics – and whom Darwinists have long disparaged. Jean-Baptiste Lamarck (1744-1829)… posited that animals acquired certain traits during their lifetimes because of their environment and choices… Lamarckian evolution came to be seen as a scientific blunder. Yet epigenetics is now forcing scientists to re-evaluate Lamarck's ideas.

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As a footnote to the above, let us consider another statement made by Dr. Schroeder while sparring with Ernst Mayr. He writes:

> Jacob is asked by his father-in-law, Laban, to fix the wages he (Jacob) is to get for tending Laban's sheep. Jacob, having been repeatedly cheated by Laban in the past (including Laban's switching brides on the then-naïve Jacob)…

The then-naïve Jacob?!

The Torah describes the first meeting between Jacob and Laban's daughter, Rachel, who was destined to become Jacob's wife years later. This was the first encounter between Jacob and any member of Laban's household. We read (Genesis 29:12):

> וַיַּגֶּד יַעֲקֹב לְרָחֵל כִּי אֲחִי אָבִיהָ הוּא וְכִי בֶן רִבְקָה הוּא וַתָּרָץ וַתַּגֶּד לְאָבִיהָ.

> Jacob told Rachel that he was her father's kinsman, and that he was Rebecca's son. She ran to tell her father.

The term אֲחִי אָבִיהָ, normally translated as *kinsman*, literally means *her father's brother*. The sages of the Talmud saw in the term

brother an indication of Jacob's being *equal* to Laban in some crucial respect. Rashi cited them in his commentary to this passage:

> קרוב לאביה כמו (לעיל יג) *אֲנָשִׁים אַחִים אֲנָחְנוּ*, ומדרשו אם לרמאות הוא בא גם אני אחיו ברמאות ואם אדם כשר הוא גם אני בן רבקה אחותו הכשרה
>
> … If he will attempt to cheat me, I will be his equal in treachery…

From the outset, before Jacob had had any interaction with Laban, he was perfectly aware of Laban's nature. Jacob's mother, Rebecca, was Laban's sister. Jacob knew who he was up against. The Talmudic sages taught that Jacob was so wary of Laban's propensity to lie, that he and Rachel agreed on secret signs, which would prevent Laban from switching brides and depriving Jacob of Rachel. How is it, then, that Laban managed to trick Jacob into marrying Leah? The sages, quoted by Rashi, tell us that in her great compassion for her elder sister, Rachel revealed the secret signs to Leah. On the night of the wedding, Laban switched Leah for Rachel. Being in possession of the secret signs, Leah managed to dupe Jacob into thinking she was her sister. It was not because Jacob was naïve that he was deprived of Rachel.

Furthermore, the source of this information is not some obscure midrash. It is Rashi, commenting on the very passage in question. Furthermore, Rachel's nobility in revealing the secret signs to her sister so as to prevent her humiliation is mentioned in countless traditional sources and held up as the epitome of selflessness.

THE EXPANDING UNIVERSE

Chapter three of *Genesis and the Big Bang* is entitled *Inklings of Expansion*. It is devoted to a comparison of modern cosmology to that described by Nahmanides. This is the thrust of the chapter: Current cosmology envisages the beginning of the universe as a moment in which all the matter/energy which exists today in the universe was packed into an infinitesimal volume, at an infinitely-high temperature. This matter/energy began to expand in an event known as the *Big Bang*, and the universe has expanded ever since. Evidence for this continuing growth comes from observations suggesting that most galaxies are receding from us. Dr. Schroeder states that Nahmanides, relying on the Talmudic sages, made the same claim in his Bible commentary.

For added effect, Dr. Schroeder quotes two leading scientists in their respective disciplines: the late astronomer Carl Sagan, and Steven Weinberg, a Nobel Prize winner in physics[17]. Both emphasize the point that the expanding universe is a modern discovery. Here is how Dr. Schroeder presents their view (pages 59 and 60 of *Genesis and the Big Bang*):

> In the Viewer's Guide to Carl Sagan's *Cosmos* television series, there is an emphatically definitive statement about our knowledge of the very early universe and the universe of today. To quote from the Viewer's Guide: "Without these advances [in astronomy that have revealed that most galaxies are receding from each other], we would not suspect that the universe is expanding…"
>
> Steven Weinberg, in *The First Three Minutes*, made a similarly unequivocal statement. "Our knowledge of the expansion of the universe rests entirely on the fact that astronomers are able to measure the motion of a luminous body in a direction along the line of sight."

Dr. Schroeder then presents the view of Nahmanides who, supposedly, taught that the universe is expanding. Here is one statement (page 61 of *Genesis and the Big Bang*):

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[17] Both Sagan (who is deceased) and Weinberg are Jewish by birth and atheists by persuasion.

> The statements of Weinberg and Sagan… are almost, but not quite, correct… The good news for those who hold by the Judeo-Christian tradition is that mankind's awareness of the expansion is not quite so new as Weinberg and Sagan would have us believe. You see, had they studied the history of cosmological thought contained within texts of their own tradition, they might have modified the "no inkling" statement to read something like: Without the recent advances in astronomy or knowledge contained in Nahmanides's *Commentary on Genesis*, we would have no inkling that our universe is an expanding universe.

And again on page 74:

> It is the Doppler effect that Weinberg was referring to when he stated, "Our knowledge of the expansion of the universe rests entirely on the fact that astronomers are able to measure the motion of a luminous body in a direction along the line of this flight." As we learned, the sages quoted by Nahmanides discussed this "recently discovered" universal expansion more than 2000 years ago!

And again on page 83:

> As we have seen, all the current data point to an ever-expanding universe, as per Nahmanides's presentation of biblical tradition of a thousand years ago.

If all of this were true, it would be interesting. To the naked eye, the sky seems immutable (with the rare exception of comets and supernovae). It takes great scientific sophistication – in terms of both instrumentation and theory – to deduce that the universe is expanding. If Nahmanides - living some eight-hundred years ago - had taught that the universe is constantly expanding, it would be an instance of astonishing prescience.

But it is *not* true that Nahmanides made this claim. Nowhere in his commentary to Genesis does Nahmanides suggest that we live in an ever-expanding universe.

What Nahmanides *does* say is that the universe began as a speck of space. Here are his words[18]:

> והנה בבריאה[19] הזאת שהיא כנקודה קטנה ואין בה ממש נבראו כל הנבראים בשמים ובארץ.
>
> All that was created, in the heavens and the Earth, was created by means of this [initial] creation, which is like a minuscule, insubstantial point.

In the rest of his commentary to Genesis, Nahmanides does not make any reference whatsoever to any expansion.

In a separate essay, Nahmanides writes[20]:

> כי בתחילה האלהים שהוא הבורא בעל כל הכחות, ברא השמים והארץ, רצוני לומר מאפיסה מוחלטת ומאין גמור יש נקודה פחותה מגרגיר חרדל והוא השמים וכל אשר בם, ונקודה אחרת הארץ וכל אשר עליה...
>
> At the outset, God, who is the Creator [and as such] the master of all forces, created the heavens and the Earth.
> That is to say, [He brought into being] from absolute nothingness and total non-existence a substance, a point smaller than a mustard seed, which comprises the heavens an all they contain; and [brought into being] another point [which comprises] the Earth and everything upon it.

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[18] פירוש רמב"ן לפרשת בראשית א,א ד"ה והנה.

[19] The authoritative Chavell edition of Nahmanides' works reads *בריאה* and not *בבריאה*, but this is immaterial to our discussion.

[20] רמב"ן, דרשת *תורת ה' תמימה*, כתבי רמב"ן, רבי חיים דוב שעוועל, הוצאת מוסד הרב קוק.

Nowhere does Nahmanides mention the subsequent expansion of this speck. Of course, since we live in a vast world, it follows that at some point the universe grew from its initial tiny size. But at no point does Nahmanides suggest that the universe *continues* to expand.

In this, Nahmanides was indeed relying on Talmudic traditions. In one form or another, all of these statements make reference to the fact that one of God's names is Shaddai (שדי in Hebrew). The sages see in this name a contraction of two words i.e. **ש**אמר **די** – That God said, "Enough!"

Here is one such statement, from the midrash known as Pirkei D'Rabbi Eliezer[21]:

> שמים מאיזה מקום נבראו? מאור לבושו של הקדוש ברוך הוא שהוא לבוש. לקח ממנו ופרש כשלמה, והיו מותחין והולכין עד שאמר להם די. ועל כן נקרא שמו שדי, שאמר לשמים די ועמדו.
>
> From where were the heavens created? [Answer:] From the light of the garments of God. He took this light and spread it like a cloak, and the heavens stretched and expanded until He told them, "Enough!" That is why He is called Shaddai, because He said to the heavens, "Enough!" and they stopped expanding.

Here is a variant statement, from the Midrash[22]:

> רבי נתן בשם רבי אחא ורבי ברכיה בשם רבי יצחק אמר [בראשית יז, א ובראשית לה, יא] *אֵנִי אֵל שַׁדַּי* אני שאמרתי לשמים וארץ די שאלמלא כן היו מותחין והולכין עד עכשו.
>
> [The meaning of Shaddai, used in the verse (Genesis 17:1 and Genesis 35:11)] *I am El Shaddai* is this: I am the One who said to the heavens and Earth, "Enough!" Had I not done so, they would have continued expanding until now.

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[21] פרקי דרבי אליעזר, פרק ג.

[22] מדרש רבה סדר בראשית פרשה ה, אות ח [א,י].

Here is another variant, from the Talmud[23]:

> ואמר רב יהודה אמר רב בשעה שברא הקב"ה את העולם היה מרחיב והולך כשתי פקעיות של שתי עד שגער בו הקב"ה והעמידו שנאמר [איוב כו, יא] *עַמּוּדֵי שָׁמַיִם יְרוֹפָפוּ וְיִתְמְהוּ מִגַּעֲרָתוֹ* והיינו דאמר ריש לקיש מאי דכתיב *אֲנִי אֵל שַׁדַּי* אני הוא שאמרתי לעולם די.
>
> When God created the world, it expanded and grew like two bundles of thread that unravel. God then scolded the world, and stopped it [from further expanding]. This is hinted to in the verse in Job (26, 11) which states, *"The pillars of heaven tremble and are astonished at His rebuke*." It was to this teaching that Reish Lakish referred when he taught the following: What is the meaning of [God's name in the verse] I am El Shaddai? It refers to the fact that God said to the world, "Enough!"

It is obvious that the Talmudic tradition to which Nahmanides would have appealed, had he actually discussed the expansion of the universe, did not teach that we inhabit an expanding universe. The Talmudic sources emphasize that although initially - during the process of creation – the heavens spread, this was brought to a halt by the Creator.

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Even if Nahmanides *had* taught that we live in an expanding universe, Dr. Schroeder's overall claims would have remained dubious. Pointing out instances of congruence between Biblical tradition and modern science is interesting. However, in order to form a fair perspective on their compatibility, one also has to consider areas of incongruence. By way of analogy, consider the claim that Smith and Jones have almost-identical telephone numbers. If it is then demonstrated that they share the first digit in a ten-digit number, is this adequate as far as the original claim is concerned? What if they differ in the nine other digits?

Dr. Schroeder does not address this question throughout most of *Genesis and the Big Bang*. But in the context of cosmology, especially, there are glaring inconsistencies between the Torah account and current scientific hypotheses. One obvious example is the origin of the Moon.

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[23] מסכת חגיגה דף יב.

Here is a description given in the sixth chapter of Pirkei D'Rabbi Eliezer, a well-known midrash:

> ברביעי חבר שני מאורות הגדולים לא זה גדול מזה ולא זה גדול מזה ושוין בגבהן ובתארן ובאורן...
>
> On the fourth day, He created the two great luminaries [i.e. the Sun and the Moon]. Neither was larger than the other. They were equal in size, appearance and light output…

This is a commonly-found description in the Talmudic literature. Many traditional sources indicate that when they were created, the Sun and the Moon were of equal size. Thereafter, the Moon was diminished.

Needless to say, this is not the view of modern cosmologists. Although several models have been suggested to account for the formation of the Moon, the most popular model is the *Giant Impact Hypothesis*. This involves a Mars-sized object colliding with the Earth. The impact caused the ejection of a vast amount of matter from the Earth, which later coalesced to form the Moon.

Now, Mars is about one-third the size of the Earth. The Moon's volume is about one-fiftieth that of Earth, and the Earth would fit into the Sun 1.3 million times over. It follows that at no time was the Moon anywhere near the size of the Sun, according to scientific sources.

If Nahmanides would have written that we inhabit an ever-expanding universe, would that be sufficient to claim harmony between Biblical tradition and modern science? Why should such a teaching outweigh the obvious inconsistency between the two views regarding the formation of the Moon[24]?

[24] Of course, one could argue that Torah sources about the formation of the Moon are meant allegorically. The onus of proof rests on a person making such a claim to demonstrate a rigorous methodology that would indicate when statements of the sages are meant to be taken literally and when they are not, and to show that the statements about the Moon fall into the latter category.

THE BIBLE & ARCHAEOLOGICAL DATING

One of Dr. Schroeder's main objectives in *Genesis & the Big Bang* is to demonstrate that the six days of creation, as described in the Torah, are equivalent to the fourteen (or so) billion years implied by Big Bang cosmology. Dr. Schroeder devotes a substantial part of *Genesis & the Big Bang* to argue that point. He begins by showing that the apparent chronological inconsistency between Torah sources and contemporary science applies only to the pre-Adam period. To establish this point, Dr. Schroeder turns to archaeology. Now, to reconcile Torah with Biblical archaeology is quite an undertaking[25]. But since Dr. Schroeder merely uses archaeology here to establish a point regarding the Torah's chronology, I will limit my discussion to that aspect.

On page 30 of *Genesis & the Big Bang*, we read:

> Biblical dating is not totally at odds with archaeology. Within the total time span of the biblical calendar, we find no conflicts between its chronology and scientifically established dates for the entire post-Adam period, that is, the 57 centuries since Adam.

In order to make this point, Dr. Schroeder turns to the Biblical verse which describes the invention of metalworking. The verse mentions a metal (*נחושת* in Hebrew), which Dr. Schroeder translates as *bronze*[26].

At this point, it is appropriate to introduce the reader to elementary metallurgy. Copper is an element. By mixing it with other metals, alloys can be formed that have different properties to either copper or the other metal with which it is mixed. Thus, *bronze* is a mixture of copper and tin; *brass* is an alloy of copper and zinc.

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[25] Comments on this issue may be found at:

http://www.dovidgottlieb.com/comments/CommentsGenesisBigBang.htm

[26] In modern Hebrew, *נחושת* means *copper*, but we will avoid the etymological issues here, and accept that *נחושת* is bronze or brass.

Dr. Schroeder then introduces his thesis that there is complete harmony between the Torah and contemporary archaeological chronology. He writes (page 30 of *Genesis & the Big Bang*):

> Among the earliest post-Adam events of the Bible that might appear in archaeological finds is the invention of forged brass tools (Genesis 4:22). In the early Hebrew of the Bible, brass and bronze are denoted by the same word, *nehoshet*. The Bible attributes this development in forging to Tuval-Cain, a son of the biblical figure, Lemach. Archaeologically, we would call the time of Tuval-Cain the early Bronze Age.

When archaeologists speak of the Bronze Age, they are referring to a major turning point in the cultural and technological history of mankind. The ability to fashion utensils, weapons, armour and musical instruments from metals is a major advance over Stone Age man.

By tracing the genealogy of Tuval-Cain, Dr. Schroeder establishes his chronology (page 32 of *Genesis & the Big Bang*):

> … We can place the early Bronze Age at approximately 1350 years after the appearance of Adam, or 4400 years (5750-1350) before the present.

Dr. Schroeder then points to the fact that contemporary archaeology places the Bronze Age at 4400 years before the present (page 33 of *Genesis & the Big Bang*):

> Yet we have seen that the biblical date ascribed to the early Bronze Age… eminently matches the archaeologically established date for this same event. Both the archaeological record *and* the biblical record are valid.

Throughout this exercise, Dr. Schroeder never actually quotes the crucial verse in its entirety. He merely refers to Genesis 4:22 as the source for the Biblical description of the beginning of the Bronze Age.

Let us examine the verse *in its entirety*:

> *וְצִלָּה גַם הִוא יָלְדָה אֶת תּוּבַל קַיִן לֹטֵשׁ כָּל חֹרֵשׁ נְחֹשֶׁת וּבַרְזֶל וַאֲחוֹת תּוּבַל קַיִן נַעֲמָה.*

> *And Zillah, too – she bore Tuval-Cain, who sharpened all cutting implements of bronze **and iron**; the sister of Tuval-Cain was Na'ama.*

In the same breath, the verse mentions not only bronze, but also iron. This is crucial. Ironworking is much more difficult than working with copper and its alloys. That is primarily because copper and its alloys have a much lower melting point than iron. Let us compare them:

METAL	**MELTING POINT (˚C)**
Iron	1538
Copper	1085
Bronze	940

The technology needed to work with copper and its alloys is much simpler to develop and apply than that needed for iron. It is difficult enough to achieve temperatures on the order of 1000˚C with a wood-fired furnace. Achieving temperatures of 1500˚C is fiendishly hard. Consequently, according to modern archaeologists, the Iron Age began much later than the Bronze Age. Whereas the Bronze Age can be said to have begun some 4400 years ago, the Iron Age only began around 3200 years ago.

The bottom line: The fact that the Torah mentions bronze-working cannot be used to establish any archaeological period. In particular, it cannot be taken to be a reference to the Bronze Age, since bronze-working is mentioned in the same breath as ironworking.

ARAMAIC & HEBREW

Page 96 of *Genesis & the Big Bang* sees the introduction of a new chapter, entitled *Evening and Morning*. It is subtitled *Taking Order out of Chaos*. Dr. Schroeder begins with a tantalising quotation. In this case, it is from the Onkelos translation:

> *And God saw everything that He had made and behold it was a unified order. Genesis 1:31, Onkelos translation.*

Dr. Schroeder provides the briefest of introductions to Onkelos on page 18 of *Genesis and the Big Bang*. Here is a little more. The rabbinic literature tells us that he was a Roman nobleman. He became a convert to Judaism, and a disciple of the leading Talmudic sages of the time[27]. Onkelos authored the classic Targum Onkelos (תרגום אונקלוס), the translation of the Torah into Aramaic. *Authored* is not quite accurate. The sages teach that this translation was originally given to Moses at Sinai. If so, why is Onkelos credited with composing it? The Talmud explains that with the passage of time, the fidelity of the translation given at Sinai was eroded, until Onkelos restored it to its pristine state[28]. At any rate, this translation is considered so fundamental that it is incumbent on every male adult Jew to review the weekly portion of the Torah (פרשת השבוע) twice in Hebrew and once with the Onkelos translation. This, and the fact that much of the Talmud is written in Aramaic, makes many Torah-observant Jews familiar with Aramaic.

The gist of this short chapter in *Genesis & the Big Bang* is this: modern cosmology describes the early universe as a seething maelstrom of energy and fundamental particles. This state of the universe is not conducive to life. Life requires stability and continuity - it requires order. The problem, as Dr. Schroeder explains, is that in the universe we currently inhabit, everything

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[27] Tractate Megilla 3a:

> תרגום של תורה אונקלוס הגר אמרו מפי רבי אליעזר ורבי יהושע.
>
> The translation of the Torah was made by the convert Onkelos, who based himself on the teachings of רבי אליעזר and רבי יהושע.

[28] Ibid.

tends towards greater disorder. This is the meaning of the second law of thermodynamics, according to which *entropy*, a mathematical measure of disorder, always increases (in the universe as a whole). How is it, then, that there is substantial order in the universe: long-lived stars, the lattice-like structure of crystals of salt and the pens on my desk all arranged in a neat row? The answer lies in the fact that the fundamental laws of nature – gravity, the weak nuclear force, the strong nuclear force and the electromagnetic force – are able to produce local structure against the backdrop of ultimate disorder. Dr. Schroeder claims that this development from early chaos to subsequent cosmos is alluded to in the Torah, and amplified by classical scholars. He writes (page 103 of *Genesis and the Big Bang*):

> The biblical text describes this localized progression from less order to more order as a flow from evening to morning…

Dr. Schroeder bases this on analysis of the roots of the Hebrew words for evening and morning, which connote disorder and order, respectively. But he also enlists some classical sources to make his point:

> In the first 30 verses of the Bible, Onkelos translated each phrase "and it was good" literally. On the sixth day, at the end of the making of the universe, the literal translation of the Hebrew text states: "and it was very good" (Genesis 1:31). Except for the addition of *very*, the text is identical to the previous phrasing. Onkelos, however, based on an unknown source, made an exceptional, radical and quite extraordinary departure from the trend he had set. In Genesis 1:31, Onkelos interpreted "and it was very good" as "and it was a unified order."

Dr. Schroeder considers this to be a vital part of the Biblical narrative (page 101 of *Genesis and the Big Bang*):

> The author of Genesis thought this flow toward order was sufficiently important and exceptional to emphasize it by the regular repetition: "and there was evening and there was morning."

This point is so important for Dr. Schroeder's argument that he repeats it on page 156:

> In a brilliant insight into the quality of the world present at the close of the six days of Genesis, Onkelos translates the "it was very good" of Genesis 1:31 as "and it was a unified order."

And again on page 165:

> … it appears that "all My goodness" refers not to a quality of God but rather to the very nature of the creation, the exquisitely balanced, or orderly, interrelationships therein, as Onkelos translates Genesis 1:31: "And God saw everything that He had made and behold it was a unified *order*."

Is there substance to this claim? Where the Torah uses the word *מאד* ("… and it was *very* good"), Onkelos uses the Aramaic equivalent *לחדא*. Now, *לחדא* may seem to be related to the Hebrew word *אחד*, which means *one* in Hebrew. So perhaps Dr. Schroeder feels justified in translating it as *a unified order*, and with crediting Onkelos with a brilliant cosmological insight. But the fact that words have a similar spelling and are almost homonyms does not mean that they are linguistically related. *Ought* sounds like *bought*, and their spelling is nearly identical, yet their meaning is very different.

This is how Onkelos translates the thirty-first verse in the Torah:

> וחזא ה' ית כל דעבד והא תקין **לחדא** והוה רמש והוה צפר יום שתיתאי.

The key word is לחדא[29], which I have underlined and written in bold. This is Onkelos' choice for the word *מאד* in the original

[29] In one respect, Dr. Schroeder is correct. Onkelos *did* depart from the trend he had set. Up to the thirty-first verse of the Torah, he translated the Hebrew word *טוב* (good) as *טב* (which is virtually identical to the Hebrew). Here, though, he chose to translate is as *תקין*. This means *fixed* or *established*. This captures the idea, implicit in the verse, that the creation was finished at the end of the six-day period. He does so elsewhere too. Genesis 2:18 reads:

> ויאמר ה' אלהים לא טוב היות האדם לבדו אעשה לו עזר כנגדו

Hebrew. Let us compare this instance of the occurrence of the Hebrew word *מאד* with the next four times it occurs in Genesis.

Genesis 4:5

Hebrew: וְאֶל קַיִן וְאֶל מִנְחָתוֹ לֹא שָׁעָה וַיִּחַר לְקַיִן **מְאֹד** וַיִּפְּלוּ פָּנָיו.

Aramaic: ובקין ובקורבניה לא הות רעווא ותקיף לקין **לחדא** ואתכבישו אפוהי.

English: But to Cain and to his offering He did not turn. And Cain was **very** upset, and his countenance fell.

Genesis 7:18

Hebrew: וַיִּגְבְּרוּ הַמַּיִם וַיִּרְבּוּ **מְאֹד** עַל הָאָרֶץ וַתֵּלֶךְ הַתֵּבָה עַל פְּנֵי הַמָּיִם.

Aramaic: ותקיפו מיא וסגיאו **לחדא** על ארעא ומהלכא תיבתא על אפי מיא.

English: And the waters prevailed, and increased **very** much upon the Earth; and the ark went upon the face of the waters.

Genesis 7:19

Hebrew: וְהַמַּיִם גָּבְרוּ **מְאֹד מְאֹד** עַל הָאָרֶץ וַיְכֻסּוּ כָּל הֶהָרִים הַגְּבֹהִים אֲשֶׁר תַּחַת כָּל הַשָּׁמָיִם.

Aramaic: ומיא תקיפו **לחדא לחדא** על ארעא ואתחפיאו כל טוריא רמיא דתחות כל שמיא.

English: And the waters prevailed **very very** much upon the Earth; and all the high mountains that were under the whole heaven were covered.

God said, "Man's being alone is not good; I will make him a helper corresponding to him."

In translating the word *good* (טוב) in this verse, Onkelos uses *תקין* as opposed to the more usual *טב*. Although these changes are interesting, they have nothing to do with Dr. Schroeder's claim that Onkelos translated anything as *a unified order*.

Genesis 12:14

Hebrew: וַיְהִי כְּבוֹא אַבְרָם מִצְרָיְמָה וַיִּרְאוּ הַמִּצְרִים אֶת הָאִשָּׁה כִּי יָפָה הִוא **מְאֹד**.

Aramaic: והוה כד עאל אברם למצריים וחזו מצראי ית איתתא ארי שפירא היא **לחדא**.

English: And it came to pass, that when Abram came into Egypt, the Egyptians saw the woman that she was **very** beautiful.

This (tedious) process could be extended for all the numerous occurrences of the word *מאד* in the Torah. I have done so for some of the occurrences of *מאד* in Genesis[30].

The bottom line: *מאד* always means *very*, and Onkelos always translates it as *לחדא*. The thirty-first verse of the Torah reads *And God saw everything that He had made and behold it was very good*. This is true in Hebrew, English and Aramaic. There is no justification whatsoever in translating *לחדא* as *a unified order*. Furthermore, the word *מאד* is a commonly-found word in the Book of Genesis. No argument can be made that it is a rare word whose meaning is obscure and warrants an adventurous translation.

[30] See APPENDIX 1.

ADAM & HOMINIDS

Dr. Schroeder claims that *In the time of Adam, there coexisted animals that appeared as humans in shape and also in intelligence but lacked the "image" that makes man uniquely different from other animals, being as the "'image" of God.* (*Genesis and the Big Bang*, page 151). This is supposedly based on a statement from *Guide for the Perplexed* by Maimonides. Dr. Schroeder presents this as evidence for the existence of hominids that preceded Adam, consistent with the current scientific paradigm about the origins of humanity.

Writing for a general audience, Dr. Schroeder does not provide the Hebrew text. Here is the relevant passage, together with a literal translation[31]:

> ילד. הענין המובן מזאת המלה ידוע והוא הלידה... ואחר הושאלה זאת המלה להמצאת הדברים הטבעיים [תהלים צ, ב] *בְּטֶרֶם הָרִים יֻלָּדוּ* והושאלה גם כן לענין הצמחת הארץ מה שתצמיח... [ישעיהו נה, י] *וְהוֹלִידָהּ וְהִצְמִיחָהּ*... והושאלה עוד לחידושי הזמן כאלו הם ענינים יולדו [משלי כז, א] *כִּי לֹא תֵדַע מַה יֵּלֶד יוֹם* והושאלה עוד לחידושי המחשבות ... כמו שאמר [תהלים ז, טו] *וְיֵלֶד שָׁקֶר*... ועל זה הענין נקראו תלמידי הנביאים [מלכים ב, פרק ב, ג] *וַיֵּצְאוּ בְנֵי הַנְּבִיאִים*... ובזאת ההשאלה נאמר באדם [בראשית ה, ג] *וַיְחִי אָדָם שְׁלֹשִׁים וּמְאַת שָׁנָה וַיּוֹלֶד בִּדְמוּתוֹ כְצַלְמוֹ*... וכל מי שקדמו לו מן הבנים לא הגיעה אליהם הצורה האנושית באמת... אמנם שת כאשר למדהו והבינהו ונמצא שלם השלימות האנושי אמר בו *וַיּוֹלֶד בִּדְמוּתוֹ כְצַלְמוֹ*...
>
> [Maimonides is analysing the root ילד, which literally means *to give birth*]. The literal meaning of the word is well-known i.e. birth… It is used figuratively to describe the creation of physical entities, as in [Psalms 90, 2] *Before the mountains were born*. It is also used figuratively to describe the concept of plant growth, as in [Isaiah 55, 10] *For as the rain cometh down… [to] water the earth and make it bring forth*[32]*…* The term is further used figuratively to describe novel events, as if they were

[31] Maimonides, *Guide for the Perplexed*, part I chapter 7.

[32] In this and the following examples, *bring forth* is the English expression that corresponds to the Hebrew root ילד, literally, *to give birth*.

> concepts that are born, as in [Proverbs 27, 1] *… for you know not what a day may bring forth*. It is furthermore used figuratively to describe novel thoughts, as in [Psalms 7, 15] *… he conceives mischief, and brings forth falsehood*. It is in this vein that the disciples of the prophets were referred to as the sons of the prophets, as in [II Kings chapter 2, 3] *And the sons of the prophets that were at Beth-el came forth to Elisha*[33]... It is in this vein that the Torah states that *Adam lived a hundred and thirty years, and begot a son in his own likeness after his image*… His previous sons[34] did not achieve the human ideal… but when he taught and trained Seth (שת), who attained human perfection, it is described as *He had a son in his own likeness after his image*…

It is obvious to anyone who reads the entire passage *in context* that there is nothing whatsoever in this statement of Maimonides that suggests that *In the time of Adam, there coexisted animals that appeared as humans in shape and also in intelligence but lacked the "image" that makes man uniquely different from other animals, being as the "'image" of God.* This passage has *nothing to do* with literal birth. Maimonides argues that the root ילד is to be understood here in the sense of *training one's children* or *raising and educating one's children*. That is why he invokes the example of the prophets' sons. There, too, *Sons of prophets* does not connote a biological relationship. It connotes a process of training one's protégé. Maimonides argues that the root ילד is used here by the Torah in the sense of *produce a perfected human being through proper education*. His point is that until the birth of Seth (שת), Adam had failed to train his existing children properly and to bring them up as perfected human beings. Thus, Adam begot all of his children – before and after Seth – in the same biological manner. They were all equally members of the human species. It was their moral character that set them apart.

This usage, in which we refer to refined and noble people as *human beings* and to evildoers as *beasts*, is common even in English. When we read of people who commit heinous crimes we

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[33] In other words, the disciples of the prophets were not literally their sons. Since the prophets trained them, however, they are described as having given birth to them since they figuratively brought them forth.

[34] Cain and Abel.

often react by reference to *those beasts*. That does not imply that we believe that there is a biological process that distinguishes criminals from lawful citizens. We also use the term *produce* (equivalent to the way we use the Hebrew verb ילד) in ways which are not meant literally: *The meeting produced a whole lot of hot air*. We do not mean that a process has occurred which could be recorded by a thermometer.

It is precisely in this way that all the classical commentaries understand this passage in *The Guide*. There are four classical commentaries that have been printed together with *The Guide* for centuries. They are the commentaries of Abarbanel, Efodi[35], Shem Tov[36] and Crescas[37]. *All* concur with this explanation.

Let me quote extensively from Shem Tov on this passage:

> ילד. ואמר על זה הענין מי שמלמד ענין לאיש אחד והועילהו דעת כאילו הולידו האיש ההוא. ובא הרמז בזה כי כל אחד מהאנשים אשר הולידו בנים ובנות לא לבד הולידום הולדה גשמית אבל הולידום שנתנו להם דעות אמתיות ולמדום עד שהוציאו נפשם מן הכח אל הפועל...
>
> Maimonides comments on the term ילד by saying that whoever *teaches* someone something is considered [figuratively] to have begotten him. When people have children, they do not only physically beget them, but they also figuratively beget them by imbuing them with correct beliefs and teaching them so that they will reach their true potential.

[35] This is the moniker for רבי יצחק בן משה הלוי (late 14th-early 15th century C.E.). *Efodi* (אפודי) derives from one his books, *מעשה אפוד*.

[36] Shem Tov (שם טוב בן יוסף אבן פלקירה) was active in Spain (circa. 1225-1295 C.E.) and wrote numerous philosophical treatises.

[37] This commentary was authored by אשר בר רבי אברהם קרשקש.

Shem Tov continues:

> והוא אשר ביארו בשת כי אמר הרב כל מה שקדמו לו מהבנים לא הגיעה אליהם הצורה האנושית באמת; אמנם שת כאשר למדהו ונמצא שלם השלמות האנושית אז אמר בו *וַיּוֹלֶד בִּדְמוּתוֹ כְּצַלְמוֹ* ויהיה אמרו בשת ויולד בן רצונו לומר כשהאדם נטה לדברים השכליים והוציא שכלו מן הכח אל הפועל... אז הולידה צורתו הטבעית הראוי לה והוא קיום המושכל, אבל קודם לכן כשהיה נוטה שכלו... בדעות הנפסדות אז הבנים ההם שהיה מוליד לא היו כדמותו וצלמו אבל הם שדים ורוחות...
>
> This is what the sages explain regarding Seth. Maimonides explains that the children that Adam had before him [i.e. Cain and Abel, and the others described by the sages as demons etc.] were not really perfected human beings [*mentchen*]. In contrast, when Adam educated Seth properly and the latter fulfilled his human potential, then the verse says about him that *He begat a son in his own likeness and image*. The Torah refers to begetting a son when the son is inclined towards the pursuit of truth and fully utilises his potential… Beforehand, when his mind was engaged in false beliefs, the children that Adam had were not considered to be in his image and likeness. The sages refer to such children as demons and spirits.

According to Maimonides, the Torah uses terminology which is remarkably familiar to us. We too speak of a *mentch*, literally a human being; people who commit horrible crimes are labelled *demons*. This has nothing whatsoever to do with biology, and certainly not with any kind of evolutionary process whereby hominids eventually attain a Divine spark. These are terms that are used figuratively to describe a moral development which comes about as a result of training and education.

Shem Tov continues:

> וזה שאמרו רז"ל כל אותם הימים שהיה נזוף אדם הראשון היה מוליד רוחות ושדים כי לא היה עושה הענין השכלי אבל היה נוטה אל הדעות הכוזבות ואל הדעות המגונות. ומה הפליג באמרו כי מי שלא הגיע לו זאת הצורה... אינו איש אלא בהמה על צורת איש ותבניתו אלא שהוא יותר רע מהבהמה למה שיש לו היכולת במיני ההיזק והרעות יותר ממיני שאר בעלי החיים והסבה בזה כי האריה והדב

אם לא יפגע אדם בהם לא יעשו רע כי אין להם יכולת ולא מחשבה והשתדלות אבל האדם שאין לו חכמה ודעת ויראת ה' הוא יותר רע מחיות היער... ולכן היו כל הבנים אשר קדמו לשת שדים ורוחות וטפשים.

This is what the sages meant when they said[38] that throughout the years that Adam was estranged from God [because of his sin] he begat demons and spirits. [This is not meant literally. Rather,] it means that he did not utilise his human potential, but rather occupied himself with distasteful beliefs. Maimonides emphasizes this point by saying that a person who does not reach his full potential is not a human being, but rather a beast in human guise. In fact, he is worse than a beast, since his capacity to harm others is far greater than that of any animal. The reason is that lions and bears do not harm man if he does not threaten them, because they are not capable of thought, but an [evil] human being who lacks wisdom and fear of God is worse than the beast of the forest… That is why the children who preceded Seth were [described] as demons and spirits and oafs.

Once again, this has nothing remotely to do with any biological process. Have you ever heard someone saying about a heinous criminal that *he is a two-legged beast*? That *he is worse than an animal*? These are commonly-used expressions, and Maimonides argues that it is precisely in this tone that the Torah expresses itself regarding Cain and Abel, when it says that only when Seth was born did Adam have progeny that was in his likeness and image.

[38] This is a paraphrase of the following comment of the sages (Tractate Eruvin 18a):

ואמר רבי ירמיה בן אלעזר כל אותן השנים שהיה אדם הראשון בנידוי הוליד רוחין ושידין ולילין.

Throughout those [one-hundred and thirty] years when Adam was ostracised by God [because of his sin], he begat demons, spirits and Lillith-like creatures.

Abarbanel, too, explains Maimonides in this vein. He writes:

> ... ירצה שמה שאמר כשדים הוא נאמר על האנשים הרעים שידמו לאדם... ומהם רשעים פועלי הרעות ואותם קראו חז"ל שדים ומזיקים שהם אשר יעשו הרע... ולכן אמר הרב וכן בני אדם הקודמים לשת, רמז לקין והבל... והנה הביא מאמר המדרש כל אותם מאה ושלשים שנה שהיה אדם נזוף בהם היה מוליד רוחות והם הדברים שאין בהם ממש... ואני אחשוב שכוונתו שאדם למד והשכילו ולכן אמר שהולידו.
>
> It means that when the terms *demons* is used, it is a metaphor for evil people… The sages refer to them as demons and agents of harm who create evil… Therefore Maimonides said that the sons of Adam who preceded Seth, namely Cain and Abel… Maimonides cited the midrash that says that throughout the one-hundred-and-thirty years when Adam was estranged from God, he begat spirits i.e. empty things… what he means is that when Adam taught Seth it is described as giving birth [in his image and likeness].

CONFLICTS BETWEEN THE BIBLE & SCIENCE

On page 27 of *Genesis and the Big Bang*, Dr. Schroeder introduces a new chapter. It opens with a number of quotations, one of which is supposedly from Maimonides' *Guide for the Perplexed*:

> Conflicts between science and religion result from misinterpretations of the Bible.

As is the case numerous times in *Genesis and the Big Bang*, the author provides only vague references, such as "*The Guide for the Perplexed*". He does not cite any specific passage within *The Guide*. In *this* case, it would have been impossible to cite a specific statement of Maimonides, for Maimonides never made such a statement.

Much of the *Guide for the Perplexed* is concerned with Aristotelian philosophy. Maimonides was an admirer of Aristotle, to be sure. But he was first and foremost a Torah scholar. This means that he subscribed to certain core Torah beliefs. Below I will explain

Maimonides' position, and then analyse a key passage in the *Guide for the Perplexed* in order to substantiate this.

Maimonides' position was that with regard to certain verses, it is not immediately apparent whether a literal interpretation is sufficient, or whether a figurative translation is warranted. These are the factors which need to be taken into consideration:

1. Does a particular interpretation of the verses cause the Torah to be uprooted, in the sense that it demolishes core Torah principles and the received tradition? If so, we cannot interpret the verses in that way, even though, as far as exegesis is concerned, one could easily conjure an alternative interpretation.

2. Is there incontrovertible scientific evidence which contradicts a particular interpretation of a verse? *Subject to the first factor*, this would lead us to consider an alternative interpretation.

This position is radically different than Dr. Schroeder's claim. The key example, examined below, is the concept of the creation of the universe at a specific point. Aristotle taught that the universe had never been created; it was eternal (this was the position of the entire scientific community in modern times until the Big Bang model of cosmology was adopted in the mid 1960s). Maimonides argued that an eternal universe is incompatible with core Torah beliefs, and therefore cannot be accepted. This is true even though, as far as the exegetical aspects of the matter are concerned, we could easily have read the verses of Genesis to accommodate an eternal universe.

Let us now examine the key passage in the *Guide for the Perplexed*[39]. Maimonides contrasts two notions: God's corporeality[40] and the eternity of the universe:

> דע, שאין בריחתנו מלסבור קדמות העולם מחמת הכתוב אשר נאמר בתורה שהעולם מחודש, לפי שאין הכתובים המורים על חידוש העולם יותר מן הכתובים המורים על היות האלוה גוף.

[39] Maimonides, *Guide for the Perplexed*, part II, chapter 25.

[40] Numerous verses speak of God's eyes, hands, ears and similar terms.

> Our insistence that the universe has not existed forever is not due to the fact that the verses of Genesis cannot be read in any other way. The verses are no more explicit about the creation in time of the universe than those that indicate that God is corporeal, [and which we nonetheless understand figuratively].

Maimonides now explains that as far as exegesis is concerned, we could easily have read the first verses of Genesis in a way consistent with the notion of a universe which has always existed:

> וגם אין דרכי הביאור נעולים בפנינו ולא נמנעים ממנו בעניין חידוש העולם. אלא יכולים היינו לבאר אותם כדרך שעשינו בשלילת הגשמות, ויתכן שזה היה יותר קל בהרבה, והייתה לנו יכולת רבה לבאר אותם הכתובים ונקיים קדמות העולם, כדרך שביארנו הכתובים ושללנו היותו יתעלה גוף.

> The gates of interpretation are not locked. We could have interpreted the verses of Genesis [to indicate an eternal universe], as we did when we interpreted verses that describe God in corporeal terms in a figurative way. This may even be easier to accomplish in this case. We could have explained the verses of Genesis figuratively, as referring to an eternal universe. We did as much in the case of verses about God's corporeality, which we interpreted figuratively so as to totally negate any implication of God's physicality.

Maimonides now explains why there is a difference between the two cases. In the case of God's corporeality, we completely reject a literal understanding of the verses. We insist that the verses are to be understood figuratively. On the other hand, when it comes to the creation of the universe, we are not at liberty to interpret the verses figuratively.

They *must* be read literally to indicate that the universe was created in time:

> ואשר הביא אותנו שלא נעשה כן ולא נסבור כן הם שתי סיבות: האחת כי זה שאין האלוה גוף - הוכח וחובה בהחלט לבאר כל מה שפשטו נגד ההוכחה ויוודע שיש לו ביאור בהחלט וקדמות העולם לא הוכחה ולכן אין ראוי לדחות את הכתובים ולבארם למען הכרעת השקפה אשר אפשר להכריע הפכה בסוגי הכרעה רבים. זוהי סיבה אחת.
> והסיבה השניה כי סברתנו שאין האלוה גוף, אינו סותר לנו מאומה מיסודות התורה, ואינו מכחיש דברי שום נביא, ואין בו אלא מה שמדמים הסכלים שיש בכך נגד הכתוב ואינו נגדו כמו שביארנו, אלא הוא כוונת הכתוב. אבל סברת הקדמות כפי האופן הנראה לאריסטו, שהוא על דרך החיוב, ולא ישתנה טבע כלל ואין דבר יוצא ממנהגו, הרי זה סותר את התורה מעיקרה, ומכחיש את כל הניסים בהחלט, ומבטל כל התקוות שהבטיחה בהן התורה או הפחידה מהן.
>
> There are two reasons for this: The first is that God's incorporeality is established beyond any doubt; in contrast, the eternity of the universe has not been definitively proven [by scientists or philosophers]. It is therefore not appropriate to interpret the verses literally. The second reason is that our notion that God is incorporeal does not undermine any of the fundamental tenets of the Torah; nor does it contradict any of the words of any prophet. In contrast, if we were to accept Aristotle's notion that the universe has always existed, this would completely uproot the Torah and render it obsolete.

Maimonides' position is clear. Verses which lend themselves to a number of interpretations may be taken figuratively if there is incontrovertible (scientific) evidence against the literal interpretation. *But any interpretation of verses which demolishes core tenets of the Torah is rejected without reservation*. This is true even if philosophers [read *scientists*] accept notions which are consistent with a figurative reading of the relevant verses. Maimonides' own explicit declarations show that he held there

were inherent conflicts between the Torah and the science of his day. To claim that Maimonides subscribes to the view that *Conflicts between science and religion result from misinterpretations of the Bible,* as Dr. Schroeder does, is inconsistent with the facts.

I am not the first person to point this out. This issue was dealt with by David Klinghoffer[41] in a March 2008 article entitled *The Return of the Aristotelian Repressed*. Here are the relevant paragraphs:

> A few years ago in *The New Republic*, literary editor Leon Wieseltier tried to enlist Maimonides as a premature evolutionist. Wieseltier… pointed out that in "The Guide of the Perplexed," Maimonides rejected the literal interpretation of Scripture when scientific knowledge makes such an interpretation untenable.
>
> About that last point, Wieseltier was right. But Maimonides taught it in a particular context, that of a conflict between biblical faith and the philosophy of the Aristotelian school. Proponents of the latter, secular tradition believed the universe to be eternal and thus without a beginning…
>
> Maimonides replied to the Aristotleans that on this point, he rejected their opinion. As he explained, that was for two reasons. First, as a scientific proposition, it was not proven. Second, it would make nonsense of the Torah as a philosophical and religious doctrine, because it would make God superfluous[42]: "If the philosophers were to succeed in demonstrating [the universe's] eternity as Aristotle understands it, the Torah as a whole would become void."[43]

[41] Klinghoffer is an author and fellow of Discovery Institute.

[42] This is not quite correct. Maimonides rejected Aristotelian eternity because it voids reward and punishment, not because it makes God superfluous.

[43] See APPENDIX 2 for further relevant points made by Rabbi Dr. Dovid Gottlieb.

THE BIBLE & STRING THEORY

The central thesis of *Genesis and the Big Bang* is that traditional sources – the Talmud, midrashim and medieval commentators (*ראשונים*) - provide a view of the cosmos which is strikingly in agreement with modern scientific observation and hypothesis. Hence, the subtitle of the book – *The Discovery of Harmony between Modern Science and the Bible*. But Dr. Schroeder never ponders the possibility – and consequences – of contemporary scientific theories turning out to be wrong. If you claim congruence between Torah sources and scientific theories, and those theories are eventually rejected, what are the implications for the Torah?

Here is a key example. On page 59 of *Genesis and the Big Bang*, Dr. Schroeder tells his readers that traditional Torah sources presaged String Theory:

> To form the universe, God chose from the infinite realm of the Divine, ten dimensions or aspects and relegated them to be held within the universe. These dimensions are hinted at in the ten repetitions of the statements "and God said…" used in the opening chapter of Genesis. The cabalists believed that only four of the ten dimensions are physically measurable within today's world. The other six contracted into submicroscopic dimensions during the six days of Genesis…
>
> With an amazing congruity, particle physicists now talk of the String Theory, a unified description of our universe in ten dimensions… These dimensions according to the physicists are the four that we know, length, width, height and time, plus six others. These six are contracted into a size far too tiny ever to be observed even by the best of microscopes…

Let us begin with the fact that Dr. Schroeder does not provide a source for this claim. It's just "The cabalists believed…" There are several such unsubstantiated claims made in *Genesis and the Big Bang*:

On page 13 of *Genesis and the Big Bang*:

> The terms for water, darkness, wind, heavens and earth as used in the first ten verses of Genesis have meanings that are quite different when used later on in the Bible[44].

On page 63:

> Both [Science and theology] propose that if matter was present, it was present in minuscule amounts relative to the quantity of energy present.

And on page 89:

> Both the Talmud and cosmology acknowledge that this first "light" was of a nature so powerful that it would not have been visible by humans.

None of these claims merit so much as a vague indication concerning where the sages of the Talmud supposedly expressed such opinions.

Other citations leave much to be desired. On page 58 of *Genesis and the Big Bang*, Dr. Schroeder writes:

> In the thirteenth century, Nahmanides quoted a commentary on Genesis written 600 years before him, noting that prior to the existence of the universe, time did not exist.

Dr. Schroeder refers the reader to Nahmanides' *Commentary on the Torah*, Genesis 1:4,5. Perusal of his commentary reveals that Nahmanides (1194-1270) refers to two commentaries by name: Rashi (1040-1105) and Ibn Ezra[45] (1092-1167). He also makes reference to *some commentators*. Later authorities explain that

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[44] Nahmanides (in his commentary to Genesis 1:4) writes that the darkness mentioned in verse 4 is not the same as the darkness mentioned earlier:

וַיַּבְדֵּל אֱלֹהִים בֵּין הָאוֹר וּבֵין הַחֹשֶׁךְ. איננו החשך הנזכר בפסוק הראשון שהוא האש, אבל הוא אפיסת האור, כי נתן אלהים מדה לאור, ושיהיה נעדר אחר כן עד שובו.

I have not found any other instances where Dr. Schroeder's contention would be justified.

[45] Nahmanides refers to Rashi as *Rabbi Shlomo* (רבי שלמה) and to Ibn Ezra as *Rabbi Abraham* (רבי אברהם).

Nahmanides meant Rabbi Yehuda HaLevy (ca. 1075-1140) and Maimonides (1135-1204).

These are all commentators to whom Nahmanides often refers in his commentary. They all belong to the era of the medieval authorities (*ראשונים*) who lived circa 1000-1400 C.E. There is no basis for the statement that *in the thirteenth century, Nahmanides quoted a commentary on Genesis written 600 years before him*.

More serious is the following statement (page 49 of *Genesis and the Big Bang*):

> Biblical commentators such as Maimonides and Rashi expounded traditions that God created and destroyed many worlds during the process of establishing life on Earth.

When reading the words *Maimonides… expounded traditions that God created and destroyed many worlds during the process of establishing life on Earth*, the reader is left with the distinct impression that Maimonides supported these sentiments. But Maimonides rejected the idea expressed in this *מדרש* with words that possibly rank as the most vehement in his writings regarding a statement of the sages[46]:

> מה שאתה מוצא מפורש בדבריהם של כמה חכמים שקבעו שהיה זמן נמצא לפני בריאת העולם - זה מוקשה מאוד. כי זאת היא דעתו של אריסטו, שאותה הבהרתי לך. הוא חושב שאין להעלות על הדעת תחילה לזמן. וזה מגונה... לכן אמרו כלשון הזה... אמר רבי אבהו מכאן שהיה הקב"ה בורא עולמות ומחריבן. זה יותר מגונה מן הראשון. ואתה תתבונן מה היה קשה לשניהם, והוא מציאות זמן לפני מציאות השמש הזאת. בקרוב יוסבר לך פתרון למה שהיה קשה לשני אלה, אלא אם כן שני אלה רוצים להגיד שאי-אפשר בלי סדר זמנים מעולם. זאת היא האמונה בקדמות, וכל בן-תורה ייזהר מזאת... ובסיכומו של דבר, אל תביט במקומות אלה אל דברי האומרים. כבר הודעתיך שיסוד התורה כולה שהאל הביא לידי מציאות את העולם לא מִדָּבָר, לא בראשית זמנית, אלא הזמן נברא, מכיוון שהוא תולדה של תנועת הגלגל, והגלגל נברא
>
> The statements of some sages that time existed before the Creation is extremely difficult. This is Aristotle's opinion – that time was never created. This is repugnant.

[46] Maimonides, *Guide for the Perplexed* part II chapter 30.

> Rabbi Abahu expressed it thus, "God created worlds and destroyed them." And this statement is even more repugnant than the first opinion… In summary, do not pay attention to these statements.

Let us now return to our discussion of String Theory. Dr. Schroeder leaves his lay audience with the distinct - and unjustified – impression that String Theory is so well established that one simply *must* find a way to reconcile Torah sources with its tenets. This is not so.

String Theory is highly controversial, entirely theoretical (for the foreseeable future, it will not be possible to test its predictions, since that would require particle accelerators orders of magnitude larger than anything available), and of dubious usefulness to physics. In its 14th August 2006 edition, TIME Magazine published an article entitled *The Unravelling of String Theory*. The magazine's science writer, Michael Lemonick, points out that despite its initial popularity, it has accumulated many detractors:

> *Not Even Wrong*, by Columbia University mathematician Peter Woit, and *The Trouble with Physics*, by Lee Smolin at the Perimeter Institute for Theoretical Physics in Waterloo, Ontario, both argue that string theory (or superstring theory, as it is also known) is largely a fad propped up by practitioners who tend to be arrogantly dismissive of anyone who dare suggest that the emperor has no clothes.

Lemonick proceeds to describe some of the problems with String Theory:

> The mathematics is excruciatingly tough, and when problems arise, the solutions often introduce yet another layer of complexity. Indeed, one of the theory's proponents calls the latest of many string-theory refinements "a Rube Goldberg contraption."

TIME is not the only publication to highlight the trouble with String Theory. *USA Today* ran an article entitled *Hanging on by a thread*. *Nature*, perhaps the world's most prestigious science magazine,

published *Theorists snap over string pieces*[47]. In an article dated 1st June 2009 and entitled *What string theory is really good for*, *New Scientist* reporter Jessica Griggs writes,

> The critical voices have in the meantime been getting more strident. They complain about string theory's weird, unverifiable predictions - for instance, that space-time has any number of dimensions[48], usually 10, rather than the three of space and one of time we see. Folding 10 dimensions down to four can be done in a mind-boggling 10^{500} ways, with no way of saying which of them corresponds to how our universe does it. As if that weren't enough, the energies needed to create the tiny strings the theory is woven from make them impossible to detect. To its detractors, string theory is long on mathematical elegance, but woefully short on real-world relevance.

Dr. Schroeder writes for the lay public, whose knowledge of science is usually rudimentary. These readers are in no position to know that among mathematicians and physicists, scepticism of String Theory runs high. But this point is obvious to those who specialise in the intersection of religion and science. One of the most prominent of these specialists is Ian Barbour[49]. Barbour, now retired from academic life, was professor of physics and religion at Carleton College in Northfield, Minnesota, and a pre-eminent figure in the field of science and religion. He was awarded the Templeton Prize in 1999. This is the most important prize in the field of science and religion. He begins by reviewing Dr. Schroeder's approach:

> Schroeder holds that other scientific facts can be found in later rabbinic writings. He describes in detail the commentary on Genesis by the thirteenth-century kabbalist Nahmanides… Nahmanides also said that there

[47] From an article by the physicist Sean Carroll in *New Scientist*, 19th May 2007.

[48] Dr. Schroeder conveniently refers to the version of String Theory that requires ten dimensions. But other versions require eleven or twenty-six dimensions.

[49] Ian Barbour, *When Science Meets Religion*, HarperSanFrancisco, 2000, page 46.

> were ten principles or dimensions of reality corresponding to the ten times that the phrase "and God said" is repeated in Genesis. Schroeder claims that this has been confirmed in a remarkable way by recent superstring theory, which (as we saw) postulates ten initial dimensions…

Barbour proceeds to demonstrate the weakness of this argument:

> Moreover, the use of superstring theory seems to me particularly dubious because it is highly abstract and speculative and cannot be tested experimentally at energies available in any existing or projected particle accelerator…

Let us see how a more sober observer of contemporary physics than Dr. Schroeder describes String Theory. Writing a number of years before *Genesis and the Big Bang* was published, Professor Timothy Ferris said[50]:

> Such optimism [about String Theory] may, of course, prove to have been misplaced. The history of twentieth-century physics is strewn with the bleached bones of theories that were once thought to approach an ultimate answer. Einstein devoted much of the latter half of his career to trying to find a unified field theory of gravitation and electromagnetism… Yet nothing came of it… Wolfgang Pauli collaborated with Werner Heisenberg on a unified theory for a while, then was alarmed to hear Heisenberg claim on a radio broadcast that a unified Pauli-Heisenberg theory was close to completion, with only a few technical details remaining to be worked out. Put out by what he regarded as Heisenberg's hyperbole, Pauli sent… colleagues a page on which he had drawn a blank box. He captioned the drawing with the words, "This is to show the world that I can paint like Titian. Only technical details are missing."

Nobel Prize winner Sydney Glashow and his colleague Paul Ginsparg warned that *contemplation of superstrings may evolve*

[50] *Coming of Age in the Milky Way*, Timothy Ferris, pages 332-333.

into an activity as remote from conventional particle physics as particle physics is from chemistry[51].

When Dr. Schroeder claims that "the cabalists" presaged String Theory (without providing any source), does he take responsibility for the possibility that String Theory will end up on the ash-heap of history?

And it is not as if Dr. Schroeder is unaware of this possibility. Earlier in *Genesis and the Big Bang*, he reviews some of the discredited ideas that once formed the bedrock of science. Here is one example he gives (pages 22-23):

> … The advances achieved by scientific research during the last 50 years have brought major changes in our understanding of our universe… Well into the twentieth century… oceanographers gave the origin of the ocean waters as condensation from a primeval cloud that surrounded a once molten Earth… As the core sciences… made their way into what were once primarily descriptive fields… the amount of water able to be contained in a cloud surrounding a molten Earth was found to be a small fraction of the water now present in the world's oceans.

If String Theory is eventually junked – a distinct possibility in the world of cutting-edge theoretical physics - how will Dr. Schroeder explain the fact? One possibility is that Dr. Schroeder will claim that the (alleged) kabbalistic sources can easily be interpreted otherwise, in a way unrelated to String Theory. But if that is so, why should anyone believe that they *actually* refer to String Theory? The only reason given by Dr. Schroeder (apart from the alleged kabbalistic sources) is that there are ten Divine utterances in the creation account (*and God said*) and that String Theory speaks of ten physical dimensions. This is an exceedingly flimsy basis on which to link two concepts. One could equally well point out that there are ten bottles in the famous nursery rhyme about green bottles perched on a wall. Should we strive to associate the Creation account with *them*?

[51] *Ibid.* page 333.

String Theory is not the only example of such speculative associations. On page 93 of *Genesis and the Big Bang*, Dr. Schroeder uses the flimsiest pretext in order to form an association between his ideas and contemporary theories in physics. In this case, it is *inflation*. As used in physics, the term has nothing to do with the declining value of money. Rather, writes Dr. Schroeder,

> At that instant [in the first split second after the initial creation] a unique, one-time force – a sort of antigravity – developed. This force, acting for a minuscule fraction of a second, caused an expansion of the universe at a rate far in excess of any rate prior to, or after, this episode.

Dr. Schroeder believes that this phenomenon, too, was presaged by the Bible:

> The biblical allusion to this one-time inflation is found in Genesis 1:2. "And darkness was on the face of the deep… and a wind of God [a one-time force mentioned only here in all of Genesis] moved on the face of the water…[52]

The point is repeated on pages 154-155:

> This [inflationary epoch] one-time, never-to-be-repeated, superrapid expansion set the universe on a course… How does ancient biblical scholarship comment on this early period of the universe?... A one-time phenomenon occurred that started the very young universe on its life-directed course. Biblically, this phenomenon is referred to as "the wind of God" [Gen. 1:2]…

[52] The parenthetical comment is in the original.

Let us look carefully at the second verse of Genesis:

> וְהָאָרֶץ הָיְתָה תֹהוּ וָבֹהוּ וְחֹשֶׁךְ עַל-פְּנֵי תְהוֹם וְרוּחַ אֱלֹהִים מְרַחֶפֶת עַל-פְּנֵי הַמָּיִם

> The Earth was astonishingly empty and there was darkness over the surface of the abyss and the spirit [or wind] of God hovered over the water.

The *wind of God* to which Dr. Schroeder refers does nothing other than hover over the water. It is not described as a force, and it accomplishes nothing. Nonetheless, this is sufficient for Dr. Schroeder to claim that, since the phrase *wind of God* appears only once in all of Genesis, and the cosmological theory of *inflation* is hypothesized to have acted only once in the entire history of the universe, that they must be the same.

How robust is this methodology? In other words, can one link concepts from physics with religion in ways that undermine Dr. Schroeder's theses? In 1961, Murray Gell-Mann introduced a classification of elementary particles called hadrons[53]. For his work, Gell-Mann won the Nobel Prize in physics in 1969[54]. Gell-Mann's own name for the classification scheme was the *eightfold way*, because of the octets of particles in the classification. The *eightfold way* achieved experimental verification when a previously undetected particle which it predicted, omega minus, was identified in a bubble chamber experiment at Brookhaven National Laboratory. The term Gell-Mann used for his scheme – the *eightfold way* - is a reference to the *eightfold way of Buddhism* - a choice which is reflective of Gell-Mann's eclectic interests.

How would Dr. Schroeder approach this? Would he write of the amazing congruity between particle physics and Buddhism, and encourage us to accept the truth of the latter? If not, why not? Is the eightfold classification scheme any less convincing as evidence for Buddhism than associating *inflation* with *wind of God* because the latter phrase appears only once in Genesis?

Let us further develop this argument. Rational people reject the suggestion that the visions of Nostradamus were prophecies

[53] Hadrons are particles that respond to the strong nuclear force.

[54] This scheme is now explained by the quark model.

because they are far too vague to ever be considered testable or refutable. The "prophecies" only ever work in hindsight. Nostradamus' reputation as a prophet is largely manufactured by modern-day supporters who fit his words to events that have either already occurred or are so imminent as to be inevitable. There is no evidence to suggest that any Nostradamus quatrain has ever been interpreted as predicting a specific event before it occurred, other than in vague, general terms that could equally apply to any number of other events. The same rational process should be in evidence here. Did our sages and medieval authorities (ראשונים) *ever* suggest that the phrase *spirit of God* alludes to an expansion process? The answer is unequivocally *No*!

This is a point of fundamental importance: The Torah – in its broadest sense, encompassing the Written and Oral sections - is a received tradition from Sinai, transmitted via a chain of masters. For Torah Jewry, the Torah is: The Talmudic sages (חז"ל), as seen through the eyes of the medieval commentators (ראשונים). This imposes constraints on our ability to interpret the Torah. We do not interpret traditional texts on our own. We are not entitled to invent novel categories of explanation or redefine the technical vocabulary of the bearers of the tradition. The very fact that no traditional authority for the past three-thousand years identifies *the spirit of God hovering on the waters* with an expansion process means that Dr. Schroeder's reading is wrong.

A further example of this phenomenon is Dr. Schroeder's use of a midrash:

מלמד שהיה הקב"ה בונה עולמות ומחריבן

> This teaches that God created worlds and destroyed them.

According to Dr. Schroeder this statement is a reference to the lifecycle of stars[55].

[55] Pages 91 and 92 of *Genesis and the Big Bang*.

Dr. Schroeder assures his readers that this interpretation is entirely plausible, even though its originator, Rabbi Abahu, did not actually refer to stars:

> Before radioastronomy and spectrophotometry, could you expect Rabbi Abahu to talk of recycling of helium in stellar cores?

Of course, the answer is *No*. But that does not mean that Rabbi Abahu *was* referring to the recycling of helium in stellar cores. There is no basis on which to think that Rabbi Abahu *was* referring to the lifecycle of stars. Nor does Dr. Schroeder attempt to show any instances in the Talmudic literature in which stars are referred to as *worlds*.

GOD & EVOLUTION

In *Genesis and the Big Bang*, Dr. Schroeder promotes a view which, in the years since the publication of the book, has come to be called *theistic evolution*. As opposed to the strictly materialist evolutionary doctrine of the likes of Richard Dawkins and Jerry Coyne, theistic evolutionists such as Dr. Schroeder and Francis Collins believe that there is a spiritual component to creation. They believe in a God-guided evolution. As opposed to life arising as a result of Divine fiat, life, according to theistic evolutionists, arises through a lengthy natural process which is guided by God towards His final goal.

There are two main variants of *theistic evolution*. The first posits the injection of Divine direction into inert matter at creation. This imbues matter with the "urge" to produce life and, in particular, human life. Creation, then, is left to proceed – on auto-pilot, so to speak – towards a foregone conclusion. Another variant of *theistic evolution* requires God to intervene periodically in natural processes, in order to ensure that inert matter reaches its intended objective. For example, God would influence certain genetic mutations at crucial junctures.

Dr. Schroeder combines these variants. Thus, on page 105 of *Genesis and the Big Bang*, he speaks of natural laws being imbued with Divine direction:

> We have learned… that physical and chemical reactions follow natural laws, which were established with the creation of the universe. If we believe that this creation was the result of an act by God, then we might acknowledge a random development of life as being God-given through the Divine origin of the laws of nature. After all, it would have been these God-given laws of nature that had governed the interactions that led to life.

On page 138, we are acquainted with the second variant of theistic evolution:

> Natural forces influence the development of life, but tradition insists that these forces at key junctures were and are divinely directed. It is the "And God said…" that signifies the imposition of the Divine will, punctuating the

> natural processes of the world during the six days of genesis.

Why are theistic evolutionists disposed to this view? What would compel one to read *And God said…* not as Divine fiat, but as an interjection into a natural process? The answer is that theistic evolutionists believe that the evidence for evolution is overwhelming. Since one cannot dismiss it, the solution is to marry materialism with Divine providence of one sort or another.

Thus, throughout *Genesis and the Big Bang*, Dr. Schroeder introduces us to arguments which he believes form an irrefutable indication of the evolutionary history of life. These arguments did not originate with Dr. Schroeder. They are staples of evolutionary textbooks, articles and documentaries. They have become so entrenched in the public eye as to become veritable icons of evolution.

A book critique is not a suitable format for analysing the entire evolution debate[56]. Suffice it to say that the icons of evolution are deeply flawed and misleading. We will briefly examine only those icons mentioned by Dr. Schroeder.

On page 148 of *Genesis and the Big Bang*, we read:

> The fact that the development of a fertilized human egg proceeds through gill-bearing and tail-bearing stages shows that the ability to produce those organs is still within our genetic material. Our final structure is molded in part from a composite of these earlier forms.

This is as iconic as they come. Countless students and members of the public have been taught that at the embryonic stage, humans develop rudimentary gills. Dr. Schroeder would not have had to search far in order to find support in the literature for his contention. For example, Curtis and Barnes's *Invitation to Biology* states that *Early [vertebrate] embryos are almost indistinguishable.*

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[56] As an introduction to the topic, see *Icons of Evolution* by Jonathan Wells (from which much of the material in this section is taken); *Darwin on Trial* by Philip Johnson; *Why Us?* By James Le Fanu; and *Evolution: A Theory in Crisis* by Michael Denton.

All have prominent gill pouches[57]. Gould and Keeton's *Biological Science* informs students that *telltale traces of their genealogy are obvious in vertebrates… Human embryos, for instance, have gill pouches*[58]. Raven and Johnson's *Biology* claims that *early in development, human embryos possess gill slits, like a fish*[59].

The truth, outside of the alternative universe inhabited by evolutionary biologists, is otherwise. Midway through development, all vertebrate embryos possess a series of folds in the neck region. The convex parts of the folds are called *pharyngeal arches* or *ridges*, and the concave parts are called *pharyngeal clefts* or *pouches*. But pharyngeal folds are not gills. In a fish, pharyngeal folds later develop into gills, but in reptiles, mammals and birds they develop into other structures entirely, such as the inner ear and parathyroid gland. In reptiles, mammals and birds, pharyngeal folds are never even rudimentary gills. They are never gill-like, except in the superficial sense that they form a series of parallel lines in the neck region. This is how British embryologist Lewis Wolpert expresses it[60]:

> A higher animal, like the mammal, passes through an embryonic stage when there are structures that resemble the gill clefts of fish. But this resemblance is illusory and the structures in mammalian embryos only resemble the structures in the embryonic fish that will give rise to gills.

So there is no embryological reason to call pharyngeal pouches *gill-like*. The only justification for that term is the *a priori* belief that mammals evolved from fish-like ancestors.

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[57] Page 405.

[58] Pages 10 and 347.

[59] Pages 416 and 1181.

[60] Lewis Wolpert, *The Triumph of the Embryo*, Oxford University Press, 1991, page 185.

Swiss embryologist Günter Rager explains[61]:

> The concept *pharyngeal arches* is purely descriptive and ideologically neutral. It describes folds which appear [in the neck] region… In man, however, gills do never exist.

The only way to see gill-like structures in human embryos is to *assume* that human beings evolved from fish-like ancestors. But to use pharyngeal folds as *evidence* for the evolution of mammals from fish-like creatures is, needless to say, circular reasoning. If one believed that 1950s-vintage Cadillac cars with enormous metal appendages at the rear are the evolutionary end-product of fish, one could refer to these structures as *tail fins*. One could proceed to tell the public that Cadillac cars are the product of evolution, having descended with modification from fish. This would not be convincing evidence for evolution. It would only reflect the *a priori* conviction that there was an evolutionary process at play here.

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On page 148 of *Genesis and the Big Bang*, Dr. Schroeder refers to another icon of evolution:

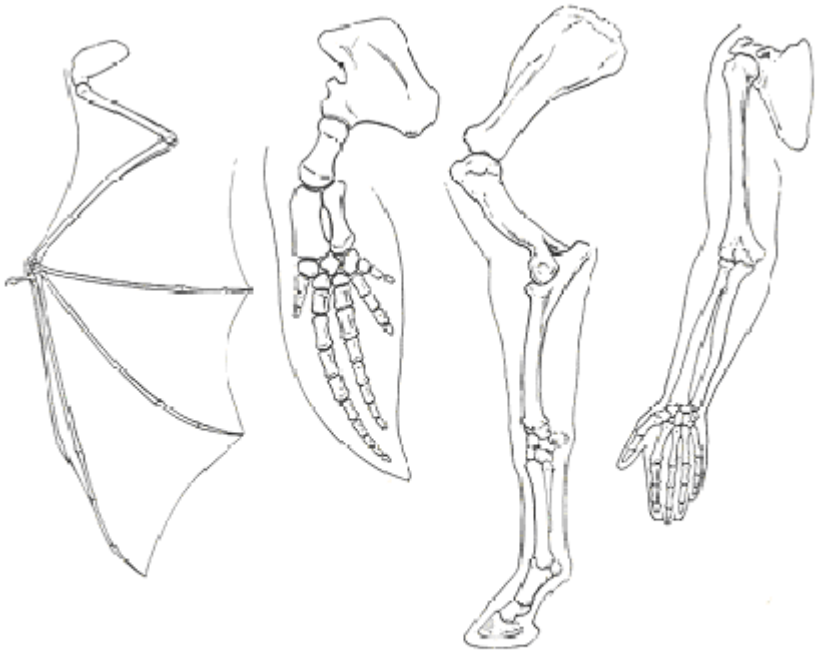
> The flippers of the porpoise have retained the bone structure of the forearm and hand that forebearers [sic] of this mammal had.

Without referring to it by name, Dr. Schroeder here invokes *homology*. Homology, too, is a staple of biology textbooks, television documentaries, articles in scholarly journals and museum displays. Although a bat has wings for flying, a porpoise has flippers for swimming, a horse has legs for running, and a human has hands for grasping, the bone patterns in their forelimbs are similar. This is interpreted by evolutionary biologists as evidence for a common ancestor who possessed this skeletal arrangement, and who bequeathed it to its descendants.

Thus, according to evolutionary biologists, homology is a *phenomenon of continuity*. Biological information from an ancestor is preserved in anatomical features of its descendants. How is this

[61] Günter Rager, *Human Embryology and the Law of Biogenesis*, Rivista di Biologia 79 (1986) pages 449-465.

biological information transmitted from one generation to the next? There are two possibilities: Developmental pathways – the patterns of cell division, cell movement, and tissue differentiation by which embryos produce adult structures. Or it could be encoded in genes that affect the development of the embryo.



From the left: The bone structure in the forelimbs of the bat, porpoise, horse and human.

The problem with homology is that for decades, biologists have known that homologous features are *not* due to similar genes or to similar developmental pathways, so the mechanism that produces them remains unknown. We will now briefly review the evidence concerning homologous structures in terms of the two posited mechanisms: similar developmental pathways and similar genes.

The belief that homologous structures are products of similar developmental pathways does not fit the evidence, and this has been known for more than a century. The American embryologist Edmund Wilson wrote in 1894 that,

> It is a familiar fact that parts which closely agree in the adult, and are undoubtedly homologous, often differ widely in larval or embryonic origin either in mode of formation or in position, or in both[62].

More than sixty years later, after reviewing the embryological evidence that had accumulated since Wilson's time, British embryologist Gavin de Beer wrote[63]:

> The fact is that correspondence between homologous structures cannot be pressed back to similarity of position of the cells in the embryo, or the parts of the egg out of which the structures are ultimately composed, or of developmental mechanisms by which they are formed.

De Beer's assessment is still correct. His conclusion is echoed by developmental biologist Pere Alberch[64]:

> [It is] the rule rather than the exception that homologous structures form from distinctly dissimilar initial states.

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[62] Edmund B. Wilson, *The Embryological Criterion of Homology*, pages 101-124 in *Biological Lectures Delivered at the Marine Biological Laboratory of Wood's Hole in the Summer Session of 1894* (Boston: Ginn & Company, 1895).

[63] Gavin de Beer, *Embryos and Ancestors*, Third Edition (Oxford: Clarendon Press, 1958) page 152.

[64] Pere Alberch, *Problems with the Interpretation of Developmental Sequences*, Systematic Zoology 34 (1985) pages 46-58.

Rudolf Raff is an evolutionary developmental biologist who studies two species of sea urchin that develop by radically different pathways into almost identical adult forms. In 1999 he wrote[65]:

> Homologous features in two related organisms should arise by similar developmental processes… [but] features that we regard as homologous… can arise in different ways in development.

The lack of correspondence between homology and developmental pathways is true not only in general, but also in the case of vertebrate limbs specifically referred to by Dr. Schroeder. The classic problem here is posed by salamanders. In most vertebrate limbs, development of the digits proceeds in the tail-to-head direction. This is true for frogs, but not for their fellow amphibians, salamanders. In salamanders, development of the digits proceeds in the head-to-tail direction[66].

Other anomalies exist. Skeletal patterns in vertebrate limbs initially form as cartilage, which later turns into bone. If it were true that the development of vertebrate limbs reflected their common ancestry, one should see a common ancestral cartilage pattern early in vertebrate limb development. But this is not so. Cartilage patterns correspond to the form of the adult limb from the beginning in salamanders, frogs, chicks and mice.

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[65] Rudolf Raff, *Larval Homologies and radical evolutionary changes in early development*, in *Homology* (Novartis Symposium 222; Chichester, UK: John Wiley & Sons, 1999) page 111.

[66] Regarding the differences between salamanders and other vertebrates, see Neil H. Shubin and Pere alberch, *A Morphogenetic Approach to the Origin and Basic Organization of the Tetrapod Limb*, in *Evolutionary Biology 20* (1986) pages 319-387.

British zoologists Richard Hinchliffe and P.J. Griffiths capture the situation perfectly[67]:

> [The idea that vertebrate limbs develop from a common ancestral pattern in the embryo] has arisen because investigators have superimposed their preconceptions [on the evidence].

If homologous structures are not the result of similar developmental pathways, the only remaining candidate is similar genes. The neo-Darwinian explanation for homologous features is that they are programmed by similar genes inherited from a common ancestor. If it could be shown that homologous structures in different organisms arise from similar genes, and that homologous structures are not produced by different genes, then there would be evidence for common ancestry. But on both of these points, this is not the case, and biologists have known this for decades. Back in 1971 Gavin de Beer wrote,

> Because homology implies community of descent from… a common ancestor it might be thought that genetics would provide the key to the problem of homology. This is where the worst shock of all is encountered… [because] characters controlled by identical genes are not necessarily homologous… [and] homologous structures need not be controlled by identical genes[68].

The above discussion leads to a clear conclusion: the mechanism that produces homologous structures remains unknown. What *is* certain is that common descent is *not* the cause of homologous structures: if that were the case, we would always find that homologous structures arise through homologous developmental pathways which are coded for by homologous genes. This is not the case.

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[67] Hinchliffe, J.R. and Griffiths, P.J., *The prechondrogenic patterns in tetrapod limb development and their phylogenetic significance*, pages 99-121 in *Development and Evolution* (Cambridge University Press, 1983) page 118.
[68] Gavin de Beer, *Homology: An Unsolved Problem* (Oxford University Press, 1971) pages 15-16.

As a footnote to this brief discussion on homology, it is worthwhile to examine the logical aspects of the science and religion debate. Most biologists (in fact, most scientists) are not trained in logic. They can thus be very good in the technical aspects of their craft, and yet make appalling mistakes when drawing conclusions from their research. Homology is a good example of this phenomenon.

On what basis do evolutionary biologists claim that vertebrate limbs provide evidence for common descent? If the similar bone pattern is not due to genes or developmental pathways, why should we think that it is due to common descent? Some biologists wish to settle the matter by *defining* homology as a consequence of common descent. But then it follows that homology cannot be used as *evidence* for common descent. Yet many biology textbooks seem to relish the logical equivalent of having your cake and eating it too. They seem oblivious to the circularity of reasoning. Take the 1999 edition of *Biology: Life on Earth*. It states that *internally similar structures are called homologous structures, meaning that they have the same evolutionary origin.*" The book thus *defines* homology in terms of common descent. On the same page, however, the authors proceed to state that homologous structures *provide evidence of relatedness in organisms*[69]. The sixth edition of *Biology* commits the same solecism[70]. It first states that *structures that are similar because they were inherited from a common ancestor are called homologous structures*. On the same page the author claims that *this unity of plan is evidence of a common ancestor*.

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On page 147 of *Genesis and the Big Bang*, Dr. Schroeder touches on the human brain:

> The shapes of the interiors of fossil skulls indicate that even the three-layered structure of our brains has existed for at least hundreds of thousands of years… What appears to be the oldest part of our brain is a mass of nerves at the top of the spinal cord. In this region, referred to as the stem, or brain stem, automatic body functions

[69] Teresa and Gerald Audesirk, *Biology: Life on Earth*, Prentice Hall, 1999, page 264.

[70] Sylvia Mader, *Biology*, sixth edition, McGraw-Hill 1998 page 298.

> such as breathing and heartbeat are controlled. Overlying the brain stem is the reptilian part of our brain, where the instincts for territorial control and for fight or flight are seated… Above the reptilian brain lies the limbic system… The most recent part of the brain to evolve is the cerebral cortex… The very fact that the brain is layered, with each successive advance in intellectual development literally placed on top of its predecessor, indicates a pattern in development of brain morphology…

Knowledge of the human brain has been completely transformed by the progress made during the *Decade of the Brain*. This was a designation for 1990-1999 by U.S. president George H. W. Bush to enhance public awareness of the benefits to be derived from brain research. The main engines driving this progress were the new technologies known as PET scanning[71] and fMRI (functional magnetic resonance imaging) which enabled researchers to scan the working brain of volunteers as they conducted various mental tasks.

First, some background. Brain research in the modern era has gone through three broad stages. The first, initiated by Pierre Paul Broca (1824-1880), was the era of mapping the brain. It was characterised by autopsies in which various regions of the brain were identified with particular functions. Most often, it was done by identifying brain lesions or other irregularities in people with well-defined handicaps. A link was made between the handicap and the region of the brain which was damaged.

The next era in brain research was characterised by the computer metaphor, in which the brain was likened to a massive information-processing machine. It yielded useful insights, but had to be abandoned eventually. One reason was that the comparison stretched the imagination. Communications expert Charles Jonscher writes:

> We don't just have the power of a single computer in our heads. The true comparison would be a figure more like twenty billion computers. The complexities involved are genuinely difficult to imagine[72].

[71] Positron Emission Tomography scanning.

Another reason why the computer metaphor was abandoned is the discovery of astonishing *neuroplasticity* – the ability of the brain to rewire itself. Let us examine some examples. The first concerns a fifty-five-year-old lorry driver who was involved in a motor accident and subsequently underwent a brain scan (see below). The scan revealed a massive congenital cyst which occupied much of his skull. And yet, the lorry driver was a normal individual, whose condition was never suspected until he underwent a scan. The reason for this is that during his childhood, his brain (what there was of it) reallocated a whole variety of functions to diferent regions of its real estate[73].

The second example is even more astonishing:

> There's a young student at this university who has an IQ of 126, has gained a first-class honors degree in mathematics, and is socially completely normal. And yet the boy has virtually no brain[74].

The student's physician at the university noticed that the youth had a slightly larger than normal head, and so referred him, out of interest, to a neurologist:

> When we did a brain scan on him, we saw that… his cranium is filled mainly with cerebro-spinal fluid.

This may seem to be a cover story from *The National Enquirer*, but it is in fact research reported by John Lorber, a neurologist and professor at Sheffield University.

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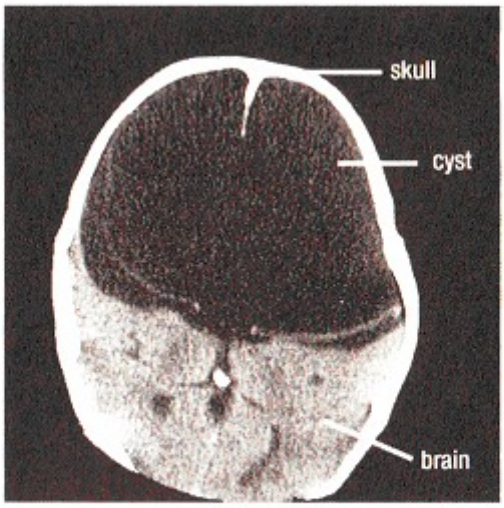
[72] Charles Jonscher, *Wired Life: Who Are We in the Digital Age?* Bantam 1990. It is estimated that the human brain has the potential to perform a quadrillion computations per second, which far outstrips the capacity of even the most sophisticated supercomputers.

[73] Leonard Yuen, *British Medical Journal*, 2003, volume 327, page 998.

[74] Roger Lewin, *Is Your Brain Really Necessary? Science*, 210 (12 December 1980): 1232.



The phenomenal power of neuroplasticity

As research during the *Decade of the Brain* progressed, it turned out that the properties of the mind can be programmed onto *any part of the brain*. This emerged dramatically in the early 1980s when paediatric neurosurgeons at Johns Hopkins University Medical Center sought to treat children with intractable epilepsy by means of a last-ditch operation of excising the affected half of the brain. They anticipated that this would cause paralysis or loss of speech.

To their delight, the results proved extremely encouraging[75]:

> We were always amazed. Here they are running, jumping talking, doing well in school… able to lead a normal life. The worst they suffered from losing half a brain was some impairment of peripheral vision and fine motor skills on one side of the body.

In its August 2003 edition, Scientific American published an article on the cerebellum entitled *Rethinking the "Lesser Brain"*. The article reviewed research into this baseball-sized, bean-shaped brain tissue and its functions.

[75] James Le Fanu, *Why Us?* Pantheon Books 2009, pages 191-192.

The authors note that:

> What is even more confounding is that people can recover from cerebellar injury. Although total removal of the cerebellum initially disrupts movement coordination, individuals (particularly young ones) can, with sufficient time, regain normal function to a considerable degree. Such plasticity is a general characteristic of the brain…

In the overview, the following point is made:

> Removing the cerebellum from young individuals often causes few obvious behavioural difficulties, suggesting that the rest of the brain can learn to function without a cerebellum.

The September 2003 edition of Scientific American was a special issue dedicated to the brain. In the introductory article (page 27), the magazine noted that

> The most important realization to emerge during the Brain Decade is that the organ being feted is more changeable than we ever thought. Even in maturity, some areas of the brain can renew themselves – a fact astonishingly contrary to a century of neurologists' dogma.

These and many other discoveries persuaded neuroscientists that the computer metaphor had been exhausted:

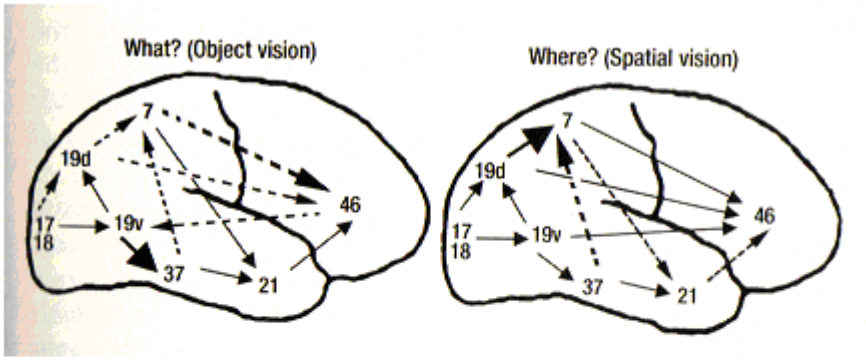
> Standing by a pond in London Zoo, Karl Friston[76] described a new vision of the brain…: traditional thinking holds that the brain is some kind of computer, crunching its way through billions of inputs each second to output a state of consciousness. But really, the brain acts more as if the arrival of those inputs provokes a widespread disturbance in some already existing state. The pond, Friston suggested, gives you a better way of thinking about it. The brain is like a surface, its circuits drawn tight in a certain state of tension. You toss in a pebble – that's your sensory input – and you immediately get ripples of activity. The patterns say something about the way the

[76] Friston is a neurobiologist at London's Institute of Neurology.

pebble hit the surface, but they are mixed with the lingering patterns of earlier pebbles on input. And then everything begins echoing off the sides of the pond[77].

One key lesson here is that one cannot conceive of the brain - as does Dr. Schroeder – as a simple assemblage of *Lego*-like, discrete modules tacked on by natural selection over millions of years. This research also refutes the notion that a gradual increase in brain capacity over eons transformed primitive hominids into intelligent *homo sapiens*.

The brain is an integrated whole. This is best appreciated graphically:



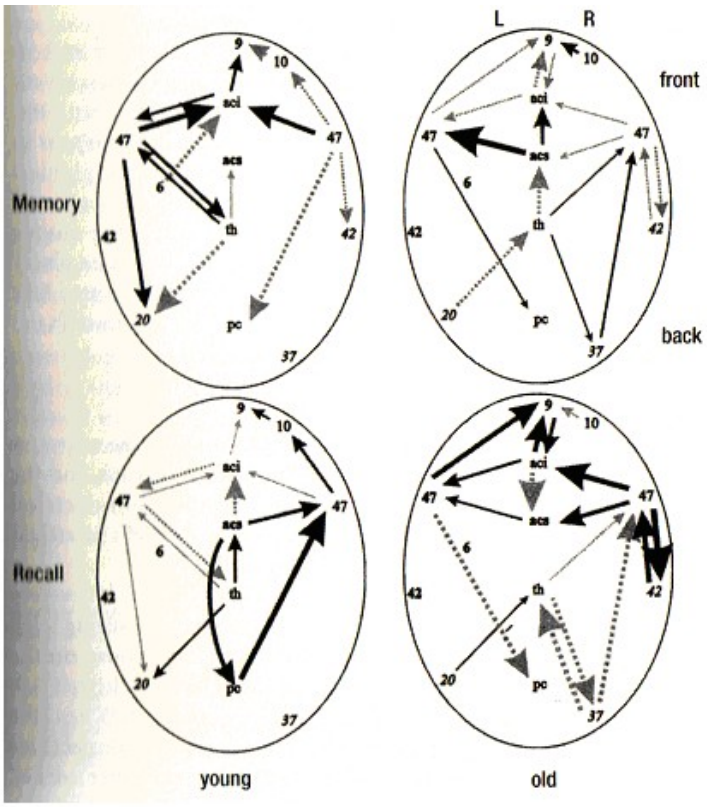
The "what" and "where" of perception. The numbers correspond to a conventional numeration for distinct parts of the brain. The solid lines indicate a positive effect, the dotted lines an inhibitory one, and the width of the lines reflects the strength of the influence.

[77] John McCrone, *Going Inside: A Tour Around a Single Moment of Consciousness* (Faber & Faber, 1999).

This is how Professor David Hubel summarises the conundrum raised by the latest research[78]:

> This abiding tendency for attributes such as form, colour and movement to be handled by separate structures in the brain immediately raises the question of how all the information is finally assembled, say for perceiving a bouncing red ball. It obviously must be assembled, but where and how, we have no idea.

Similar conclusions came as a result of research into memory:



The spread of memory. The memorising of word pairs and their recall are scattered diffusely throughout the brain in quite different regions for young and old.

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[78] David Hubel, *Scientific American Library*, 1988. Quoted in *Why Us?* James Le Fanu, Pantheon Books, 2009, page 206.

So much for what Dr. Schroeder refers to as *all but irrefutable* evidence for evolution (page 148 of *Genesis and the Big Bang*).

It must be stressed again that the above discussion does not purport to be an exhaustive analysis of the entire evolution debate. It is a brief review of the icons of evolution mentioned by Dr. Schroeder in *Genesis and the Big Bang*. But it is entirely safe to say that *all* icons of evolution, upon scrutiny, readily yield weaknesses and flaws which make them anything but irrefutable.

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A more subtle issue of logic raised in *Genesis and the Big Bang* requires careful scrutiny. Dr. Schroeder cites what he considers to be a crucial piece of evidence for common descent from genetics. Thus, on page 24 of *Genesis and the Big Bang*, we read:

> All life was found to have a single and extraordinarily complex genetic code – clear indication of man's evolution from bacteria.

This point is repeated on page 113:

> This equivalence among all life-forms is strong evidence for a single source of all life.

And again on page 136:

> The similarity of the proteins in diverse life forms is statistically strong evidence that they have a common ancestor… the strongest evidence for a common ancestor of all life is the similarity of genetic material among all forms of life.

Dr. Schroeder is quite correct when he writes that *This equivalence among all life-forms is strong evidence for a single source of all life*. But one could equally well write it as follows: *This equivalence among all life-forms is strong evidence for a single Source of all life*. Finding an extraordinarily-complex, information-dense language in all forms of life is *not* a clear indication of man's evolution from bacteria, unless one rules out the possibility of a Creator *a priori*. If one is prepared to contemplate the possibility of a Creator creating all forms of life, it becomes apparent that the

code of life could be a reflection not of common descent, but rather of a sublime unity in creation.

An extraordinarily-complex code excludes only one possibility: that it evolved independently many times, with nothing more to guide it than mutations and natural selection. This is the absurdity inherent in the notion of *convergent evolution*. This is a term used by evolutionary biologists to describe similar complex structures which must have evolved independently numerous times in the history of life. For example, human eyes and octopus eyes are astonishingly similar, but, according to evolutionary biologists, evolved independently. This is because when one traces the ancestry of humans and octopuses to their (alleged) last common ancestor, one finds that it did not possess an eye. So this remarkably complex organ must have evolved separately a number of times. In fact, evolutionary biologists believe that the eye has emerged independently at least forty times in the history of life!

Now, if one accepts this (truly ridiculous) argument, one can no longer use the complexity of DNA or proteins as evidence for common descent. If eyes evolved multiple times in the history of life, then DNA too could have evolved independently in different forms of life. But Dr. Schroeder is convinced - as we saw above - that it is statistically impossible for such complex entities to evolve separately. How then does he explain what appear to be convergent organs such as the eyes of humans and octopuses? The only way to resolve this conundrum is to accept that common descent is *not* the only explanation for extraordinarily complex structures. They can just as well be explained by a common Creator, who, for whatever reason, saw fit to use one "component" – whether DNA or the lens-type eye – in a broad range of applications. This would be similar to the case of a manufacturer who uses the same type of screw or electronic chip in diverse applications such as washing machines and mobile telephones.

Paradoxically, evolutionary biologists' only response to this argument is theological. Thus, we find statements such as *God would not have done this or that*. In the context of the present discussion, the argument goes like this: God would not have used the same structure (DNA, proteins) in such diverse creatures as armadillos and bacteria. *But this presupposes that we know what God would have done!* And this is a theological argument, not a scientific one. It requires us to be fully aware of all of God's

motivations, so as to be able to unequivocally state, *There is no reason to expect that God would have used the same extraordinarily complex genetic code for all forms of life*. This curious phenomenon – of evolutionary biologists (most of whom are atheists) using metaphysical arguments to motivate a materialistic explanation of natural history – has been well documented by the philosopher Elliott Sober and the biophysicist Cornelius Hunter. It can be traced back at least as far as Charles Darwin himself[79]:

> What can be more curious than that the hand of man… that of a mole… the paddle of the porpoise and the wing of the bat should all be constructed on the same pattern[80]… Nothing can be more hopeless than to explain this similarity of pattern [by supposing] it has pleased the Creator to construct all the animals in each great class on a uniform plan.

Since the theological argument is often used in the context of biogeography – the study of the distribution of various organisms around the globe - let us examine an example from that realm[81].

In his book *Why Evolution Is True* evolutionary biologist Jerry Coyne asserts that fossil finds seem to follow a pattern:

> Where can we dig up fossil kangaroos that most closely resemble living kangaroos? In Australia. Then there are the armadillos of the New World… They live only in North, Central, and South America. Where do we find fossils resembling them? In the Americas, the home of the glyptodonts, armored plant-eating mammals that look just like overgrown armadillos.

This type of argument suffers from two weaknesses. Firstly, new evidence often emerges which refutes the original assertion. And

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[79] Charles Darwin, *On the Origin of Species*, chapter XIV.

[80] Darwin is here referring to *homology*. See the discussion above.

[81] The quotations in this section are taken from: http://darwins-god.blogspot.com/2009/07/sermon-by-jerry-coyne-on-biogeography.html

secondly, there are numerous counter-examples. Let us illustrate these weaknesses by means of a few examples.

First Weakness – New Evidence

In his book *Science on Trial: The Case for Evolution* Douglas Futuyma[82] wrote that *The molelike and wolflike animals of Australia are marsupials, clearly related to each other, because only marsupial ancestors had reached Australia.* Futuyma's argument collapsed when, a few years later, placental fossil species were discovered in Australia.

Second Weakness – Counter Examples

New-world monkeys are remarkably similar to their old-world cousins. According to standard biogeography arguments, like those advanced by Coyne, they should have been different. When this occurs, there is no end to the inventiveness of evolutionary biologists' stories: African monkeys crossed the ocean on rafts. Or lizards somehow floated across thousands of kilometres of ocean from the Americas to islands in the Pacific.
Are the fauna similar between two different continents? Then that is because those continents were once joined, but have since drifted apart. What if the fauna on two continents are *different*? Then that is because those continents must have drifted apart farther back in time. In an attempt to capture the fantastical nature of these "explanations", the late biologist S.J. Gould used the term *just-so stories*.

The pathetic state of biogeography arguments is captured well by Dr. David Berlinski[83]:

> In a study reported in the November 20, 2007, edition of *Science Daily*, Vicky Friesen, a professor of biology, observed: "While that model fits for many parts of the natural world, it doesn't explain why some species appear to have evolved separately, within the same location, where there are no geographic barriers to gene flow." And, indeed, some species *have* evolved separately within the same location... It is her conclusion that must

[82] Futuyma is a prominent evolutionary biologist and textbook writer.

[83] David Berlinski, *The Devil's Delusion*, Crown Forum 2008, page 187.

> give pause. It is "exciting", she affirms, "to be able to verify Darwin's original theory!" But no *theory* has been confirmed since every possibility has been justified. Speciation proceeds in the presence of geographic barriers, and it proceeds in their absence. The demand that the facts somehow support the theory may thus be treated as it so often is in Darwinian thought, and that is as an inconvenience.

But besides the dubious nature of the biogeography argument, Coyne also makes a theological argument:

> Creationism is hard-pressed to explain these patterns: to do so, it would have to propose that there were an endless number of successive extinctions and creations all over the world, and that each set of newly created species were made to resemble older ones that lived in the same place.

The details of Coyne's argument need not concern us. The core of his argument is this: *God would not have done it this way*. This is not a scientific argument; it is metaphysical. It relies on the assumption that God is bound by what appeals intuitively to us. *God would not have done it* is only valid if we can be certain that God is bound by *our* sensibilities. It is to refute this latter notion that the prophet Isaiah (55:8) proclaims:

> For My thoughts are not your thoughts, neither are your ways My ways, says HASHEM[84].

[84] ישעיהו נה, ח: כִּי לֹא מַחְשְׁבוֹתַי מַחְשְׁבוֹתֵיכֶם וְלֹא דַרְכֵיכֶם דְּרָכָי נְאֻם ה'

FACT & FAITH

Stephen Jay Gould was one of the best-known scientists of the late twentieth century. A palaeontologist and historian of science at Harvard, he wrote many informative, entertaining texts for the public on the subject of biological evolution. He also made a contribution to the philosophical aspects of the religion/science debate. He proposed the concept of *magisterium* – a domain in which only one discipline holds the appropriate tools for meaningful discussion[85]. He then suggested drawing an impenetrable boundary between the magisteria of religion and science. The concept of *Non-Overlapping Magisteria* (NOMA) describes the task of science as covering "the empirical realm: what the Universe is made of (fact) and why does it work in this way (theory). The magisterium of religion extends over questions of ultimate meaning and moral value."

This, of course, is nothing but sophistry. Gould claims to accord religion and science equal status. But once he excludes any factual claims from the domain of religion, and relegates it to the realm of impression and subjective opinion, he eviscerates it. Why *should* anyone take religion seriously if all it amounts to is impression and opinion? This point is exposed by Professor Phillip Johnson[86]:

> In that philosophy, science (i.e. naturalism) defines the objective picture of reality for everyone; religion contributes value judgments or subjective reactions to that picture… Science and religion are separate but

[85] Gould was not the first to try to draw a line between different disciplines. The historian Richard Weikart writes, "German theologians in the late nineteenth century, partly because of the onslaught of antireligious Darwinists, but even more in response to the rise of biblical criticism (which they generally embraced), drew a strict line of separation between God and nature. The latter was science's province, while the former belonged to theology… Most German philosophers and many sociologists reacted to the encroachments of science on their domains in a similar manner, adopting the philosopher Wilhelm Dilthey's distinction between the natural sciences and the human sciences. Dilthey and his followers vehemently denied that the scientific method could be applied to the social sciences…" Richard Weikart, *From Darwin to Hitler*, Palgrave MacMillan, 2004, page 13.

[86] Phillip Johnson, *Darwin on Trial*, InterVarsity Press, 1993, page 161.

> equal in importance, [Gould wrote], "because science treats factual reality, while religion struggles with human morality." That is naturalistic metaphysics in a nutshell, and its version of "separate but equal" means about what the same phrase did in the days of Jim Crow [or of Apartheid South Africa][87].

Another writer who sees through Gould's deception is James Le Fanu. Commenting on Gould's suggestion of separate magisteria, he writes[88]:

> Nothing at first sight could be more reasonable – except, of course, it is not like that… Gould's reasonable view might be better summarised as: We scientists are very broad-minded people and have no objection to those who might find a purpose or meaning in their existence in one religious belief or another. That's fine, as long as all acknowledge science is the guardian of the flame of objective and rational knowledge…

It goes without saying that Torah Jewry rejects the notion of NOMA without reservation. The Torah *does* make statements about the *empirical realm*, sometimes directly, often indirectly. Let us consider one example of each.

Torah sources state, frequently and unequivocally, that the universe was created at a specific point i.e. it has not existed forever. There was nothing, and then there was something. This occurred as a result of Divine fiat, which created matter/energy from absolute nothingness. This radical notion – a universe which came to be, and prior to which nothing existed - only achieved respectability in the scientific community in the mid 1960s. Before that, scientists followed in the footsteps of Aristotle, who argued for an eternal universe. Much of *The Guide for the Perplexed* is taken up by Maimonides arguing, *contra* Aristotle, that the universe had a beginning.

A more subtle case is presented by Newtonian mechanics. It is a superb physical theory, able to explain the orbits of the planets and

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[87] I added the parenthetical comment.

[88] James Le Fanu, *Why Us?* Pantheon Books, 2009 page 233.

the trajectory of cannonballs, and much else besides. It is also *deterministic*, as George Gilder writes[89]:

> [Newton] had a vision of the world that was profoundly materialistic and determinist. He believed that at the basis of the universe were solid, immutable, impenetrable, mindless bits of matter. Further, he maintained that the universe was built up from these bits of matter in a great determinist machine like the workings of a clock.

A deterministic system is one in which, given an initial state, one can determine (at least in principle) any subsequent state of the system. Since freedom of choice is a fundamental component of Judaism, the implication is that Newtonian mechanics cannot be the most fundamental explanation of the universe's machinery. For some three centuries, Newtonian mechanics reigned supreme in physics. Yet, as soon as physics was revolutionised by quantum mechanics in the 1920s, it was understood that Newtonian mechanics explains only a slice of reality, and that freedom of choice may well be compatible with quantum mechanics.

These two examples suffice to show that the Torah does not restrict itself to *questions of ultimate meaning and moral value*. It also expresses itself regarding empirical, objective phenomena.

Without mentioning either Gould or any of his critics, Dr. Schroeder consistently employs the terminology of separate magisteria[90]. When it comes to issues of science, even when conclusions require dubious chains of inferences and speculation, points are *proved*, *measured*, *determined*. When Torah concepts are analysed, they are *believed*, *hypothesized*, *conjectured*.

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[89] George Gilder, *The Materialist Superstition*, The American Enterprise 9 (September-October 1998): 38

[90] In all the quotations in this section emphasis has been added.

Here are the representative examples. On page 20 of *Genesis and the Big Bang*, Dr. Schroeder writes:

> "… The cosmologist interprets spectra of starlight to *prove* that the universe is 10 to 20 billion years old…"

On page 23 we read:

> "Cosmologists *measured* the age of the universe…"

On page 24:

> "The observable *facts* of palaeontology…"

On page 27:

> "The age of the universe has been *measured* using a variety of independent… systems"

On page 28:

> "… Phenomena that are readily *measurable* by modern archaeological, paleontological and cosmological instrumentation."

On page 29:

> "Current cosmology claims, it even *proves*, that nature took some 15 billion years to…"

In stark contrast, when it comes to Biblical sources, we read (Page 20 of *Genesis and the Big Bang*):

> "… The validity of biblical interpretations… are usually taken (or rejected) on faith."

Again on page 28:

> "In sharp contrast… stands the faith that accepts the Bible's brief account…"

And on page 144:

> "… has led me to a… conclusion… that at some stage requires a leap of faith."

Since most of Dr. Schroeder's statements in this context deal with cosmology, we will limit our discussion to it. Even a cursory acquaintance with cosmology shows that it *proves nothing* about the age of the universe. Every conclusion in cosmology is a deduction, based on a string of assumptions and theoretical underpinnings. All conclusions in cosmology are tentative[91].

Dr. Schroeder speaks of measuring the red-shift of distant galaxies as if that were no different to reading the temperature off a thermometer. The truth is otherwise. Galaxies, in addition to participating in the apparent expansion of the universe, evidence other sorts of motion as well. Many are binary, and orbit a common centre-of-mass. Most belong to clusters of galaxies and orbit the cluster's gravitational centre. Many of the clusters belong in turn to super-clusters, further complicating their dynamics. And there is evidence that "bulk" motions send whole super-clusters sliding along in directions unrelated to their expansion velocities. Astronomers must correct for all this and more to derive the "pure Hubble flow" that alone is due to cosmic expansion[92].

In order to do so, astronomers must be able to estimate the distances to various galaxies, so as to determine which are closer and which lie at the edge of the observable universe. This involves a variety of problems associated with identifying "standard candles" such as Cepheid variables (stars whose brightness grows and wanes periodically). One of the basic steps in deducing that the universe is expanding - that of determining the distance from the Earth to distant galaxies - is so intricate that it is described by cosmologists as the *cosmological distance ladder*. As Professor Timothy Ferris puts it, "But reliance on each of these "standard candles" is subject to error, and the errors mount up, so that the

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[91] A brief and readable account of these difficulties is contained in *The Whole Shebang*, Timothy Ferris, Touchstone, 1997, in the chapter entitled *The Expansion of the Universe*.

[92] To get an inkling of the uncertainties inherent in measuring distances even within our *own* galaxy, see http://www.youtube.com/watch?v=gzvPH6A5CmQ. Last accessed 12th October 2009.

ladder eventually becomes very precarious indeed. Yet it is precisely at these large removes that measuring the value of the redshift-distance relation becomes most important, since it is only far away – beyond the Virgo Supercluster, to which our galaxy belongs – that local gravitational interference ebbs and pure Hubble flow is exhibited… None of these effects is fully understood."

Furthermore, conclusions in cosmology are made doubly speculative by the fact that we do not even know what the universe is made of. Visible matter – the kind of stuff that people and planets are made of – is outweighed by a factor of 6 or 7 by invisible, cold dark matter. Nobody knows what dark matter is made of, but its existence has been postulated to explain how the stars in spiral galaxies can orbit at such breakneck speeds without being flung off into the void. Astronomers appear to have considerable fun in speculating on the nature of this hypothetical dark matter: is it made up of MACHOs (Massive Compact Halo Objects)? Or is it WIMPs (Weakly Interacting Massive Particles)? Others, however, do not believe that dark matter even exists. Various problems with the dark matter model led Mordehai Milgrom, now at the Weizmann Institute in Rehovot, Israel, to suggest in the 1980s an alternative to dark matter, known as Modified Newtonian Dynamics, or MOND. The basic idea of MOND is that the force of gravity is not constant. Below a critical threshold of acceleration, gravity is stronger than what Newtonian theory predicts[93]. Whether the dark matter theory, MOND or neither is correct, the fact remains that we have little understanding of the stuff of the universe. To be so convinced, as Dr. Schroeder is, of the validity of cosmological hypotheses to do with the ancient, unobserved past, is grossly premature when we have yet to learn some basic facts about the universe we inhabit now.

To complicate things further, throw in some *dark energy*. This is not techno-speak from a Star Wars film. It is a phenomenon, discovered by cosmologists in the late 1990s, which appears to cause the universe's expansion to accelerate. According to cosmologist Michael Turner of the University of Chicago, "Cosmic acceleration is the biggest mystery in all of science." He was quoted in the January 2006 issue of *New Scientist*. The magazine went on to report that "… at a meeting of the American

[93] For a discussion of the merits and weaknesses of both dark matter and MOND, see *New Scientist*, 22 August 2009, pages 37-39.

Astronomical Society (AAS) in Washington DC, the mystery deepened when Brad Schaefer of Louisiana State University in Baton Rouge reported that dark energy appears to be changing - rapidly. Though his experimental method left most cosmologists unconvinced, *the result stressed how little we know about dark energy* and the need for different approaches."[94] Needless to say, if there *is* a force which is accelerating the universe's expansion, and especially if its strength is varying, attempts to estimate the expansion of the universe in the past are enormously complicated.

As if this were not enough, enter the *Axis of Evil*. Sometimes cosmologists are bold enough to borrow controversial phrases from politicians - former American president George W. Bush in this case - and press them into service to their benefit. In 2005, Kate Land and João Magueijo at Imperial College London discovered a mysterious pattern in the radiation left over from the Big Bang. In analysing the cosmic background radiation, widely considered to constitute the remnants of the Big Bang, they discovered that instead of hot and cold spots being randomly scattered across the sky, as expected, the spots appeared to be aligned in one particular direction through space. In a masterstroke of public relations, the two cosmologists named this the Axis of Evil. Why evil? Because it undermines some of the fundamental beliefs about the early universe. Modern cosmology is built on the assumption that the universe is isotropic i.e. roughly the same in whatever direction you look. If cosmic radiation has a preferred direction, the assumption of isotropy – and the best theories about cosmic history – would be jettisoned. In commenting on this problem, Michael Longo of the University of Michigan in Ann Arbor said that "We are dealing with the limits of our capabilities. All observations beyond our galaxy are obscured by the disc of the Milky Way, so we need to be cautious as to how we interpret them."[95]

[94] Emphasis added.

[95] *Nine Things Sent To Try Us*, New Scientist, 5 September 2009, page 34.

We could continue discussing further inherent weaknesses of cosmology. The above discussion is not an attempt to trivialize cosmology. It is a fascinating subject and its practitioners are making a worthy contribution to the body of knowledge known as *science*[96]. Nonetheless, to speak of its techniques as having *proved* anything is unjustified. Basic lessons from the history and philosophy of science must be applied here. One such precaution is the distinction between different levels of the practice of science. When science deals with repeatable, observable phenomena, it is at its strongest (though never infallible). As one proceeds to areas which involve extrapolation, unverifiable assumptions and, most importantly, repercussions and implications – whether economic, political, ethical, or religious – one must exercise greater and greater scepticism when reviewing the claims of the scientific community.

Notwithstanding all of this, Dr. Schroeder insists that because several independent methods are used to "measure" the age and expansion of the universe, they must be correct. Of course, having a similar answer emerge from a variety of independent methods lends credibility to one's hypotheses. But it by no means guarantees that one is correct, and familiarity with the history of science demonstrates the folly of speaking about *proof* of the age of the universe. Here is one example, taken from the history of geo-chronometry, the attempt to measure the age of the Earth.

In 1715, Edmund[97] Halley (of comet fame) tried to use the saltiness of the oceans to deduce the age of the Earth. He surmised that the oceans were salty because the rivers of the world carried down into the ocean small amounts of salt dissolved from continental rocks and soil. The water would eventually evaporate and recycle back through the rivers as rain, but the salt, unable to evaporate, would be left behind and accumulate. Halley did not carry out the actual calculations, but 200 years later, the Irish scientist John Joly (1857-1933) did. He measured the average salt content of river water, estimated the total flow of all the rivers of the world, and calculated how long it would take to bring the total volume of ocean water to its present level of saltiness, assuming no loss of salt. His answer: 80 to 89 million years.

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[96] As opposed to, for example, evolutionary psychologists.

[97] Historical accounts differ as to the spelling of his name. It is sometimes spelled *Edmond*.

Joly's contemporary, Lord Kelvin (1824-1907), took a different approach. Assuming the Earth to have begun as a ball of incandescent ("white-hot") molten rock and assuming that heat was lost to space by the process of conduction alone, he calculated how long it would take to cool to its present state of heat loss, which had recently been determined by measuring how the temperature increases with depth in deep mines. His answer: 100 million years.

Who were these scientists? Lord Kelvin was perhaps the pre-eminent physicist of his era. The absolute temperature scale – the Kelvin scale – is named in his honour. John Joly is best known for his development of radiotherapy in the treatment of cancer. Kelvin and Joly used completely independent methods to determine the age of the Earth, and reached strikingly similar results – around 95 million years. And they were wrong. Nobody today accepts a figure of 95 million years as an accurate estimate of the age of the Earth. The consensus figure in scientific circles is about 4500 million years.

What went wrong? Was the logic in the methodology of Kelvin and Joly deficient? Were their estimates of various parameters wrong? No. Both scientists made sincere and logically-impeccable attempts to measure certain natural processes, but there were various assumptions in their methodology that proved to be erroneous.

If Dr. Schroeder had been writing in the early part of the twentieth century, what would his account be like? Would he have assured his readers that it has been *proved* that the Earth is approximately 95 million years old? Would he have written that Lord Kelvin and Professor Joly had *measured* the age of the Earth? Would he have emphasised that the results were reached by independent methods?

Does this historical experience prove that *current* estimates of the age of the universe are wrong? Of course not. But it certainly demonstrates that Dr. Schroeder's consistent use of definitive statements about the conclusions of cosmology is unwarranted. No matter what technique is used, determining the age of the Earth and the universe is always going to depend on layer upon layer of theoretical underpinnings and experimental uncertainties, as well

as huge extrapolations of measurements taken over a tiny fraction of the history of the Earth and assumed to apply to vast stretches of time. The age of the Earth will never be *proved*.

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Dr. Schroeder's attitude towards Torah sources is equally in need of analysis. The very term that he employs to describe reaching a conclusion[98] - *a leap of faith* - is alien to the Torah community. It has no equivalent in traditional Talmudic literature. A tradition and a body of knowledge which are based on the simultaneous prophetic experience of millions of people at the foot of Mount Sinai leave no room for *faith*. Not if faith is - as Dr. Schroeder's terminology implies - the tentative, timid, doubt-wracked speculations of pusillanimous exegetes. It was not *faith* that prompted Maimonides to resolutely reject Aristotle's insistence that the universe was eternal. It was not *faith* that prompted modern Jews to insist, before the widespread acceptance of Big Bang cosmology, that the universe had been created at a specific point, before which nothing material existed. It was not *faith* that prompted Jews to reject the deterministic aspects of Newtonian mechanics and to insist that human beings have free choice, even before quantum mechanics restored the respectability of that notion among the community of physicists.

Furthermore, Biblical interpretations are not taken (or rejected) on faith in the Torah community, as Dr. Schroeder would have his readers believe (on page 20 of *Genesis and the Big Bang*). It is not *faith* that determines that *lex talionis* is not a Jewish notion, despite appearances to the contrary[99]. It is not *faith* that determines that the owner of an animal that kills a human being is not executed, but rather forced to pay compensation to the family of the deceased[100].

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[98] Page 144 of *Genesis and the Big Bang*.

[99] The Torah (Exodus 21:24-25) speaks of exacting an eye for an eye and a tooth for a tooth in the case of malicious injury. Talmudic tradition insists that this is not to be taken literally. The Torah here refers to monetary compensation.

[100] The Torah (Exodus 21:29) appears to sanction the death penalty for the owner of an aggressive animal which kills a human being. Talmudic tradition insists that this death sentence is not to be carried out by an Earthly court. It is a Heavenly penalty, to be applied only if the owner of the animal refuses to pay the prescribed compensation.

If Torah sources - whether the Talmud, midrashim or Zohar - indicate a position at odds with current scientific paradigms, then one would be justified and rational in adhering to that position. We have enough historical precedent wherein the entire community of scientists was committed to a particular paradigm which turned out to be wrong that we do not need to constantly peek behind our shoulders to check whether a particular view expressed in Torah sources has the support of the community of scientists. Phlogiston, the ether, geosyncline theory and dozens of other inhabitants of the rubbish-heap of science history illustrate the fallibility of the scientific endeavour.

*****

When Isaac Newton, perhaps the greatest scientist who ever lived, reflected on his achievements, he said that the reason he saw further than others did was that he stood on the shoulders of giants. A contemporary physicist who won a Nobel Prize in physics had a rather different perspective. He said that the reason he saw further than others did is that he was surrounded by dwarfs[101].

One of the themes consistently pursued by modern proponents of scientism (a materialist philosophy whose contention is that since only matter and energy exist, science is the only reliable methodology by which to access the deeper truths of the universe) is the gradual intellectual and moral development of mankind. From an existence famously described by Thomas Hobbes as *nasty, brutish and short*, humanity has matured into a sophistication, borne of scientific advances, which makes it immeasurably superior to its ancestry. This picture has been carefully cultivated over more than a century. Its causes were many: religious and social factors played a crucial role in nourishing the illusion that everything old is outdated and must be replaced.

Unfortunately, this caricature is echoed in *Genesis and the Big Bang*. A consistent theme throughout the book is the intellectual superiority of modern humanity over our ancestors.

For example, on page 129 of *Genesis & the Big Bang*, we read:

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[101] Timothy Ferris, *Coming of Age in the Milky Way*, Anchor Books, page 311.

> Because it would have been unrealistic to expect a mass of newly freed slaves 3400 years ago at Sinai to grasp the meaning of bacteria and microalgae…

The theme is further developed on page 157:

> Can mankind comprehend billions of years? Not likely today and even less likely at the time of Moses.

And again on page 175:

> It [the Bible] had to be meaningful to the just-freed slaves standing at Sinai, while retaining the depths of meaning intended for generations yet to be born.

My intention here is not to convince outsiders of the immense chasm that separates us – intellectually and otherwise – from the generation of the Exodus. Even a rudimentary acquaintance with traditional Torah sources reveals the breathtaking superiority of those individuals over our impoverished abilities. Nor is this, as ignorant anthropologists would have their students believe, a case of ancestor worship. It is simply recognition of cognitive abilities far beyond anything imaginable today. But the average Westerner has had too much conditioning to the contrary to be overcome by a mere book critique. My comments here are intended for those who consider themselves to be part of the Torah community, and have some grasp of the implications of Dr. Schroeder's comments about newly-released slaves. It is those readers who should carefully scrutinise those statements.

These readers should also ponder the following question: Who is Dr. Schroeder referring to when he speaks of *theology* or *the biblical tradition*? For example, on page 149 of *Genesis and the Big Bang*, we read:

> Well within the scope of biblical tradition is the fact of a directed evolution of man…

And on page 150:

> A theological problem is not posed by having the physique of mankind develop through an evolutionary process.

Indeed, as a *theologian*, one may imply that the generation of Israelites who experienced the Exodus were intellectually inferior to us, unable to grasp concepts such as bacteria or billions of years. But are these views on what the Torah community refers to as *The Generation of Knowledge* (דור דעה) representative of mainstream Torah society?

THE UNCHANGING NATURE OF NATURE

The intellectual scaffolding on which *Genesis and the Big Bang* depends is the idea that the evidence for an ancient universe is incontrovertible.

A book critique is not the appropriate forum for scrutinising the various techniques used to date the Earth and the universe. But one point which must be borne in mind is that all dating methods rely on the assumption that unlimited extrapolation is warranted. Measurements of radioactive processes which are used to estimate the age of the Earth, for example, have been possible only for about the last sixty years[102]. This, of course, constitutes a tiny fraction of the age of the Earth. In order to use these methods to date the ancient past, it is necessary to assume that the relevant processes always operated, and always operated at the same *rate* at which they are observed to operate today. That assumption, though perhaps reasonable, is an assumption nonetheless. The possibility remains that at some point, the rules of the game change. This could involve processes of which we have no inkling. Imagine telling a physicist before 1911 that an electric current can be passed through a wire without any resistance. His reaction - if the history of science is a guide - would be incredulity and scorn. This is because, before 1911, he would not have heard of *superconductivity*.

[102] Carbon-14 dating, for example, was developed by Willard Libby in the late 1940s.

Dr. Schroeder is committed to the principle of the immutability of natural laws. He therefore dismisses the notion that the results on which his central theses rely could, in fact, be illusory. On page 15 of *Genesis and the Big Bang* he writes,

> Again, it is impossible to disprove the idea that patterns of radioactive decay have changed during the past few thousand years. But the very concept of a fickleness in nature is contrary to all modern evidence…

Not so. There is plenty of evidence regarding the possibility that even the most fundamental and seemingly-immutable of natural constants are not constant.

Here is one example. In June 2005, Scientific American published an article entitled *Inconstant Constants*. The sub-title was, *Do the Inner Workings of Nature Change with Time?* The article was written by the physicists John D. Barrow and John K. Webb, both world-class in their respective fields and world-famous.

Barrow & Webb begin by reviewing the orthodoxy:

> Some things never change. Physicists call them the constants of nature. Such quantities as the velocity of light, c, Newton's constant of gravitation, G, and the mass of the electron, m_e, are assumed to be the same at all places and times in the universe. They form the scaffolding around which the theories of physics are erected… Physics has progressed by making ever more accurate measurements of their values.

The authors then proceed to describe cutting-edge research into the *fine-structure constant*, α, that calls all of this into question:

> Indeed, the word "constant" may be a misnomer. Our constants could vary both in time and space… And if we looked far enough out in space, we might begin to see regions where the "constants" have settled into different values. Ever since the 1930s, researchers have speculated that the constants may not be constant.

In the overview of the *Scientific American* article, the following points are noted:

- The equations of physics are filled with quantities such as the speed of light. Physicists routinely assume that these quantities are constant: they have the same values everywhere in space and time.

- Over the past six years, the authors and their collaborators have called that assumption into question…

- Small though [the change in the fine-structure constant, α] might seem, this change, if confirmed, would be revolutionary. It would mean that the observed constants are not universal…

The article concludes with these words:

> If α is susceptible to change, however, other constants should vary as well, making the inner workings of nature more fickle than scientists ever suspected.

The constancy of other "constants" has also been called into question. In an article dated 21st April 2006, New Scientist reported on the possibility that *mu*, the constant that represents the ratio of the masses of the proton to the electron, may have been different in the past. The author of the report wrote that "If confirmed, the result could force some physicists to radically rethink their theories."

It is not just that various fundamental constants of nature may have been different in the past. The very *laws* of nature could have been otherwise. One prominent proponent of this view was John Archibald Wheeler, one of the pre-eminent physicists of the twentieth century. Paul Davies, another world-famous physicist, reports in his book *The Goldilocks Enigma* (page 236) that

> Wheeler maintained that the laws of physics did not exist a priori but emerged from the chaos of the quantum big bang… congealing along with the universe that they govern in the aftermath of its shadowy birth… Crucially, Wheeler did not suppose that the laws just popped up,

> ready-made, in their final form, but that they emerged in approximate form and sharpened up over time…

Obviously, if the laws of nature are not today what they were in the past, then the platform on which Dr. Schroeder builds his arguments collapses. The extrapolation of current processes into the distant past becomes meaningless, just as it is meaningless to extrapolate aspects of respiration observed in an adult all the way back to an embryo consisting of a few cells.

Surprisingly, Dr. Schroeder *himself* appears to accept that the laws of nature were not necessarily fixed during the creation process. Quoting Maimonides[103], he writes (pages 53-54 of *Genesis and the Big Bang*):

> … from this first Sabbath and for all thereafter, the laws of nature, including the flow of time, would function in a "normal" manner.

Given the fact that he concedes that the laws of nature themselves are fluid, and that nature may have behaved in radically different ways in the distant past, Dr. Schroeder's statement (page 29 of *Genesis and the Big Bang*) that,

> Radioactive carbon-14 had a 5600-year half-life in the early universe just as it has now

rings hollow.

Furthermore, it seems that Dr. Schroeder's assessment of the potency of various phenomena also fluctuates. On page 28 of *Genesis and the Big Bang* Dr. Schroeder briefly examines the possibility that the Biblical Flood could have had a profound influence on quantities and processes which are of interest to scientists now. He writes:

> Any "proof" for or against… the Flood… is weak… Sediments from so brief a period would… not be extensive…

A mere four pages later, on page 32, things change dramatically. There, Dr. Schroeder investigates the difference between the

[103] Maimonides, *The Guide for the Perplexed*, part I, chapter 67.

current lifespan of humans – on the order of 80 years – and the gigantic lifetimes enjoyed by the early generations according to the Bible – on the order of 800-900 years. Dr. Schroeder mentions the view of Nahmanides as to what caused this precipitous decline in longevity. He writes,

> [Nahmanides] claims that prior to the Flood, the conditions on Earth favored long life. The upheaval that accompanied the Flood changed the atmosphere and climate causing a gradual shortening of individual life spans.

Dr. Schroeder does not explicitly endorse Nahmanides' view, but he appears to accept it. Evidently, he considers it quite possible that the atmospheric and climatic changes associated with the Flood could be so profound so as to alter life spans dramatically, over the span of but a few generations.

If the Flood can induce such cataclysmic changes in the Earth's climate and atmosphere that life spans change by an order of magnitude, how can Dr. Schroeder be so confident that it would have had only a minor effect on other natural phenomena[104]?

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Some readers may wish to point out that *Genesis and the Big Bang* was published in 1994. Thus, Dr. Schroeder did not have access to the research I quoted above.

One of the main themes of this essay is the caution (even skepticism) that one should harbour about prevailing scientific notions. Even without access to research in the 2000s, making absolute statements about any aspect of cutting-edge physics is unwarranted. Moreover, the Scientific American article that I quoted states that *Ever since the 1930s, researchers have speculated that the constants may not be constant*. Even if there were no hard evidence for this, for Dr. Schroeder to say that *the very concept of a fickleness in nature is contrary to all modern evidence* is unjustified. He should be well aware that advances in modern physics are often made as the energies of particle-accelerators grow and other technologies improve.

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[104] It should be kept in mind that modern science has only a rudimentary understanding of the process of ageing.

Furthermore, a new printing of *Genesis and the Big Bang* appeared in 2009. This was an opportunity to assess and update the claims originally made in *Genesis and the Big Bang*. No such attempt was made.

TIME DILATION & THE UNIVERSE

Perhaps the most important suggestion made in *Genesis and the Big Bang* is that there is complete harmony between Biblical chronology and modern scientific estimates of the age of the universe. This is so fundamental a part of the book that we will avoid quoting the relevant passages. In short, Dr. Schroeder maintains that both accounts – the six-day creation process described in the Torah, as well as the fourteen-odd billion years suggested by modern science – are literally true.

This synthesis has been tried myriad times before. There are variations on the theme, but the common denominator is that God's perception of time – if such a concept has any meaning – is different to our perception. A verse is often quoted[105]: For a thousand years in Your eyes are but as yesterday…

Dr. Schroeder's contribution is to provide a scientific gloss on this idea. His evidence consists of the well-known phenomenon of muons[106] undergoing time dilation, in effect experiencing time differently to us, owing to their near-luminal velocities (close to the speed of light). But the average reader of *Genesis and the Big Bang*, having a rudimentary scientific education, does not realize that extrapolation from the micro scale to the macro is not warranted.

Richard Feynman (1918-1988) was an American theoretical physicist who is widely regarded as the most brilliant, influential, and iconoclastic figure in his field in the post-World War Two era.

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[105] Psalms 90:4:

כִּי אֶלֶף שָׁנִים בְּעֵינֶיךָ כְּיוֹם אֶתְמוֹל כִּי יַעֲבֹר...

[106] Dr. Schroeder refers to the particles as *Mu-mesons*. Muons were sometimes referred to as *mu mesons* in the past, even though they are not classified as mesons by modern particle physicists.

One of his many seminal contributions to physics is known as Feynman diagrams. A Feynman diagram is a two-dimensional representation in which one axis, usually the horizontal axis, is chosen to represent space, while the second (vertical) axis represents time. Straight lines are used to depict *fermions*, or matter particles. Wavy lines are used for *bosons*, so-called "force-carrier," or field, particles.

One intriguing feature of Feynman diagrams is that antiparticles are represented as ordinary matter particles moving *backward* in time. For example, in a typical interaction, an electron collides with its antiparticle, a positron, and both are annihilated. A photon is created by the collision, and it subsequently forms two new particles in space: a muon and its antiparticle, an antimuon. In the Feynman diagram of this interaction, both antiparticles are represented as their corresponding particles moving *backward* in time (toward the past)[107].

Feynman diagrams are ubiquitous in particle physics. They are used to make very precise calculations of the probability of any given process, such as electron-electron scattering, for example, in quantum electrodynamics. Nonetheless, physicists are not scrambling to declare that time travel is imminent. This is because they are aware that the jump from the micro to the macro is unjustified. There is no indication whatsoever that phenomena on the subatomic scale – well-known, experimentally-verified phenomena – have parallels on the macro scale. The fact that certain particle interactions can be understood as involving time travel (particles traveling backwards in time) does not mean that humans will ever journey into their history.

[107] **"Feynman diagram."** Encyclopædia Britannica. Encyclopædia Britannica 2009 Ultimate Reference Suite. Chicago: Encyclopædia Britannica, 2009.

This disjuncture between the infinitesimally small and the large is captured by David Berlinski, in a passage that must rank as one of the most elegant in the popular science genre[108]:

> Over *there* [i.e. on the subatomic level], fields are pregnant with latent energy, particles flicker into existence and disappear, things are entangled, and no one can quite tell what is possible and what is actual, what is here and what is there, what is now and what was then. Solid forms give way. Nothing is stable. Great impassive symmetries are in control... Where they come from, no one knows. Time and space contract into some sort of agitated quantum foam. Nothing is continuous. Nothing stays the same for long, except the electrons, and they are identical, like porcelain Chinese soldiers. A pointless frenzy prevails throughout.
>
> Over *here* [i.e. on the level of our experience], space and time are stable and continuous. Matter is what it is, and energy is what it does. There are solid and enduring shapes and forms. There are no controlling symmetries. The Sun is largely the same Sun now that it was 4000 years ago when it baked the Egyptian deserts. Changes appear slowly, but even when rapid, they appear in stable patterns. There is dazzling variety throughout. The great River of time flows forward.

Unfortunately, the vast majority of readers of *Genesis and the Big Bang* simply do not have the necessary background to assess the credibility of Dr. Schroeder's claims in this regard. One correspondent wrote to me that *[Dr. Schroeder's thesis] is based on scientifically accepted and verifiable facts*. This is a mistake. Yes, the time-dilation experienced by subatomic particles is well-known. But the *application* of this idea to the universe *as a whole* is nothing more than fantasy. As far as I am aware, no physicist has concurred with Dr. Schroeder regarding his claim that time dilation resolves the incompatibility between the Biblical viewpoint and current estimates of the universe's age.

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[108] David Berlinski, *The Devil's Delusion*, Crown Forum 2008, pages 200- 201.

Dr. Schroeder's scheme has other fundamental faults. One critic wrote[109]

> Finally, concerning the author's main new idea in the book that the difference in reference frames can solve the contradiction in the dating of the universe's age, it is totally unclear how Einsteinian relativity can make sense out of an inertial frame embracing the entire universe. It is the essence of Einstein's method to define any phenomenon in terms of how it is measured. How could one measure time in an inertial frame including the entire universe? Real clocks are affected only by local gravitational fields - e.g. near a black hole. The total mass of the universe does not affect real clocks since each clock is surrounded with rough uniformity by the mass of the universe, so the total gravitational field at the clock is close to zero. That is why the author needs to speak about a clock at the "edge" of the universe. But the universe has no physical edge. The talk of "edge" is a physically nonsensical metaphor for the fact that God is not in the universe. If it is poetry we want, this is OK, but it is not science. It needs much more than merely explaining the most elementary aspects of relativity to make this scientifically credible.

[109] See http://www.dovidgottlieb.com/comments/CommentsGenesisBigBang.htm

PHILOSOPHY

There are issues of Jewish philosophy (*השקפה*) mentioned in *Genesis and the Big Bang* which require careful scrutiny. Here are two examples. On page 85 of *Genesis and the Big Bang*, we read:

> Now if there is anything in this universe for which we do not have an "inkling" it is the ultimate goal of the Creator.

This position, which Dr. Schroeder states categorically and without attribution, is in fact that of Maimonides. In *The Guide for the Perplexed*, Maimonides argued that God's ultimate purpose in creating the world is inscrutable[110]:

> ...דע שאין דרך לבקש תכלית לכלל המציאות... אי אפשר בהכרח מבלתי שיגיע הענין בנתינת התכלית אלא כן רצה השם או גזרה כן חכמתו, וזהו האמת...

> One cannot ascertain the ultimate purpose of existence… This question will ultimately be answerable only as follows: The universe exists because God so wished or because His wisdom decreed that it exist…[111]

Dr. Schroeder omits any mention of other Torah giants who espoused different views. Two of the greatest Jewish thinkers of all time, Nahmanides and Ramchal[112], hold that God's ultimate goal *is* known to us.

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110 Maimonides, *The Guide for the Perplexed*, III:13.

111 Maimonides points out that it follows logically that *no* Divine purpose (other than utility) is known to us. Purposes are nested in an ascending hierarchy; no purpose can be known without knowing its higher purpose; since the ultimate purpose is unknown, no purpose is known.

112 *Ramchal* is the Hebrew acronym for Rabbi Moshe Chaim Luzzato (רמח"ל). He lived from 1707 to 1746, and authored several classics, including *The Way of God* and *The Path of the Upright*. The comment below is from *The Way of God*, chapter 2, paragraph 1.

In his commentary to the Torah, Nahmanides writes[113]:

> וכוונת כל המצות שנאמין באלהינו ונודה אליו שהוא בראנו והיא כוונת היצירה, שאין לנו טעם אחר ביצירה הראשונה ואין אל עליון חפץ בתחתונים מלבד שידע האדם ויודה לאלהיו שבראו, וכוונת רוממות הקול בתפילות וכוונת בתי הכנסיות וזכות תפילת הרבים זהו שיהיה לבני אדם מקום יתקבצו ויודו לאל שבראם והמציאם ויפרסמו זה ויאמרו לפניו בריותיך אנחנו...
>
> The point of all the commandments is that we should believe in God and acknowledge that He created us, **and this is the purpose of creation**. For there is no other justification for our being created in the first place, and the supreme God has no interest in the lower worlds, other than that man should know and acknowledge his God for having created him.

Here is how Ramchal explains the Creator's ultimate aim in his classical exposition on Jewish philosophy, *The Way of God*:

> הנה התכלית בבריאה היה להיטיב מטובו יתברך שמו לזולתו... ועל כן בהיות חפצו יתברך שמו להיטיב לזולתו, לא יספיק לו בהיותו מיטיב קצת טוב, אלא בהיותו מיטיב תכלית הטוב שאפשר לברואים שיקבלו...
>
> God's purpose in creation was to bestow of His good onto others… since God desired to bestow good, a partial good would not be sufficient. The good that He bestows would have to be the ultimate good that His handiwork could accept…

Dr. Schroeder continues:

> Erroneous notions regarding this goal often stem from the misconception that all existence exists for man alone.

[113] Commentary on Exodus 13:16.

Once again, Dr. Schroeder's position is that of Maimonides[114]:

> ... וכן יחשבו שתכלית המציאות כולו מציאות מין האדם לבדו לעבוד את השם ושכל מה שנעשה אמנם נעשה בגללו... וזה הדעת... יתבאר מה שבו מן הטעות...
>
> Some people think that the purpose of existence is for the sake of humanity alone, so that it may worship God; and that everything else was created for man's sake… But this is a mistake…

However, other masters of the Torah tradition took a different view. This is how Nahmanides addresses the issue[115]:

> וחשוב בלבך שהקב"ה ברא כל השפלים להנאתו ולתשמישו של אדם, שאין לנו טעם ביצירת בעלי חיים השפלים והצמחים שאינם מכירים את בוראם זולתי זה, וברא את האדם שיכיר את בוראו ית', ואם האדם אינו יודע שבראו כלל, וכל שכן שאינו יודע שיש אצל בוראו מעשה נבחר ונרצה ומעשה אחר מרוחק ונמאס, נמצא האדם כבהמה, וכונת בריאתו בטלה, וזהו מה שאמרו חז"ל תמיד, שאלו לא קבלו ישראל את התורה היה מחזיר העולם לתהו ובהו, כלומר שאם לא היו חפצים לדעת וללמוד ידיעת בוראם, ושיש הפרש לפניו בין טוב לרע, נמצא שכונת בריאת העולם בטלה
>
> God created all the lower creatures for man's benefit and use. There is no reason for the creation of animals and plants - who do not know their Creator - other than this. He created man so that man would know his Creator. If man does not know that he was created, and even more so, if man does not know that his Creator considers some deeds desirable and others abominable, man is then like a beast, and the purpose of his having been created is voided…

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[114] Maimonides, *The Guide for the Perplexed*, III:13.

[115] רמב"ן, דרשת *תורת ה' תמימה*, כתבי רמב"ן, רבי חיים דוב שעוועל, הוצאת מוסד הרב קוק.

This is how Ramchal addresses the question[116]:

> אך הבריאה העיקרית באמת היא המין האנושי וכל שאר הנבראים בין השפלים בין הגבוהים ממנו אינם אלא בעבורו להשלמת ענינו
>
> The essence of creation is humankind. All other created beings, whether lower [i.e. animals] or higher [i.e. angels] were created for his sake.

For Dr. Schroeder to apply the label *misconception* to a position explicitly endorsed by Nahmanides and Ramchal is, at the very least, misguided.

CONCLUSION

We live in a world of astonishing paradoxes. Here is one. Imagine an organisation which states, frequently and unequivocally, its intention to murder an entire nation. This organisation not only speaks about this objective. It manufactures thousands of rockets and lobs them, intentionally, into urban areas, hoping to inflict as many civilian injuries as possible. The rockets are launched with the aid of human shields – people (often children) coerced into shielding the militants against air strikes by the enemy. Schools and hospitals thus become favourite staging grounds for rocket attacks, safe in the knowledge that the enemy has moral restraint as its Achilles heel. The state against which this terror is perpetrated launches a counter-offensive, after thousands of rockets have hit its territory, causing death, injury and the economic annihilation of one town. Before conducting bombing raids, it rains down leaflets on the designated targets, urging civilians to flee so as to avoid injury. This state of affairs does not go unnoticed in Europe. Its citizens organise mass demonstrations against what they perceive to be gross violations of human rights. The marchers speak of genocide and terror. They organise commercial and academic boycotts of the object of their scorn.

All is well up to this point, until it dawns on one that the Europeans are marching in *support* of Hamas. The boycotts are aimed at Israel. Could Kafka have imagined something more absurd (even if he had access to modern pharmacological agents)?

[116] Ramchal, *The Way of God*, chapter 2 paragraph 5.

Unfortunately, these paradoxes have home-grown variants, too. Being a South African, I will give a few examples from familiar territory:

- A prominent synagogue in Johannesburg's northern suburbs houses a cultural centre, named after a deceased chief rabbi. In 2008, it hosted an exhibition in honour of a famous South African palaeoanthropologist. The scientist who was honoured is a Jew, which was presumably the justification for the exhibition. But the fact remains that the Jewish cultural centre - housed inside a shul! - was transformed into a temple to human evolution.

- In 2009, the South African high-school science curriculum included a section on biological evolution for the first time. The Jewish day schools in the country, representing a wide spectrum of commitment to Torah ideals, reacted in different ways. One school, after independent consultations with several Torah sages, chose to excise the section on evolution from the biology curriculum. In this, it followed the standard procedure of Torah schools throughout the world. It took the principled stance that as a Torah institution, it could not live up to its vision if it taught material which is antithetical to Torah.

  Other schools decided to teach the material. As far as I know, this decision was taken without any consultation with Torah sages. Nor was there a public response from any official institution of South African Jewry. This would not have happened had the school curriculum changed in some other subject. For example, had the English-literature curriculum changed to include a novel about teenage pregnancy and recreational drug use, there would have been fierce opposition from the Jewish public. But in the case of evolutionary biology, only the sounds of silence were heard. No rabbinical conference to devise strategy; no official communiqué from the bodies overseeing Jewish education; no advice sought from international experts on this matter.

  Of the schools that thus decided to adopt the new syllabus, some agreed to introduce supplementary material, which is

permitted in South Africa[117]. I was thus invited to present an audio-visual seminar to the students, introducing material which would never have been even hinted to in the tendentious textbooks which are typically prescribed. Other schools, however, which are ostensibly committed to Torah ideals, took a different approach. In one case, after initially displaying enthusiasm for the audio-visual seminar, the school administration back-pedalled. A brief email to me from the teacher concerned explained that *concerning your presentation to the kids, I have spoken to both the Principal and the Biology teacher and they both felt that there is not enough time in the schedule to facilitate the presentation*. So there *is* enough time in the school's schedule to teach material which can have the most serious repercussions to the students' *אמונה*. But there is not enough time to afford the children a glimpse of the many serious difficulties inherent in Neo-Darwinism. A principal and a teacher took a decision that may adversely affect the spiritual health of hundreds of children over the coming years using the same criterion that would be used if the subject at hand were the next school outing. Would this have happened if there was an issue of straightforward Jewish law to decide? If the principal and teacher were confronted with a question in kashrus, for example, they would doubtless have referred it to a competent rabbinical authority. Yet somehow, when the issue concerns *hashkafa*, it is assumed that the most mundane criteria are adequate to reach valid conclusions.

Why does this absurd state of affairs exist?

One reason is that most rabbis prefer to ignore the issue. As stated in the introduction, the intersection of science and religion has long been the unloved stepson of most rabbis. Some are intimidated by a subject with which they are unfamiliar and therefore prefer to remain uninvolved. Even those rabbis who are attracted to *hashkafa* in general tend to shun the discussion when it comes to scientific concepts. So, when a Torah-observant author purports to have reconciled inconsistencies between Torah and science, many rabbis are delighted. Careful scrutiny of the arguments is neglected because the fact that *someone* is dealing

[117] Those who follow the evolution debate in the United States know that bitter legal wars have been- and continue to be fought regarding the permissibility of supplementary material in biology classes.

with these issues offers the opportunity to remain in familiar terrain.

For many in the Jewish community, there are similar considerations. It boils down to *convenience*. The prospect of a confrontation between one's religion and science is intimidating. It is so much easier to just accept the claims of those who peddle *reconciliation* and *harmony*. There is no incentive to scrutinise their arguments.

But this approach is untenable. The conflict between contemporary evolutionary dogma and Torah sources and philosophy is real. Evolutionary theory[118] is the cornerstone of contemporary Western intellectualism. It influences everything from economics to parenting and politics[119]. This influence is growing and cannot be wished away. I sincerely hope that this essay will serve as a palatable introduction to the subject for those who have until now been convinced that they need not be involved.

[118] By *evolution* I do not mean small changes within a species, such as fluctuations in the size of finch beaks. I mean universal common descent – the notion that all of the millions of species on Earth, living and extinct, are descended from a unicellular organism through a process of mutations and Natural Selection that took eons.

[119] Here are just three examples (out of many) of books published over the past few years which indicate the scope of the influence of Darwinian evolution on modern Western thought: *Economics as an Evolutionary Science*; *Divided Labours – An Evolutionary View of Women at Work*; *Executive Instinct – Managing the Human Animal in the Information Age*.

Rabbi Isaac Hutner (1906-1980), one of the foremost thinkers and leaders of Torah Jewry in the twentieth century, spoke about the link between three apparently-disparate ideologies which dominated his century:

> שלשה מהפכנים הכרנו: דארווין הכניס חומרנות לטבע. מרקס החדיר חומרנות להיסטוריה, ופרויד החדיר חומרנות אל תוך נשמת האדם עצמו...[120]

> We have known three revolutionaries: Darwin introduced materialism into nature; Marx injected materialism into history; and Freud brought materialism into the very soul of man…

It goes without saying that intellectuals from outside the Torah world also saw the connection between Darwin, Marx and Freud. George Gilder, a leading contemporary analyst, has this to say:

> I believe that the notion that the intricate biological structures of the world bubbled up from a prebiotic brew and that ideas are an after-effect of a meaningless random material flux is the most sterile and stultifying notion in the history of human thought. It inspired all the reductionist futilities of the twentieth century, from the obtuse materialism of Marx to the pagan worship of a static material environment, from the Freudian view of the brain as a thermodynamic machine to the zero-sum Malthusian panic over population, treating people more as mouths than as minds[121].

Rabbi Hutner was convinced that Darwinian biology was fundamentally linked to Marxism and Freudianism. All three are vehicles for materialism, and undermine different aspects of core Torah concepts. Marxism denies Divine providence (השגחה) in the history of mankind; Darwinian biology denies God in nature; Freudianism denies the Divinity of the human soul. Rabbi Hutner

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[120] *ספר הזכרון לרב הוטנר*, מתוך אגרותיו (מצוטט בספר *שטייגן*, הרב יעקב ב. פרידמן, עמוד תקעא).

[121] George Gilder, *The Materialist Superstition*, Discovery Institute, October 18, 2004. Available online at http://www.discovery.org/scripts/viewDB/index.php?command=view&id=2258.

was equally convinced that sooner or later, Marxism and Freudianism would shift over to make room for evolutionary biology in the dustbin of history.

With the end of evolutionary biology (except as a minor phenomenon in which natural selection is able to bring about small intra-species adaptations such as bacterial resistance to drugs[122]) will come the end of all attempts to marry materialism with Divine guidance. Professor Michael Egnor puts it elegantly while discussing a current, desperate attempt to achieve this[123]:

> P.Z. Myers [a militant evolutionary biologist] has a recent post in which he takes issue with Robert Wright, who is proposing a new kind of rapprochement between religion and science. Wright recommends that we move to a consensus on the view that purpose and moral law is inherent in nature, a view cleverly dubbed *Neism* (Naturalism melded with Deism) by Joe Carter. I believe that Wright's view is philosophically incoherent and even pernicious. His motives for imputing teleology and morality to nature are clear enough: Darwinism is faltering under scrutiny, as it denies teleology and fails to explain the moral law, and it will crumble unless it is welded to an ideology that invokes both. It's ironic that Darwinism may well segue into a nature religion, which is probably its only way out of its inexorable slide into the materialist dust-bin… But mankind has had plenty of nature religions, and they have never failed to be intellectually vacuous and culturally pernicious. We don't need another.

Together will all of these attempts, an end will come to such profoundly misleading books as *Genesis and the Big Bang*. It won't happen a moment too soon.

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[122] It is more accurate to refer to this process as one in which bacteria *lose sensitivity* to the drugs. There is a short-term advantage to the organism, but this is not a process which can lead to the development of any significant new structure. In the case of insects which have become "immune" to certain insecticides, this is reflected in the fact that certain neurological reactions are degraded.

[123] See http://www.evolutionnews.org/2009/09/on_atheism_and_morality_a_repl.html#more

APPENDIX 1

A list of some of the occurrences of the word *מאד* in the Book of Genesis.

In each case, I have listed the original Hebrew first, then the Aramaic translation, followed by the English translation. The Hebrew word *מאד* and its Aramaic and English equivalents – *לחדא* and *very*, respectively – are underlined and in bold.

1. א, לא: וַיַּרְא אֱלֹהִים אֶת כָּל אֲשֶׁר עָשָׂה וְהִנֵּה טוֹב **מְאֹד** וַיְהִי עֶרֶב וַיְהִי בֹקֶר יוֹם הַשִּׁשִּׁי.

וחזא ה' ית כל דעבד והא תקין **לחדא** והוה רמש והוה צפר יום שתיתאי.

1:31 And God saw everything that He had made, and, behold, it was **very** good. And there was evening and there was morning, the sixth day.

2. ד, ה: וְאֶל קַיִן וְאֶל מִנְחָתוֹ לֹא שָׁעָה וַיִּחַר לְקַיִן **מְאֹד** וַיִּפְּלוּ פָּנָיו.

ובקין ובקורבניה לא הות רעווא ותקיף לקין **לחדא** ואתכבישו אפוהי

4:5 But to Cain and to his offering He did not turn. And Cain was **very** upset, and his countenance fell.

3. ז, יח: וַיִּגְבְּרוּ הַמַּיִם וַיִּרְבּוּ **מְאֹד** עַל הָאָרֶץ וַתֵּלֶךְ הַתֵּבָה עַל פְּנֵי הַמָּיִם.

ותקיפו מיא וסגיאו **לחדא** על ארעא ומהלכא תיבתא על אפי מיא.

7:18 And the waters prevailed, and increased **very** much upon the Earth; and the ark went upon the face of the waters.

4. ז, יט: וְהַמַּיִם גָּבְרוּ **מְאֹד מְאֹד** עַל הָאָרֶץ וַיְכֻסּוּ כָּל הֶהָרִים הַגְּבֹהִים אֲשֶׁר תַּחַת כָּל הַשָּׁמָיִם.

ומיא תקיפו **לחדא לחדא** על ארעא ואתחפיאו כל טוריא רמיא דתחות כל שמיא

7:19 And the waters prevailed **very very** much upon the Earth; and all the high mountains that were under the whole heaven were covered

5. יב, יד: וַיְהִי כְּבוֹא אַבְרָם מִצְרָיְמָה וַיִּרְאוּ הַמִּצְרִים אֶת הָאִשָּׁה כִּי יָפָה הִוא **מְאֹד**.

והוה כד עאל אברם למצריים וחזו מצראי ית איתתא ארי שפירא היא **לחדא**.

12:14 And it came to pass, that when Abram came into Egypt, the Egyptians beheld the woman that she was **very** beautiful.

6. יג, ב: וְאַבְרָם כָּבֵד **מְאֹד** בַּמִּקְנֶה בַּכֶּסֶף וּבַזָּהָב.

ואברם תקיף **לחדא** בבעירא בכספא ובדהבא.

13:2 And Abram was **very** rich in cattle, in silver, and in gold.

7. יג, יג: וְאַנְשֵׁי סְדֹם רָעִים וְחַטָּאִים לַה' **מְאֹד**.

ואנשי סדום בישין בממונהון וחייבין בגוויתהון קודם ה' **לחדא**.

13:13 Now the men of Sodom were wicked and sinners against Hashem, **very** much.

8. טו, א: אַחַר הַדְּבָרִים הָאֵלֶּה הָיָה דְבַר ה' אֶל אַבְרָם בַּמַּחֲזֶה לֵאמֹר אַל תִּירָא אַבְרָם אָנֹכִי מָגֵן לָךְ שְׂכָרְךָ הַרְבֵּה **מְאֹד**.

בתר פתגמיא האילין הוה פתגמא דה' עם אברם בנבואה למימר לא תדחל אברם מימרי תקוף לך אגרך סגי **לחדא**.

15:1 After these things the word of Hashem came to Abram in a vision, saying: 'Fear not, Abram, I am your shield; your reward shall be **very** great.

9. יז, ב: וְאֶתְּנָה בְרִיתִי בֵּינִי וּבֵינֶךָ וְאַרְבֶּה אוֹתְךָ בִּ**מְאֹד מְאֹד**.

ואתין קיימי בין מימרי ובינך ואסגי יתך **לחדא לחדא**.

17:2 And I will make My covenant between Me and you, and will multiply you **very** much.

10. יז, ו: וְהִפְרֵתִי אֹתְךָ בִּ**מְאֹד מְאֹד** וּנְתַתִּיךָ לְגוֹיִם וּמְלָכִים מִמְּךָ יֵצֵאוּ.

ואפיש יתך **לחדא לחדא**, ואתנינך לכנשן ומלכין דשלטין בעממיא מינך ייפקון.

17:6 And I will make you **very**, **very** fruitful, and I will make nations of you; kings shall come out of you.

APPENDIX 2

Comment by Rabbi Dr. Dovid Gottlieb (www.dovidgottlieb.com)

Maimonides seems to write[1] that if there were a demonstration of the eternity of the world, we would accept it and reinterpret the verses that seem to describe creation *ex nihilo*.[2] The question is: What counts as a demonstration? In particular, does a very solid result of theoretical science, even when based upon observation and experiment, count as a demonstration?

The Newtonian picture of the universe describes it as having no beginning, and there were solid scientific reason for this. [It was not a naturalistic prejudice against religion.] And yet no one in our mesorah suggested that according to Maimonides this would be sufficient reason to give up creation *ex nihilo*. So at least we can say that the mesorah from Newton on did not regard such a scientific result as reason to use Maimonides' permission to reinterpret the verses.

The solid scientific reasons are three:

1. The consistent observation of the heavens as unchanging. The Greeks described the heavens as eternally without change. Indeed, the difference between form and matter was invented to account for change, and the heavens were described as composed of objects *not* possessing both form and matter.

2. Conservation of mass and energy. Conservation of X means that the amount of X remains constant in any event in a closed system. However much of X is measured at the beginning of the event, the exact same amount is found at the end of the event. This was observed to be universal. Now conservation means that the system is sealed – nothing gets in and nothing gets out. Thus the sum total of mass and of energy never changes. So the universe must be eternal.

3. Entropy. The universe shows constant increase in entropy from a past of lower entropy. It was recognized that since any time other than our own should have higher entropy [because states of higher entropy are much more numerous than states of low entropy], it

needs to be explained why our past had lower entropy. Here is one recognized explanation:

http://plato.stanford.edu/entries/statphys-statmech/:

It was Boltzmann who first proposed a kind of "cosmological" solution to the problem. As noted above he suggested a universe overall close to equilibrium with "small" sub-regions in fluctuations away from that state. In such a sub-region we would find a world far from equilibrium. Introducing the familiar time-symmetric probabilistic assumptions, it becomes likely that in such a region one finds states of lower entropy in one time direction and states of higher entropy in the other. Then finish the solution by introducing the other Boltzmann suggestion that what we mean by the future direction of time is fixed as that direction of time in which entropy is increasing.

This requires a very much older universe, and is consistent with a universe with no beginning.

Einstein was so certain that the universe must be static and eternal that he rejected the implication from his own theory of relativity that the universe as a whole might be changing, and revised the equations to prevent this implication.

Nevertheless, no one in the mesorah said that since Newtonian science demands eternity, we should use Maimonides' principle of reinterpretation to accept eternity. I suggest the reason is that theoretical science, even when based on observation and experiment, is not what Maimonides means by *demonstration*.

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This comment was made by a scholar who wishes to remain anonymous. I will refer to him as *Rabbi Levy*:

Maimonides [*Guide for the Perplexed* II:25] said that only a demonstration could refute an axiom of the Torah. (I had a discussion with Rabbi Gottlieb about this a while ago. All the editions are clear: Maimonides *does* hold that in principle a demonstration could prove Aristotelian eternity.] Demonstrations establish conclusions by deduction from *a priori* axioms and

undeniable facts of observation. Contemporary theoretical science works differently. Its conclusions are always open to revision by new observations. See also the work of a superb contemporary philosopher of science, Elliott Sober, who, developing Pierce's notion of abduction, holds that scientific theories are testable only in relation to their competitors. The conclusions of contemporary science arguably do not qualify as a demonstration on Maimonides' understanding.

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I freely acknowledge that the scholars quoted above – Rabbi Dr. Dovid Gottlieb and "Rabbi Levy" – are of a calibre well above my own. Nonetheless, I have not incorporated their comments into the main body of the essay for two reasons:

Firstly, both Rabbi Gottlieb and "Rabbi Levy" acknowledge that it is not entirely clear what Maimonides meant by *demonstration*. Thus, Rabbi Gottlieb writes:

> I suggest the reason is that theoretical science, even when based on observation and experiment, is not what Maimonides means by *demonstration*.

And "Rabbi Levy" writes:

> The conclusions of contemporary science arguably do not qualify as a demonstration on Maimonides' understanding.

So there is some ambiguity in what the position of Maimonides is. לעניות דעתי, there is some justification for my understanding of Maimonides.

Secondly, the main point I address in the essay is whether Dr. Schroeder is justified in stating that according to Maimonides, *conflicts between science and religion result from misinterpretations of the Bible.* Nuances in Maimonides aside, this is false. Maimonides never made such a statement.