

Age of the Universe by Dr. Gerald Schroeder

One of the most obvious perceived contradictions between Torah and science is the age of the universe. Is it billions of years old, like scientific data, or is it thousands of years, like Biblical data? When we add up the generations of the Bible, we come to 5700-plus years. Whereas, data from the Hubbell telescope or from the land based telescopes in Hawaii, indicate the age at about 15 billion years.

Let me clarify right at the start. The world may be only some 6000 years old. God could have put the fossils in the ground and juggled the light arriving from distant galaxies to make the world appear to be billions of years old. There is absolutely no way to disprove this claim. God being infinite could have made the world that way. There is another possible approach that also agrees with the ancient commentators' description of God and nature. The world may be young and old simultaneously. In the following I consider this latter option.

In trying to resolve this apparent conflict, it's interesting to look historically at trends in knowledge, because absolute proofs are not forthcoming. But what is available is to look at how science has changed its picture of the world, relative to the unchanging picture of the Torah. (I refuse to use modern Biblical commentary because it already knows modern science, and is always influenced by that knowledge. The trend becomes to bend the Bible to match the science.)

So the only data I use as far as Biblical commentary goes is ancient commentary. That means the text of the Bible itself (3300 years ago), the translation of the Torah into Aramaic by Onkelos (100 CE), the Talmud (redacted about the year 500 CE), and the three major Torah commentators. There are many, many commentators, but at the top of the mountain there are three, accepted by all: Rashi (11th century France), who brings the straight understanding of the text, Maimonides (12th century Egypt), who handles the philosophical concepts,

and then Nachmanides (13th century Spain), the earliest of the Kabbalists.

This ancient commentary was finalized long before Hubbell was a gleam in his great-grandparent's eye. So there's no possibility of Hubbell or any other modern scientific data influencing these concepts.

A universe with a beginning.

In 1959, a survey was taken of leading American scientists. Among the many questions asked was, "What is your concept of the age of the universe?" Now, in 1959, astronomy was popular, but cosmology -- the deep physics of understanding the universe -- was just developing. The response to that survey was recently republished in *Scientific American* -- the most widely read science journal in the world. Two-thirds of the scientists gave the same answer: "Beginning? There was no beginning. Aristotle and Plato taught us 2400 years ago that the universe is eternal. Oh, we know the Bible says 'In the beginning.' That's a nice story, but we sophisticates know better. There was no beginning."

That was 1959. In 1965, Penzias and Wilson discovered the echo of the Big Bang in the black of the sky at night, and the world paradigm changed from a universe that was eternal to a universe that had a beginning. After 3000 years of arguing, science has come to agree with the Torah.

It all starts from Rosh Hashana.

How long ago did the "beginning" occur? Was it, as the Bible might imply, 5700-plus years, or was it the 15 billions of years that's accepted by the scientific community?

The first thing we have to understand is the origin of the Biblical calendar. The Jewish year is figured by adding up the generations since Adam. Additionally, there are six days leading up to the creation to Adam. These six days are significant as well.

Now where do we make the zero point? On Rosh Hashana, the Jewish New Year, upon blowing the shofar, the following sentence is said: "*Hayom*

Harat Olam -- today is the birthday of the world."

This verse might imply that Rosh Hashana commemorates the creation of the universe. But it doesn't. Rosh Hashana commemorate the creation of the Neshama, the soul of human life. We start counting our 5700-plus years from the creation of the soul of Adam.

We have a clock that begins with Adam, and the six days are separate from this clock. The Bible has two clocks.

That might seem like a modern rationalization, if it were not for the fact that Talmudic commentaries 1500 years ago, brings this information. In the Midrash (*Vayikra Rabba* 29:1), an expansion of the Talmud, all the Sages agree that Rosh Hashana commemorates the soul of Adam, and that the Six Days of Genesis are separate.

Why were the Six Days taken out of the calendar? Because time is described differently in those Six Days of Genesis. "There was evening and morning" is an exotic, bizarre, unusual way of describing time.

Once you come from Adam, the flow of time is totally in human terms. Adam and Eve live 130 years before having children! Seth lives 105 years before having children, etc. From Adam forward, the flow of time is totally human in concept. But prior to that time, it's an abstract concept: "Evening and morning." It's as if you're looking down on events from a viewpoint that is not intimately related to them.

Looking deeper into the text.

In trying to understand the flow of time here, you have to remember that the entire Six Days is described in 31 sentences. The Six Days of Genesis, which have given people so many headaches in trying to understand science vis-a-vis the Bible, are confined to 31 sentences! At MIT, in the Hayden library, we had about 50,000 books that deal with the development of the universe: cosmology, chemistry, thermodynamics, paleontology, archaeology, the high-energy physics

of creation. At Harvard, at the Weidner library, they probably have 200,000 books on these same topics. The Bible gives us 31 sentences. Don't expect that by a simple reading of those sentences you'll know every detail that is held within the text. It's obvious that we have to dig deeper to get the information out.

The idea of having to dig deeper is not a rationalization. The Talmud (Chagiga, ch. 2) tells us that from the opening sentence of the Bible, through the beginning of Chapter Two, the entire text is given in parable form, a poem with a text and a subtext. Now, again, put yourself into the mindset of 1500 years ago, the time of the Talmud. Why would the Talmud think it was parable? You think that 1500 years ago they thought that God couldn't make it all in 6 days? It was a problem for them? We have a problem today with cosmology and scientific data. But 1500 years ago, what's the problem with 6 days for an infinitely powerful God? No problem.

So when the Sages excluded these six days from the calendar, and said that the entire text is parable, it wasn't because they were trying to apologize away what they'd seen in the local museum. There was no local museum. The fact is that a close reading of the text makes it clear that there's information hidden and folded into layers below the surface.

The idea of looking for a deeper meaning in Torah is no different than looking for deeper meaning in science. Just as we look for the deeper readings in science to learn the working of nature, so too we need to look for the deeper readings in Torah. King Solomon in Proverbs 25:11 alluded to this. "A word well spoken is like apples of Gold in a silver dish." Maimonides in The Guide for the Perplexed interprets this proverb: The silver dish is the literal text of the Torah, as seen from a distance. The apples of gold are the secrets held within the silver dish of the Torah Text. Thousands of years ago we learned that there are subtleties in the Text that expand the meaning way beyond its simple reading. It's those subtleties I want to see.

Natural history and human history.

There are early Jewish sources that tell us that the Bible's calendar is in two-parts (even predating Leviticus Rabba which goes back almost 1500 years and says it explicitly). In the closing speech that Moses makes to the people, he says if you want to see the fingerprint of God in the universe, "consider the days of old, the years of the many generations" (Deut. 32:7) Nachmanides, in the name of Kabbalah, says, "Why does Moses break the calendar into two parts -- 'The days of old, and the years of the many generations?' Because, 'Consider the days of old' is the Six Days of Genesis. 'The years of the many generations' is all the time from Adam forward."

Moses says you can see God's fingerprint on the universe in one of two ways. Look at the phenomenon of the Six Days, and the development of life in the universe which is mind-boggling. Or if that doesn't impress you, then just consider society from Adam forward -- the phenomenon of human history. Either way, you will find the imprint of God.

I recently met in Jerusalem with Professor Leon Lederman, Nobel Prize winning physicist. We were talking science, and as the conversation went on, I said, "What about spirituality, Leon?" And he said to me, "Schroeder, I'll talk science with you, but as far as spirituality, speak to the people across the street, the theologians." But then he continued, and he said, "But I do find something spooky about the people of Israel coming back to the Land of Israel."

Interesting. The first part of Moses' statement, "Consider the days of old" - about the Six Days of Genesis - that didn't impress Prof. Lederman. But the "Years of the many generations" - human history - that impressed him. Prof. Lederman found nothing spooky about the Eskimos eating fish at the Arctic circle. And he found nothing spooky about Greeks eating Musika in Athens. But he finds something real spooky about Jews eating falafel on Jaffa Street. Because it shouldn't have happened. It doesn't make sense historically that the Jews would come back to the Land of Israel. Yet that's what happened.

And that's one of the functions of the Jewish People in the world. To act as a demonstration. We just want people in the world to understand that there is some monkey business going on with history that makes it not all just random. That there's some direction to the flow of history. And the world has seen it through us. It's not by chance that Israel is on the front page of the New York Times more than anyone else.

What is a "day?"

Let's jump back to the Six Days of Genesis. First of all, we now know that when the Biblical calendar says 5700-plus years, we must add to that "plus six days."

A few years ago, I acquired a dinosaur fossil that was dated (by two radioactive decay chains) as 150 million years old. My 7-year-old daughter says, "Abba! Dinosaurs? How can there be dinosaurs 150 million years ago, when my Bible teacher says the world isn't even 6000 years old?" So I told her to look in Psalms 90:4. There, you'll find something quite amazing. King David says, "One thousand years in Your (God's) sight are like a day that passes, a watch in the night." Perhaps time is different from the perspective of King David, than it is from the perspective of the Creator. Perhaps time is different.

The Talmud (Chagiga, ch. 2), in trying to understand the subtleties of Torah, analyzes the word "*choshech*." When the word "*choshech*" appears in Genesis 1:2, the Talmud explains that it means black fire, black energy, a kind of energy that is so powerful you can't even see it. Two verses later, in Genesis 1:4, the Talmud explains that the same word -- "*choshech*" -- means darkness, i.e. the absence of light.

Other words as well are not to be understood by their common definitions. For example, "*mayim*" typically means water. But Maimonides says that in the original statements of creation, the word "*mayim*" may also mean the building blocks of the universe.

Another example is Genesis 1:5, which says, "There is evening and morning,

Day One." That is the first time that a day is quantified: evening and morning. Nachmanides discusses the meaning of evening and morning. Does it mean sunset and sunrise? It would certainly seem to.

But Nachmanides points out a problem with that. The text says "there was evening and morning Day One... evening and morning a second day... evening and morning a third day." Then on the fourth day, the sun is mentioned. Nachmanides says that any intelligent reader can see an obvious problem. How do we have a concept of evening and morning for the first three days if the sun is only mentioned on Day Four? There is a purpose for the sun appearing only on Day Four, so that as time goes by and people understand more about the universe, you can dig deeper into the text.

Nachmanides says the text uses the words "*Vayehi Erev*" -- but it doesn't mean "there was evening." He explains that the Hebrew letters Ayin, Resh, Bet -- the root of "*erev*" -- is chaos. Mixture, disorder. That's why evening is called "*erev*", because when the sun goes down, vision becomes blurry. The literal meaning is "there was disorder." The Torah's word for "morning" -- "*boker*" -- is the absolute opposite. When the sun rises, the world becomes "*bikoret*", orderly, able to be discerned. That's why the sun needn't be mentioned until Day Four. Because from *erev* to *boker* is a flow from disorder to order, from chaos to cosmos. That's something any scientist will testify never happens in an unguided system. Order never arises from disorder spontaneously and remains orderly. Order always degrades to chaos unless the environment recognizes the order and locks it in to preserve it. There must be a guide to the system. That's an unequivocal statement.

The Torah wants us to be amazed by this flow, starting from a chaotic plasma and ending up with a symphony of life. Day-by-day the world progresses to higher and higher levels. Order out of disorder. It's pure thermodynamics. And it's stated in terminology of 3000 years ago.

The creation of time.

Each day of creation is numbered. Yet there is discontinuity in the way the days are numbered. The verse says: "There is evening and morning, Day One." But the second day doesn't say "evening and morning, Day Two." Rather, it says "evening and morning, a second day." And the Torah continues with this pattern: "Evening and morning, a third day... a fourth day... a fifth day... the sixth day." Only on the first day does the text use a different form: not "first day," but "Day One" ("*Yom Echad*"). Many English translations make the mistake of writing "a first day." That's because editors want things to be nice and consistent. But they throw out the cosmic message in the text! Because there is a qualitative difference, as Nachmanides says, between "one" and "first." One is absolute; first is comparative.

Nachmanides explains that on Day One, time was created. That's a phenomenal insight. Time was created. You can't grab time. You don't even see it. You can see space, you can see matter, you can feel energy, you can see light energy. I understand a creation there. But the creation of time? Eight hundred years ago, Nachmanides attained this insight from the Torah's use of the phrase, "Day One." And that's exactly what Einstein taught us in the Laws of Relativity: that there was a creation, not just of space and matter, but of time itself.

Einstein's Law of Relativity.

Looking back in time, a scientist will view the universe as being 15 billion years old. But what is the Bible's view of time? Maybe it sees time differently. And that makes a big difference. Albert Einstein taught us that Big Bang cosmology brings not just space and matter into existence, but that time is part of the nitty gritty. Time is a dimension. Time is affected by your view of time. How you see time depends on where you're viewing it. A minute on the moon goes faster than a minute on the Earth. A minute on the sun goes slower. Time on the sun is actually stretched out so that if you could put a clock on the sun, it would tick more slowly. It's a small difference, but it's measurable and measured.

If you could ripen oranges on the Sun, they would take longer to ripen. Why? Because time goes more slowly. Would you feel it going more slowly? No, because your biology would be part of the system. If you were living on the Sun, your heart would beat more slowly. Wherever you are, your biology is in synch with the local time. And a minute or an hour where ever you are is exactly a minute or an hour.

If you could look from one system to another, you would see time very differently. Because depending on factors like gravity and velocity, you will perceive time in a way that is very different. The flow of time varies one location to another location. Hence the term: the law of relativity.

Here's an example: One evening we were sitting around the dinner table, and my 11-year-old daughter asked, "How you could have dinosaurs? How you could have billions of years scientifically - and thousands of years Biblically at the same time? So I told her to imagine a planet where time is so stretched out that while we live out two years on Earth, only three minutes will go by on that planet. Now, those places actually exist, they are observed. It would be hard to live there with their conditions, and you couldn't get to them either, but in mental experiments you can do it. Two years are going to go by on Earth, three minutes are going to go by on the planet. So my daughter says, "Great! Send me to the planet. I'll spend three minutes there. I'll do two years worth of homework. I'll come back home in three minutes, and no more homework for two years."

Nice try. Assuming she was age 11 when she left, and her friends were 11. She spends three minutes on the planet and then comes home. (The travel time takes no time.) How old is she when she gets back? Eleven years and 3 minutes. And her friends are 13. Because she lived out 3 minutes while we lived out 2 years. Her friends aged from 11 years to 13 years, while she's 11 years and 3 minutes.

Had she looked down on Earth from that planet, her perception of Earth time would be that everybody was moving very quickly because in one of

her minutes, hundreds of thousands of our minutes would pass. Whereas if we looked up, she'd be moving very slowly.

But which is correct? Is it three years? Or three minutes? The answer is both. They're both happening at the same time. That's the legacy of Albert Einstein. It so happens there literally billions of locations in the universe, where if you could put a clock at that location, it would tick so slowly, that from our perspective (if we could last that long) 15 billion years would go by... but the clock at that remote location would tick out six days.

Time travel and the Big Bang.

But how does this help to explain the Bible? Because anyway the Talmud and Rashi and Nahmanides (that is the kabala) all say that Six Days of Genesis were six regular 24-hour periods not longer than our work week!

Let's look a bit deeper. The classical Jewish sources say that before the beginning, we don't really know what there is. We can't tell what predates the universe. The Midrash asks the question: Why does the Bible begin with the letter *Beit*? Because *Beit* (which is written like a backwards C) is closed in all directions and only open in the forward direction. Hence we can't know what comes before -- only after. The first letter is a Beit - closed in all directions and only open in the forward direction.

Nachmanides expands the statement. He says that although the days are 24 hours each, they contain "*kol yemot ha-olam*" -- all the ages and all the secrets of the world.

Nachmanides says that before the universe, there was nothing... but then suddenly the entire creation appeared as a minuscule speck. He gives a dimension for the speck: something very tiny like the size of a grain of mustard. And he says that is the only physical creation. There was no other physical creation; all other creations were spiritual. The *Nefesh* (the soul of animal life) and the *Neshama* (the soul of human life) are spiritual creations. There's only one physical creation, and that creation was a tiny speck. The

speck is all there was. Anything else was God. In that speck was all the raw material that would be used for making everything else. Nachmanides describes the substance as "*dak me'od, ein bo mamash*" -- very thin, no substance to it. And as this speck expanded out, this substance -- so thin that it has no essence -- turned into matter as we know it.

Nachmanides further writes: "*Misheyesh, yifos bo zman*" -- from the moment that matter formed from this substance-less substance, time grabs hold. Not "begins." Time is created at the beginning. But time "grabs hold." When matter condenses, congeals, coalesces, out of this substance so thin it has no essence -- that's when the Biblical clock of the six days starts.

Science has shown that there's only one "substance-less substance" that can change into matter. And that's energy. Einstein's famous equation, $E=MC^2$, tells us that energy can change into matter. And once it changes into matter, time grabs hold.

Nachmanides has made a phenomenal statement. I don't know if he knew the Laws of Relativity. But we know them now. We know that energy -- light beams, radio waves, gamma rays, x-rays -- all travel at the speed of light, 300 million meters per second. At the speed of light, time does not pass. The universe was aging, but time only grabs hold when matter is present. This moment of time before the clock begins for the Bible, lasted about 1/100,000 of a second. A minuscule time. But in that time, the universe expanded from a tiny speck, to about the size of the Solar System. From that moment on we have matter, and time flows forward. The Biblical clock begins here.

Now the fact that the Bible tells us there is "evening and morning Day One" (and not "a first day") comes to teach us time from a Biblical perspective. Einstein proved that time varies from place to place in the universe, and that time varies from perspective to perspective in the universe. The Bible says there is "evening and morning Day One".

Now if the Torah were seeing time from the days of Moses and Mount Sinai --

long after Adam -- the text would not have written Day One. Because by Sinai, hundreds of thousands of days already passed. There was a lot of time with which to compare Day One. Torah would have said "A First Day." By the second day of Genesis, the Bible says "a second day," because there was already the First Day with which to compare it. You could say on the second day, "what happened on the first day." But as Nahmanides pointed out, you could not say on the first day, "what happened on the first day" because "first" implies comparison -- an existing series. And there was no existing series. Day One was all there was.

Even if the Torah was seeing time from Adam, the text would have said "a first day", because by its own statement there were six days. The Torah says "Day One" because the Torah is looking forward from the beginning. And it says, How old is the universe? Six Days. We'll just take time up until Adam. Six Days. We look back in time, and say the universe is approximately 15 billion years old. But every scientist knows, that when we say the universe is 15 billion years old, there's another half of the sentence that we never say. The other half of the sentence is: The universe is 15 billion years old as seen from the time-space coordinates that we exist in on earth. That's Einstein's view of relativity. But what would those billions of years be as perceived from near the beginning looking forward?

The key is that the Torah looks forward in time, from very different time-space coordinates, when the universe was small. But since then, the universe has expanded out. Space stretches, and that stretching of space totally changes the perception of time.

Imagine in your mind going back billions of years ago to the beginning of time. Now pretend way back at the beginning of time, when time grabs hold, there's an intelligent community. (It's totally fictitious.) Imagine that the intelligent community has a laser, and it's going to shoot out a blast of light, and every second it's going to pulse. Every second --- pulse. Pulse. Pulse. It shoots the light out, and then billions of years later, way far down the time line, we here on Earth have a big satellite dish, and we receive that pulse of light.

And on that pulse of light is imprinted (printing information on light is called fiber optics - sending information by light), "I'm sending you a pulse every second." And then a second goes by and the next pulse is sent.

Light travels 300 million meters per second. So the two light pulses are separated by 300 million meters at the beginning. Now they travel through space for billions of years, and they're going to reach the Earth billions of years later. But wait a minute. Is the universe static? No. The universe is expanding. That's the cosmology of the universe. And that does not mean it's expanding into an empty space outside the universe. There's only the universe. There is no space outside the universe. The universe expands by its own space stretching. So as these pulses go through billions of years of traveling, the universe and space are stretching. As space is stretching, what's happening to these pulses? The space between them is also stretching. So the pulses really get further and further apart.

Billions of years later, when the first pulse arrives, we say, "Wow - a pulse!" And written on it is "I'm sending you a pulse every second." You call all your friends, and you wait for the next pulse to arrive. Does it arrive another second later? No! A year later? Maybe not. Maybe billions of years later. Because depending on how much time this pulse of light has traveled through space, will determine the amount of stretching of space between the pulses. That's standard astronomy.

15 billion or six days?

Today, we look back in time. We see 15 billion years. Looking forward from when the universe is very small -- billions of times smaller -- the Torah says six days. They both may be correct.

What's exciting about the last few years in cosmology is we now have quantified the data to know the relationship of the "view of time" from the beginning, relative to the "view of time" today. It's not science fiction any longer. Any one of a dozen physics text books all bring the same number. The general relationship between time near

the beginning when stable matter formed from the light (the energy, the electromagnetic radiation) of the creation) and time today is a million million, that is a trillion fold extension. That's a 1 with 12 zeros after it. It is a unit-less ratio. So when a view from the beginning looking forward says "I'm sending you a pulse every second," would we see it every second? No. We'd see it every million million seconds. Because that's the stretching effect of the expansion of the universe. In astronomy, the term is "red shift." Red shift in observed astronomical data is standard.

The Torah doesn't say every second, does it? It says Six Days. How would we see those six days? If the Torah says we're sending information for six days, would we receive that information as six days? No. We would receive that information as six million million days. Because the Torah's perspective is from the beginning looking forward.

Six million million days is a very interesting number. What would that be in years? Divide by 365 and it comes out to be 16 billion years. Essentially the estimate of the age of the universe. Not a bad guess for 3300 years ago.

The way these two figures match up is extraordinary. I'm not speaking as a theologian; I'm making a scientific claim. I didn't pull these numbers out of hat. That's why I led up to the explanation very slowly, so you can follow it step-by-step.

Now we can go one step further. Let's look at the development of time, day-by-day, based on the expansion factor. Every time the universe doubles, the perception of time is cut in half. Now when the universe was small, it was doubling very rapidly. But as the universe gets bigger, the doubling time gets longer. This rate of expansion is quoted in "The Principles of Physical Cosmology," a textbook that is used literally around the world.

(In case you want to know, this exponential rate of expansion has a specific number averaged at 10 to the 12th power. That is in fact the temperature of quark confinement, when matter freezes out of the energy: 10.9 times 10 to the 12th power Kelvin

degrees divided by (or the ratio to) the temperature of the universe today, 2.73 degrees. That's the initial ratio which changes exponentially as the universe expands.)

The calculations come out to be as follows:

The first of the Biblical days lasted 24 hours, viewed from the "beginning of time perspective." But the duration from our perspective was 8 billion years.

The second day, from the Bible's perspective lasted 24 hours. From our perspective it lasted half of the previous day, 4 billion years.

The third 24 hour day also included half of the previous day, 2 billion years.

The fourth 24 hour day -- one billion years.

The fifth 24 hour day -- one-half billion years.

The sixth 24 hour day -- one-quarter billion years.

When you add up the Six Days, you get the age of the universe at 15 and 3/4 billion years. The same as modern cosmology. Is it by chance?

But there's more. The Bible goes out on a limb and tells you what happened on each of those days. Now you can take cosmology, paleontology, archaeology, and look at the history of the world, and see whether or not they match up day-by-day. And I'll give you a hint. They match up close enough to send chills up your spine.

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