

Lecture 10

Determinism is one of the great questions faced by modern science. If we believe that we can perfectly know all the causes and their effects, then we should be able to know everything. If we could just put all the initial data into our man made computer, we should be able to predict all future events. This understanding of determinism, which indeed does contradict the concept of free-will, which is the basis of the Torah, was a dogma of classical science. Laplace, one of the greatest scientists of the previous century, wrote clearly that if you could tell him the exact position and movement of every single particle in the universe, then he could tell you everything that would happen in the future.

This definitely contradicts the entire Torah, the entire faith system that is built on the principle that man has free choice, and that man is free to determine his own path in life—that it is not predetermined, that it is not fate. If there is one reason that science contradicted faith it is not because the age of the universe, or some other external thing that will eventually be explained by science itself. It is only because of this problem, the problem of determinism. Evolution is not the problem, unless it is entirely based on determinism.

Classic determinism was the dogma of science until quantum mechanics. So quantum mechanics was a very good innovation. Quantum mechanics declares that it is impossible to really even know the initial conditions, all the more so that I cannot know where things will end up. So, initially it seemed that quantum mechanics was the downfall of classic determinism. About which, we may say: *"Baruch Hashem"; "Shehechyanu."* We can make a blessing that quantum mechanics came along and destroyed classic determinism, for our good, for the good of the Torah, for the good of faith.

But, then quantum mechanics came up with another form of determinism, which is not the same; it seems to be more o.k. than the classic determinism. This is called quantum determinism. What is this? Quantum determinism says that though I cannot know exactly what will happen, I can still know pretty much (maybe 99%) what will happen, because of probability considerations. The foundation of quantum mechanics is probability. Probability is

the essence of the wave function, which is actually a probability function. So if there is a tremendous probability that something will happen, I can say with almost complete certainty that it will happen.

Though it leaves a very tiny little bit of room for choice, but it is really tiny. This is also sometimes called probabilistic determinism—everything is probable, not 100% determined as thought before quantum mechanics. Even Einstein had a problem with this little bit of choice that was left. Einstein was a Jew, so he should have preferred this quantum determinism, but he had a real problem with it and he preferred classical determinism. It was very hard for him to accept that God plays dice with the universe. We explained previously that there is an inherent mortal consciousness in nature that is the result of Adam's primordial sin and the descent of nature into an uncertain state.

In any case, this is the second stage of determinism: though science no longer believes in classical determinism, it accepts quantum determinism.

But, then along came Stephen Hawking, who is the greatest authority on black holes. Black holes were already predicted by general relativity, so Einstein knew about them more or less. A black hole is a region of space that has so much matter and so much gravitational pull that even light that approaches the black hole will be drawn and sucked and swallowed by the gravity field surrounding the black hole. That is why it is called a black hole, because its light cannot reflect off of its surface, it is dark. It is the ultimate prison, that whoever enters cannot leave. Everything has a verse to describe it. In this case the verse that describes such an inescapable prison is: "All who enter will not return."⁸² This verse actually refers to heresy. Whoever comes into it will not be able to get out of it. That's what Egypt appeared to be. No slave could escape. It was the absolute prison. Nonetheless, the Almighty delivered us out of Egypt.

Hawking's first insight was that because of Dirac's sea (which we discussed in the previous lecture), the continuous activity in the apparent vacuum of space, there forms what is called Hawking radiation or glow. Remember that because of quantum uncertainty, pairs of virtual particles are constantly being created spontaneously everywhere in space. Since these pairs of virtual particles comprise a particle and its anti-particle, normally, they just annihilate each other immediately. But, in the case that they are created exactly on the event horizon of a black

⁸². Proverbs 2:19.

hole—the event horizon is the theoretical barrier beyond which anything entering will not be able to escape the black hole’s gravitational field—then one particle is ejected and one is sucked into the black hole’s gravitational field. Since one is ejected, even though the black hole cannot be seen, it does have a distinctive glow around it, made up of these ejected virtual particles. This theory is of course all mathematical. No one has actually observed a black hole. This was Hawking’s first insight into black holes. This is very interesting. You would have thought that anything that is black could not be seen. The color black is such because it absorbs all colors of light, yet somehow, here, black does glow, something comes out of it.

As we will explain, black holes are related to how the entire universe was created, and it is surmised that every galaxy has a black hole at its center, including our own galaxy.

Then Hawking had a second insight, which is arguably one of the greatest disputes in the scientific world today. It has to do with information and with the question of whether when a virtual particle is sucked into a black hole, is its wave function forever lost and unrecoverable. This idea is controversial, because if it is correct then quantum determinism does not hold. If I would know the state of the universe now, which is all the information, then I could by probability predict 99% correctly the future. But, if a chunk of information is lost, it would destroy the possibility of determining the future, even within probability. This is because quantum determinism assumes that all of the information (all of the possible outcomes of the wave function) is still present. But, if all of a sudden the universe loses information, due to the black hole, then even probability cannot tell me about the future.

Perhaps the greatest innovation of string theory—even greater than the notion of strings, or more dimensions, etc.—has to do with this paradox. String theory says that even after wave destruction the information lost in a black hole can be retrieved. Not only does a black hole cause a radiation to be emitted around it, but even the information that is swallowed up in it can reemerge, meaning that the information is not lost forever. This would seem to return us to quantum determinism.

So if retrieving the information is like resurrecting it, Hawking believes that once something is buried in a black hole, it can never be resurrected. But, string theory believes, like the Torah, in resurrection.

So all this has tremendous scientific ramifications. But, our goal here is to answer how all of this is alluded to in the Torah, and how it stands in relation to the Torah?

There are two simple and obvious images for "lost information." The first is that losing information is like forgetting. To lose information psychologically is like forgetting. So the question about information lost in a black hole is, is there something inherent in the universe that allows it to forget. According to the Torah, it is very good to forget, because by forgetting you can open up new directions of choice. But, if the world is never going to forget all of its previous information, it will be a much more deterministic world.

The second, even more straightforward image for information loss is of losing, like misplacing something (in Hebrew, אבדה). As King David says in Psalms: "I am lost like a sheep, seek Your servant." Like "lost and found." When a person loses something, there is a custom to say, "Elaka de'Meir Aneini" ("God of Me'ir, answer me") and then he will find it. To lose psychologically is to forget; to lose a physical object is just an אבדה.

One of the most important commandments in the Torah is that if someone has lost something and you find it, you have to return it to him. This is a commandment governing our relationship with other people. So if the universe also "loses" things (information), we might ask if we are obligated to return them to it.

The initials of "the lost" and "the forgotten" are the Hebrew word for "fire" (אש, אבדה שכחה). The sages use the image of finding something that has been lost as an image for the whole topic of finding one's soul-mate. Finding your spouse is like finding your back-side (your lost "rib"), as originally Adam and Eve were one person joined back to back. Indeed, in Hebrew, the word for woman (אשה) etymologically stems from the word for "forgotten" (נשה). The backside represents the unconscious, the "hole" where things are forgotten. There are seven synonyms for "earth" in the Bible.⁸³ One of them is נשיה, pronounced "neshiyah,"⁸⁴ and meaning "the place where things are forgotten." These are idioms that are thousands of years old and which are black-hole like.

Let us look at the numerical values of these two words:

- Something that is lost is אבדה, whose numerical value is 12.
- Forgetfulness, שכחה, is equal to 333.

Their numerical sum is 345, which is the numerical value of the name "Moshe" (משה).

This is quite strange as Moshe Rabbeinu signifies memory. The verse in Malachi says: "Remember the Torah of My servant Moshe."

⁸³. *Midrash Vayikra Rabbah* 29:11.

⁸⁴. *Psalms* 88:13.

Moshe is the epitome of mind and wisdom. So if Moshe equals "forgetfulness" and "loss" together then that means that he is their opposite. This is a case of a rectifying *gematria* where one side of the equivalency rectifies the other.⁸⁵ So it is very interesting that these two images for information lost in a black hole equal the value of Moshe Rabbeinu's name. This is once again one of the most important issues in all of modern science, as it can change our entire understanding of determinism in nature, which is especially relevant in respect to science in relation to faith.

Now, the root of the word for "forgetfulness" is: שכח. The most important permutation of this root is "darkness," חשך. This is the literal meaning of a "black hole," eternal darkness, a symbol of death, or being buried forever. But, most significantly, these two words "darkness" and "forget" have the same letters in Hebrew.

The first time that darkness appears in the Torah is even before the creation of light. Before God created light, the earth was dark. This follows the natural order of things as stated by the sages: "first [comes] darkness then [comes] light."⁸⁶ In respect to science, what this means is that first comes the darkness of the black hole and only then, as a secondary phenomenon, does the light, the glow (Hawking radiation) begin to come out of the black hole. This is the type of light that is described in Ecclesiastes as, "light is more beneficial [when it comes] from darkness."⁸⁷ The order in creation is first darkness then light.

The most important phenomenon of a black hole is its border, its event horizon.

What does the Torah say about the primordial darkness? "And darkness on the face of the abyss."⁸⁸ If there is a term in the Torah that refers to the event horizon of a black hole, this is it. The "face of the abyss" is the border of the abyss, where the abyss of course is a beautiful metaphor for a black hole. Everything is trapped in there. What is the only thing that can come out of there; that we can resurrect? It is lost information!

In the Talmud, the image for a case of lost information is that of a *talmid chacham*, a scholar, who has forgotten his

⁸⁵. For example: the numerical value of "Mashiach" (משיח = 358) is the same as the numerical value of "serpent" (נחש = 358).

⁸⁶. ברישא חשוכא והדר נהורא, *Shabbat* 77b.

⁸⁷. Ecclesiastes 2:13.

⁸⁸. Genesis 1:2.

learning.⁸⁹ Even if it seems to have totally disappeared, it is destined to reappear. That is why the sages say that you still have to honor him, even if he seems not to remember anything. It will ultimately be retrieved. It will resurface. This resurfacing of information is alluded to in the final part of the verse describing the “event horizon”: “And the spirit of God hovered over the face of the waters.” And then “God said: Let there be light...”

So we have here beautiful images in the beginning of the Torah that represent black holes, event horizons, and darkness before light.

So we could say that all of science (*vis à vis* faith) is revolving around the question of whether the universe forgets or not, and whether that forgetfulness is permanent. The answer to this question seems to hinge on whether the wave collapse that the virtual particle entering the black hole experiences is complete or not. If it is complete, then essentially, the information is not retrievable. If it is not, the information may reappear elsewhere, or could be retrieved from the black hole itself. To date, no one knows how to interpret quantum mechanics in respect to the reality that we experience everyday. There are many competing interpretations. Two of these are dubbed the Copenhagen interpretation and the Many-universes interpretations and they differ on the question of the necessity of wave collapse. According to the Copenhagen interpretation, wave collapse is essential to the quantum mechanical take on our reality, because without it, reality would not be strictly defined and things would stay in a state of indeterminacy. But, according to the Many-universes interpretation, wave collapse is not essential as *all* possible outcomes occur, each in a different universe.

Let us say that Hawking’s notion about black holes swallowing up information forever is found in the verse: “death swallows [things] forever.”⁹⁰ Whereas string theory’s notion of information

⁸⁹. תקפה עליו משנתו, *Mishnah Avot* 3:10. From the verse, “Be very careful and guard yourself, lest you forget those things that your eyes saw” (Deuteronomy 4:???) the sages learn that a person must not forget the Torah that he has studied. However, from another verse, “lest they shall be discarded from your heart, all the days of your life” (Ibid. *ibid*:???), they learn that the prohibition of forgetting is only if a person does so on purpose—choosing to forget his studies—implying, that if it happens naturally (תקפה עליו משנתו), it is not lost altogether and can still be retrieved.

⁹⁰. Isaiah 25:8.

being retrievable from a black hole corresponds to the verse: "It has swallowed strength and spit it out."⁹¹ חיל בלע ויקיאנו

The point we are trying to emphasize is the concept of forgetting. It says that the Almighty remembers all that has been forgotten (זוכר את כל הנשכחות). Everything that has been destroyed is still remembered by God.

We said that sometimes it is good to forget, because it opens up possibilities of choice. Sometimes it's good to forget, as the Ba'al Shem Tov says that in general it is not good to know your previous incarnations as it will limit your free will. The Arizal said that it is good to know your past incarnations in order to focus on what your rectification is in this life time. But, the Ba'al Shem Tov felt that such knowledge may well fixate you on a certain image of what your life should be about. It would limit you to a certain rectification. Consequently, you will not be free to progress infinitely in this lifetime to greater things than just seeking one particular rectification. Death is a classic parallel to information that has been swept up and swallowed up by a black hole and the question of retrieving the information from the black hole is like the process of remembering one's previous incarnations.

Let us now address the paradox of determinism and free-will. It is important to know that in Judaism determinism and free-will are not an either or proposition. They are paradoxically both true simultaneously. Everything is predetermined and yet, there is free-will. This is because Judaism is inherently paradoxical.

In Jewish philosophy, as for instance in the thought of Maimonides, the two sides of the paradox are known as "[God's] knowledge and [our] choice," or "[God's] decree and [our] choice." But, in the original way that this paradox was stated by the sages, the paradox is not between God's knowledge and our choice. There is only one way that this paradox is phrased, which is not the normative philosophical way of putting the question in an abstract way. This singular phrase, which states the paradox of the most important spiritual problem of life, is: "All is foreseen, and permission is given."⁹² This expression is from Rabbi Akiva, the Moshe Rabbeinu of the Oral Torah. He was the only one who could express the essential nature of this paradox in words. This is very poetic language. The poetry here is very significant. It is not a dry, dead intellectual question. It is saying simultaneously: "all is foreseen" and "permission is given." "Foreseen" does not mean the same thing as "known," i.e.,

⁹¹. Job 20:15.

⁹². הכל צפוי, וְהַרְשׁוּת נְתוּנָה, Mishnah Avot 3:15.

that God knows all. It certainly does not mean "decreed" (גזירה), meaning that God has decreed that we act in a certain way. By the way, the usual answer given to the problem of knowledge and free will is to distinguish between "knowledge" and "decree." Meaning that decree is much stronger and affects our actions much more than knowledge does, but that in reality God only knows, He does not decree. "Determinism" usually implies "decreed." But, here the word is neither knowledge nor decree.

Now, whoever has a fine knowledge of Hebrew knows that the translation of this word is not even "foreseen," but rather "foreseeable." This is a nuance in Hebrew. It is like saying that "this was foreseeable," I should have been able to guess this. Now, this sounds a lot like quantum determinism. It is a very probabilistic way of seeing. But, you are given permission to do what you like. Again the word here is not that you have free choice, or free will, but that you have permission, you have a green light, to act as you like.

We could go on in length about this point. But, now let us make a "sign" for this teaching.⁹³ The symbol for this paradox is the bird, as the Hebrew word for "bird" (צפור) is an acronym for the two key words of this phrase: צפוי וְשׁוֹת. God sees everything in a foreseeable way, and everything has freedom to act. So now we have a symbol of a bird to go together with our particle zoo.

The *Zohar* says that the Mashiach's soul, before it comes down, resides in the Bird's Nest (קן צפור). The nest itself represents consciousness. "Bird's Nest," קן צפור = מודעות, "consciousness." If I would have perfect consciousness, then I would be like a bird in the nest, like the Mashiach, able to exercise complete freedom of will, but still in the nest waiting to fly out and come to us. Like a chick that is waiting to mature sufficiently to fly into the world, into our minds and hearts.

Let us see some slightly more sophisticated *gematria* than what we have until now.

Let us begin with a little understanding of what happens when you add dimensions to space-time. When you add a dimension you are really going up, numerically, by square roots.

One of the basic principles in Kabbalah⁹⁴ is called the "twelve diagonals" (יב גבולי אלכסון).⁹⁵ If I have a unit square, the length of its diagonal is $\sqrt{2}$.

⁹³. As the sages say that one should make signs to remember one's learning (סייע סימנים עשה), see *Shabbat* 104a.

⁹⁴. *Sefer Yetzirah* 5:2.

⁹⁵. One of the things that these twelve diagonal lines correspond to is the 12 tribes of Israel.

If it is a square with length and width n , then the diagonal will be $n\sqrt{2}$.

In any case, $\sqrt{2}$ is to be associated with the diagonal.

Rabbi Levi Yitzchak of Berditschev explains that the word "diagonal" in Hebrew, **אלכסן**, means "seeing the nothing" **סכל אן**. So if you can see the "diagonal" of something, you are seeing the aspect of "nothingness" in it. If you want to see nothingness, do not look straight, look diagonally.

All diagonals are multiples of square roots.

If I have a unit cube, then the diagonal is $\sqrt{3}$. To compute this we see that it is the diagonal of the diagonal of two of the sides and one more dimension. Or in other words:

The diagonal of two sides is $\sqrt{2}$, as we said above. And then the diagonal of that with another of the dimensions is, following the Pythagorean theorem:

$$\sqrt{(2 + 1)} = \sqrt{3}$$

Now, for space-time, which has four dimensions, the diagonal is $\sqrt{4} = 2$.

But, the Book of Formation defines that there are 5 dimensions, 3 space, 1 time, and 1 value dimension which runs from good to evil (we mentioned that if science would take this dimension into account, many of the problems it encounters today would be solved). The diagonal of a unit 5-dimensional cube would be $\sqrt{5}$. This is also the basis of the golden section, as explained in our book on the Golden Section. There are books that claim that the most important number in the universe is $\sqrt{2}$ and there are those who claim that that number is $\sqrt{5}$.

So first, let us state the general principle:

\sqrt{n} is the diagonal of the cube in n -dimensional space.

So the diagonal of an 11 dimensional cube is $\sqrt{11}$.

And, again, the diagonal represents the nothingness from which all somethingness comes.

In string theory, which now surmises 11 dimensions, 10 of which are spatial, the $\sqrt{10}$ is also very important. This would be the diagonal of space in String Theory.

Now let us write out the three most important square roots to four decimal places:

$$\sqrt{2} = 1.414$$

$$\sqrt{3} = 1.732$$

$$\sqrt{5} = 2.236$$

If we take out the decimal points, as is done in Kabbalah, we get that:

$$2236 = 2 \cdot 1118 \text{ or } 2 \cdot \text{שמע ישראל הוי' א-להינו הוי' אחד}$$

$2236 = 86 \cdot 26$, where 86 is the value of God's Name *Elokim* (**א-להים**) and 26 is the value of God's essential Name, *Havayah* (**י-הוה**). 1118 is the first number that is a multiple both of 86

and 26. This number 2.236 is the basis of the Golden Ratio, which is the basis of the beauty and elegance of the universe.

Now, the sum of the two other numbers is also a multiple of 26, the numerical value of God's essential Name, *Havayah* (י-הוה):

$$1414 + 1732 = 121 \cdot 26, \text{ or } 11^2 \cdot 26$$

So the sum of all three is:

$$207 \cdot 26 = \text{אור} \cdot \text{הוי} = \text{light times } Havayah$$

What is the geometric relationship between 86 (the value of "Elokim") and 207 (the numerical value of "light")? If we draw a square with length 86, the diagonal will be 121, which is the difference between 207 and 86.

Now, let us see what happens when we add the 5 to the 3:

$$2236 + 1732 = 248 \cdot 16 = \text{רמח} \cdot \text{הוה}$$

Where 248 is the number of positive commandments and הוה (16) are the final three letters *Havayah*, which as a word mean "present" (for, according to Kabbalah, the positive commandments rectify the present moment of reality, the inherent reality of the three created Worlds of Creation, Formation, Action, which correspond to these three final letters of *Havayah*).

$$2236 + 1414 = 365 \cdot 10 = \text{שסה} \cdot \text{י}$$

365 is the number of prohibitive commandments and י (10) is the first letter of *Havayah*, which corresponds to the World of Emanation (pure Divine consciousness, above experience of created time and space), the level of consciousness reached by our observing the prohibitive commandments (the level of "no" above "yes," while simultaneously giving rise to the "yes").