

# Lecture 7

We are now going to continue with elementary particles. There are three types of elementary particles. Two are referred to as real particles, and the third type is called virtual. As we will describe, these three types of particles correspond to the three Worlds of Creation, Formation, and Action. Virtual particles correspond to the World of Creation. The two other types of particles are bosons (force particles) and fermions (matter particles). Fermions—matter particles—clearly correspond to the World of Action, which is where matter exists, and bosons—force particles—most of which have 0 rest mass<sup>55</sup> (except for the particles of the weak interaction, the w and z particles, which do have mass) clearly correspond to the World of Formation. Let us summarize this in a table:

שרף			consciousness	virtual particles	ישעיה	בריאה
אריי	strong	חיה	real	force particles	יחזקאל	יצירה
שור	weak					
נשר	e/m					
אדם	gravity					
סוס				matter particles	זכריה	עשיה
$3^6 = 9^3 = 27^2 = 729$ פסח מצה מרור =						

Virtual particles are not called that because they are unreal. All physicists agree that they exist. It is because they exist for such a short time that it is *virtually* impossible to identify and observe them. There are four types of virtual particles. They can be virtual bosons, (virtual force particles) or virtual fermions (virtual matter particles). They appear in pairs, of positive and negative, as if out of nowhere, and immediately annihilate one another.

There are four sources of virtual particles. Three of these sources are a direct result of the uncertainty principle. These three consequences of the uncertainty principle are:

<sup>55</sup>. All particles have relative mass, as in relativity everything has energy which can be translated as mass.

- 1) any real particle can spontaneously emit any virtual particle,
- 2) that outer space (which is wrongly considered to be a vacuum) can also spontaneously erupt into virtual particles, which immediately annihilate one another,
- 3) the electromagnetic field gives rise to virtual particles.

The fourth source of virtual particles comes from Feynman diagrams, where virtual particles are exchanged when there is an interaction. Quantum mechanics posits that when there is an electromagnetic interaction, two virtual photons which are messengers make the interaction take place. A real photon is a particle of light. A virtual photon is like created out of nothing. This is why they are related to the world of creation. A "vacuum" like space, is continuously creating virtual particles. Another reason that we see virtual particles to correspond to the World of Creation is because three of the four sources for virtual particles are because of the uncertainty principle, which we have already identified with the counter-intuition of the World of Creation.

Based on the verse: "the concealed is for *Havayah* our God, and the revealed to us and our children, forever," Kabbalah teaches that the two higher Worlds, the Worlds of Emanation and Creation are relatively concealed, whereas the two lower Worlds, Formation and Action, are relatively revealed. So, given that virtual particles are relatively hard to detect and observe, we understand them to correspond to the World of Creation, while force and matter particles, which can be detected therefore correspond to the Worlds of Formation and Action, the revealed dimensions of reality. Only, that the World of Formation is composed of forces, whereas matter exists in the World of Action. So we have here our three types of elementary particles.

Let us repeat that the virtual particles can be either virtual force or virtual matter particles. A very interesting thing is that there are some scientists that believe that conscious systems correspond to the level virtual particles, or, put another way, that conscious thought is a result of virtual elementary particles, which once more are created *ex nihilo*. This is an amazing relationship. This is another reason to relate virtual particles to the World of Creation, which corresponds to the mind. Conscious systems in nature correspond to the World of Creation.

Now, we said before that with the primordial sin, when Adam ate from the Tree of Knowledge, all of these three worlds fell into a state of uncertainty. So that means that the conscious systems also fell 14 levels. Or, as we said before, that the very consciousness inherent within nature became mortal, which means

that it became subject to existential uncertainty. That is what is written on the right side of the board, explaining that these three types of particles exist in our three lower worlds.

To continue to explain this chart, we have to know that Kabbalah teaches that there were three prophets who in their prophecy experienced the Workings of the Divine Chariot, Isaiah, Ezekiel, and Zachariah. There are two secret subjects in the Torah: the Workings of Creation and the Workings of the Divine Chariot. "Workings of the Divine Chariot" refers to the *purpose* of creation. Three prophets had a vision of the chariot, the purpose of creation. Each of them saw the chariot from a different perspective.

The highest vision was Isaiah's, whose consciousness was in the World of Creation. Ezekiel's consciousness was in the World of Formation. Zachariah saw his vision in the World of Action. Each one saw a different image in his vision. The components of these chariots are angels, and in each image the angels were of different types. We already mentioned in one of our earlier lectures that angels can be understood as elementary particles. In each vision they saw the chariot driven by different angelic beings. Of course, the most well-known is Ezekiel's vision.

We will start from the bottom. Zachariah saw the chariot as a chariot driven by horses (מרכבת סוסים). To see the purpose of creation at the level of matter is seeing horses. In the world Action, it is all just one big horse-race. And the matter particles appear as horses on the run.

The most famous vision of the chariot is Ezekiel's vision. He sees what are called in the Bible "holy living beings" (חיות הקדוש). His chariot is composed of four different kinds of living beings. Those exist in the World of Formation. How amazing is it that there are four forces in our physical world, which therefore must be seen as corresponding to these four types of angels. The simple meaning of a "living being" is a being that gives life, or in other words life-force. These are of course the four force particles of the four forces in nature. The last of these is the living being which resembles a man. This is not the higher man that in Ezekiel's vision sits on the throne being carried on the chariot. This living being is different from the four others. Living being also means "animal," in Hebrew (i.e., animation). So of these four living beings, three are represented by animals, a lion, an ox, and an eagle. So, this fourth one, that resembles a man is obviously different. In the text of Ezekiel, the living being that resembles a man appears first, but in Kabbalah it is ordered last. This living being that resembles a man as we will see corresponds to gravity. The three others represent the three other forces of nature, which can be almost unified even without

string theory. But, the one that is elusive and cannot as yet be connected with the others is gravity. In any case we have here a beautiful allusion to the four forces in nature.

Finally, the highest vision of the Divine chariot was experienced by Isaiah (chapter 6), which corresponds to the consciousness of the World of Creation.<sup>56</sup> In the chariot of Isaiah, Isaiah sees only a pair of fiery angels (*seraphim*). As we noted, virtual particles appear in pairs. But, what is even more significant for correctly identifying which particles these angels correspond to is the word used to describe them: *seraph*. *Seraph* literally means "fiery angel," which describes them as beings that appear and are then spontaneously burnt up. In other words, they appear and immediately annihilate, which is the exact nature of virtual particles! How amazing is it that the vision of Isaiah is that of fiery angels that are born and then spontaneously burn away. To burn away means that they return to their origin in Emanation. Take the image that we gave above of the vacuum constantly erupting into virtual particles, which are then annihilated. This is an image of something being created (*ex nihilo*, like in the World of Creation) and subsequently returning back to its source. The very same process describes the creation of the *seraphim* out of the World of Emanation, which is the nothingness which creation *ex nihilo* comes from.<sup>57</sup>

So now we have three names of angels:

- the *seraph* (שרף) - the virtual particles in the World of Creation
- the living being, or animal (חיה) - the real force particles in the World of Formation
- the horse (סוס) - which corresponds to the real matter particles of the World of Action.

Now let us look at the significance of the numerical value, the *gematria* of these names:

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<sup>56</sup>. We read Isaiah's vision as the *haftarah* (the portion in the Prophets) of *parashat Yitro* in which the giving of the Torah at Mt. Sinai is described. There is always some resemblance between the *parashah*, the Torah portion, and the *haftarah* that the sages linked with it. In this case, the connection teaches us that the vision of the chariot seen by Moses and the entire Jewish people at the Mt. Sinai (which is of course never described) was the one corresponding to the World of Emanation. This is referred to as the chariot of Moses.

<sup>57</sup>. By Divine providence, in today's (כט אדר) reading of *Hayom Yom*, the Lubavitcher Rebbe mentions that the world was created as something from nothing, and the purpose of a Jew is to reveal the original nothingness within every something.

*Seraph*: שרף = 580 = 10 · חן, which is the Hebrew word for "symmetry."

Living being: חיה = 23, a very important number in Kabbalah. In the entire story of creation there are 469 words. The middle word is the 235<sup>th</sup> word, which is this word, which appears in the verse: God said: "Let the waters swarm with living beings" (וַיֹּאמֶר אֱלֹקִים (יִשְׂרָאֵל) שְׂרָצוּ הַמַּיִם שָׂרָץ נֶפֶשׁ חַיָּה), which is also the first appearance of this word in the Torah. So this word acts as the axis of symmetry for the entire story of creation. This alludes to the fact that while in Ezekiel's vision there is no mention of fish, only land animals, in the Torah the first example of living beings specifically refers to fish.

סוס = 126. The letters of this word are themselves symmetric. There is something very symmetric about a horse. (So apparently a horse can go back in time, retaining CPT symmetry).

So we have now seen that each of these three words exhibits a different form of symmetry.

If we sum all three words together, we get  $729 = 27^2 = 9^3 = 3^6$

Whenever we have a power, an expression of the form  $x^y$ , we are expressing a quality of inter-inclusion.

We are taught in Kabbalah that there is another triplet of words that are connected and have this same value. In the *Hagadah* we say that whoever does not experience three things on Pesach has not performed the *seder* properly. They are: the Paschal lamb (פסח = 148), *matzah* (מצה = 135), and bitter herbs (מרור = 446). And numerically:  $148 + 135 + 446 = 729!$  This is a meditation for Pesach.<sup>58</sup>

Let us see how these three components of Passover correspond to the three types of particles. Indeed, today the פסח remains at the virtual level for us as we cannot offer the sacrifice. The *mitzvah* of the Paschal lamb is that it be eaten roasted, more burnt than anything else eaten in the Temple service. There is no more "burnt," *seraph*-like, offering that we eat. This represents the level of consciousness attained by a *tzadik* who always feels how the world is coming into being out of nothing and instantaneously returning to nothingness.

Eating the *matzah* corresponds to the four force particles. Bread is what gives a person energy, or life-force. As the verse states: "Not on bread alone can man live, but on the word of God will man live." So it is not the physical matter that gives life, but the inner life-force. *Matzah*, which is a form of poor bread reveals this, that it is not the physical but the spiritual

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<sup>58</sup>. So our Passover cleaning is really to clean out all the negative virtual particles and to reveal the good virtual particles, which are then revealed in the burning of the Paschal lamb.

within the physical that gives life. So eating *matzah* is to remind us that real *force*, real life, comes from the utterance of the Almighty.

The matter particles correspond to the bitter herbs, and remind us of the hardship that is inherent in the world of action. Hardship is ultimately a good thing, because reward comes from the hardship that we experience. In the verse that lists the four Worlds, the World of Action is preceded by the word *אף* (*af*), which also stems from the word for anger, alluding to the difficulty and hardship inherent in the physical world. So once again, we see here a very nice correspondence of the three elements of Pesach with the three types of particles, with the three lower Worlds as the foundational frame of reference for all these correspondences.

### The four forces

Let us now turn to the four forces in nature. As we have just said, all four correspond to the World of Formation. We mentioned in an earlier lecture that there are three methods for unification:

- in the World of Creation, the unifying principle is nullification (התבטלות), we see this as the *seraphim* being burnt, that is nullified, in their return to nothingness.
- in the World of Formation, the unifying principle is inter-inclusion (התכללות).
- in the World of Action, the unifying principle is cooperation (השתתפות).<sup>59</sup>

Corresponding to the three visions of the chariot, we may now say that the horses of the world of Action need to cooperate, to act, or work together. The unification of matter is when it works together.

The living beings of the World of Formation are joined through inter-inclusion. In Ezekiel's vision, each of the living beings had all four faces to it: lion, ox, eagle, and man. And furthermore, each of these faces inter-included all four in itself (just that the predominant face was one of the four). Thus, the unifying principle for force particles is inter-inclusion. The paradigmatic enigma today in science is how to unify the four forces in nature. We mentioned in that earlier lecture that this is what science is still lacking: a model of unification based on inter-inclusion. This type of unification is readily apparent from a holographic image that is etched on a crystal. In other words, somehow in the strong force you should

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<sup>59</sup>Or.. שיתוף פעולה

be able to see the weak force, and the electromagnetic force, and gravity, all reflected in it.

The *Targum Yonatan*, based on the sages says that together the four *chayot*, the living beings, had 256 wings.  $256 = 4^4$ . This is a beautiful example of inter-inclusion, because, as mentioned, each of the four living beings had four sides to it and each side had four faces and each face had four wings. So altogether the four living beings had  $4^4$  wings. There is a particular type of symmetry known as angular symmetry, if you look at something from a different angle you will still see the same thing (like in a ball under rotation). Here whatever direction you looked at the living being, you saw the same thing. So in that sense, wings are like spin.

The *seraphim*, the fiery angels of Isaiah's vision, each had 6 wings. The horse angels of Zachariah's vision each had 2 wings. They are the most like how we usually imagine angels to have 2 wings (like physical birds).

Now we can draw the following correspondence:

Force particles (living beings) have four wings each;

Matter particles (horses) have two wings;

And, virtual particles (fiery angels) have six wings each.

This correspondence and its scientific and spiritual implications need to be developed further. But, let us once more note that the living beings exhibit the greatest degree of inter-inclusion, where all four living beings, reflect all four, and each of these reflections itself reflects all four. And altogether they have 256 wings.<sup>60</sup>

The book of Ezekiel,<sup>61</sup> begins with a vision that is related to four (four faces, four wings, etc. to each *chayah*, each living being). Close to its end there is another vision related to the

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<sup>60</sup>. In the Arizal it is brought that the  $\daleth$  of אחד ("one"), which in the *Shema* is written large, should actually be written the size of 4 letters  $\daleth$  (*dalet*). So this would be like 4 ( $\daleth = 4$ ) to the fourth.  $4^4 = 256$ . Aaron's name has the numerical value of 256.

$$\text{אהרן} = 256 = (16^2 = 2^8 =) 4^4$$

Indeed, Aaron the High Priest was unique amongst the priests in that he wore 8 garments of priesthood. They themselves were divided into the four simple white garments of all priests and the four golden garments reserved for the high priest.

<sup>61</sup>. Who saw the vision of the chariot that exhibits the most inter-inclusion, and therefore in a sense inter-cludes the other two visions.

number 4, which is known as the vision of the dry bones.<sup>62</sup> The dry bones represent the state of the Jewish people in exile, which are dried up. In his vision, Ezekiel sees the entire house of Israel as dry bones, which means that they are as dead. And the bones are scattered apart, which represent a maximal state of entropy where everything has fallen apart completely.

Then Ezekiel describes something which is an example of time-reversal: the dry bones come together and sinews, flesh, and skin grow on them. When scientists want to demonstrate the concept of the arrow of time, that time has a direction, they tell us to imagine a shattering glass. Now if this shattering was filmed and played backwards, we could immediately tell that the film was playing in reverse as we would see the pieces coming together. This is an example of *teshuvah*. This is like the principle in the Torah that there is no chronological order in the Torah,<sup>63</sup> in the normal sense of chronology. Sometimes, things that happened later, are written as if they happened earlier. This is the concept that is the foundation of the concept of *teshuvah*, which allows a person to go backwards and relive, and even take positive advantage of negative past events, in the way that we explained earlier that the evil becomes a throne for the good.

But, Ezekiel sees the film of "death" being played backwards, and we see the bones coming together and growing a human being as it were. This type of experience is the experience of resurrection. So the vision of Ezekiel was an example of time reversal and a shattering of the law of entropy. From high entropy (a later state, as death progresses) suddenly comes a lower entropy (an earlier state, the energy of life). The arrow of time normally travels from low entropy to higher entropy. And here, in Ezekiel's vision he sees the opposite occurring: a high entropy state (death), a state of less order, develops into a low entropy state (resurrection), a state of more order.

In his vision he saw four components to the body: bones, sinews (blood vessels), flesh, and skin. As he saw the parts being added to the bones, entropy was lessening, but at the end the body was still not alive—life-force was still missing. So if

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<sup>62</sup>. In the *Guide to the Perplexed*, Maimonides bases many of the chapters on the number 4, even though he was against the use of numbers in a "magical" or "mystical" way. As can be seen throughout his writings, Maimonides' favorite number is 4. Nonetheless, Maimonides never explicitly mentions that the underlying uniqueness of the number 4 goes back to the Tetragrammaton, the four letter essential Name of God. The sages refer to this Name as the "Name of 4 [letters]."

□. אין מוקדם ומאוחר בתורה



these four parts of the body represent the four forces of nature, then something still had to come to unify the forces together to bring the body to life. This is what Ezekiel prophesies as: "From all four corners, the wind [spirit] shall come to enliven these dead bodies."

Now, we cannot go into great detail for lack of time, but let us see how these four parts of the body correspond to the four forces:

- Bones correspond to the strong nuclear force, which holds the nucleus of the atom together, just as the bones (the skeleton) hold the entire body together.
- Blood vessels (sinews) correspond to the weak nuclear force, because that is the force responsible for radioactivity, which bears an important relationship to blood, which we will not discuss right now.
- Flesh, or the muscular system, corresponds to the electromagnetic force. In principle, the nervous system corresponds closest to the electromagnetic force, and it is most closely represented in Ezekiel's model by the muscular system.
- Skin corresponds to gravity. The complexion of the skin represents the curvature of space. As we explained, according to Einstein, space is relatively gently curved and this curvature of space is equivalent to gravity. We mentioned that the biggest discrepancy between general relativity and quantum mechanics is that relativity speaks of gentle curvature while quantum mechanics speaks of frantic curvature. Einstein was into the World of Rectification, which is gentle, while Heisenberg was into the World of Chaos, which is frantic. In any event, it is a very beautiful image to see the skin as representing the gentle curvature of space. The skin is where you see the human features of the face (just as by the living beings, the one that resembles a man, corresponds to gravity), where man is defined as man.

The fact that then the spirit has to come in to unify these four forces, to make them into a living man, this is similar to the creation of man, where after Adam's body had been formed physically, God breathed into him the breath of life, which then animated him and made him alive.