

WHEN SCIENCE CONFRONTS *HALAKHAH*

A *halakhic* ruling is often based on a certain view of the world. Occasionally, as a result of scientific advances, that view is changed. As a result the *halakhist* must respond to the new world view. One example of this is a set of *Mishnayot* which discuss the birth of a *yotzeh dofen* (apparently a cesarean section). The *Mishnayot* imply that the mother survives, but this was contradicted by the scientific "facts" of the Middle Ages. A second example is the discovery that the liquids we are accustomed to drinking are full of "worms" (microbes). The approach of *Halakhah* to such problems is discussed and then the issue of the computation of the *tekufa*, which is based (from the scientific point of view) on an inaccurate astronomical calculation is presented. A *halakhic* framework in which this "inaccuracy" may be understood is proposed; i.e., that the length of the year chosen as the basis of the calculation was deliberately taken to be approximate to allow for ease of computation. Several arguments are presented to support this suggestion.

1. INTRODUCTION

When one thinks of the areas where *Torah* and science conflict, one usually thinks of things such as the age of the Earth. *Torah* seems to tell us that the Earth is less than 6000 years old. Science gives a number that is almost a million times larger. There is, admittedly, a difficulty here, but it is a philosophical difficulty. It might affect our outlook on the world, but, provided we keep our faith, it will not affect our actions. We will still put on *tefillin* in the morning and say the *shema*; we will still keep *Shabbat*, and we will still eat kosher food. In short, when it comes to our actions, to *Halakhah Lema'aseh*, then, provided we keep our faith, the outcome of this particular conflict of science and *Torah* is of little practical importance.

In this paper I wish to concentrate on a conflict of much greater significance: where a *halakhic* ruling already exists which has the weight of many years behind it, and this ruling is based on a particular physical (or biological) understanding of the world. What happens if science suddenly demonstrates that this understanding is wrong; that the situation is, in fact, different? What do we do in such a case?

2. THE CASE OF A *YOTZEH DOFEN*

As an example, I would like to discuss three different *mishnayot*. The first is from the tractate *Bechorot* (8,2). There, the *Mishnah* discusses special cases where the usual definition of *bechor*, the firstborn, is not completely satisfied. The *Torah*, in speaking of a *bechor*, refers to him as a *petter rechem*, one who "opens the womb" (e.g., Exod, 13:2). The *Mishnah* then states: "A *yotzeh dofen* and the one born after him, neither is considered a *bechor*..." The difficulty presented by this *Mishnah* is how to understand *yotzeh dofen*. Literally, it means "one who comes out of the side," and would seem to be referring to a child born by what we now call a cesarean section (C-section). The intent of this *Mishnah* would then be clear. The child born by a C-section would not be a *bechor* since he didn't open the womb, while the one born immediately afterwards, even if he opened the womb, was not a firstborn and therefore, he too was not a *bechor*.

The words *yotzeh dofen* appear in two other places in the *Mishnah*, and in both places they are used in a way consistent with our understanding of them. In the tractate *Keritot* (1,5) the *Mishnah* discusses which women have to bring a sacrifice after childbirth. The anonymous author of this *Mishnah* says that if a woman gave birth to a *yotzeh dofen* she is not required to bring a sacrifice, while Rabbi Shimon says that she is. The dispute can easily be understood if we take *yotzeh dofen* to refer to a child delivered by C-section. In such a case, the controversy centers around the following: The first *tanna* bases himself on the verse (Lev. 12:2): "A woman who has matured seed, and gave birth to a male...." In this verse there is a redundancy, in that "matured seed" and "gave birth" have essentially the same meaning. The redundancy is meant to teach us that the laws of impurity and special sacrifices discussed in the subsequent verses apply only in the case where the woman "gave birth" from the place where the "seed is matured," not by C-section. Rabbi Shimon, on the other hand, bases himself on verse 5 in that same chapter, which starts: "And if she gives birth to a female...." Here the words "gives birth" are unnecessary, since the whole section is talking about giving birth (this is felt even more strongly in the original Hebrew). The fact that the phrase "gives birth" is included serves to teach us that any sort of birth is being referred to. Once again, the meaning of the *Mishnah* is quite clear if we take the term *yotzeh dofen* to refer to a child delivered by C-section.

The third place where the words are found is in the tractate *Niddah*. The first *Mishnah* of the fifth chapter focuses on another dispute between the (anonymous) author of the *Mishnah* and Rabbi Shimon. According to the first *tanna*, a woman does not become unclean after the birth of a *yotzeh*

dofen,¹ and (as in the *Mishnah* in *Keritot*) she does not have to bring a sacrifice. Rabbi Shimon, however, considers a *yotzeh dofen* as following the same law as a child born by a normal delivery. Once again, the *Mishnah* can be understood if we take *yotzeh dofen* to refer to a child delivered by C-section.

In fact, in his commentary on the *Mishnah*,² Rambam explains the term *yotzeh dofen* in precisely this way, but he adds something very interesting:

What is possible in such a case is that the woman is pregnant with two fetuses and her side is torn open and one (child) comes out, and afterwards the second comes out in the ordinary way, and the woman dies after the second delivery. With regard to what the speakers say, that the woman lives after her side is torn open and becomes pregnant (a second time) and gives birth, I don't know of any reason for this, and it is very strange.

In this interpretation of Rambam we see something that is very close to, but not quite, what I am talking about. We have here a conflict between *Halakhah* (the laws relating to a *yotzeh dofen*) and science (scientific knowledge of Rambam's time). The plain meaning of the *Mishnah* is that the woman survives the C-section. The medical wisdom of Rambam's time assures us that this is impossible. Rambam must decide how to deal with this inconsistency and he chooses to give a forced interpretation of the *Mishnah* in *Bechorot* in order not to contradict the science of his day. I say the interpretation is forced, because of the *Mishnayot* in *Keritot* and *Niddah*. Since these *Mishnayot* question whether the woman is unclean afterwards, and whether she has to bring a sacrifice, the implication is that she survives! Here we have a situation where Rambam is faced with a confrontation between science and *Halakhah*. The *Mishnayot* discuss what one is required to do after giving birth to a *yotzeh dofen*. The straightforward way to interpret the term is to say that it applies to a C-section, but it is a scientific fact (at least in the time of Rambam) that the woman does not survive a C-section. How do we reconcile the *Mishnah* with science? Rambam does it by interpreting the term *yotzeh dofen* to apply to a child born by C-section, and takes the *Mishnah* to apply to a special case only: where the woman gives birth to twins. One twin is born by C-section, and he is the *yotzeh dofen*; the "one who comes after" is born at the same time, but in the normal way. In this way the contradiction between the *Mishnah* and the facts of science is removed.³

In his commentary on the *Gemara* of *Niddah* (40a), Rashi takes a different approach. He too was aware that a woman (in his time) could not survive a C-section, and was faced with the same difficulty as Rambam. He gets around this difficulty by giving a new interpretation to *yotzeh dofen*. He explains the

term as: "By means of a drug her womb is opened and the fetus emerges and she recovers." Note that Rashi stresses the fact that the woman recovers. This is in order to be consistent with the implication of the *Mishnah* that the woman who has given birth to a *yotzeh dofen* survives. Yet Rashi also avoids the obvious interpretation that this refers to a C-section, apparently for the same reasons as Rambam. Thus, in order to be consistent with this and the other places where *yotzeh dofen* is mentioned, Rashi sees the need to supply an interpretation that allows the woman to survive, even though this interpretation involves deviating from the plain meaning of the words *yotzeh dofen*. Not so Rambam, however. He insists on taking the literal meaning of the words and interpreting them in the context of his understanding of medicine, even at the cost of getting into difficulties with other *Mishnayot*.

3. A CHANGE IN THE NATURE OF THINGS

There is another way of avoiding the problem of the apparent conflict between the *Mishnah* and the medical knowledge of the Middle Ages. It is a solution suggested by *Tosafot* to a difficulty that occurs in the *Gemara* (*Avodah Zara*, 24b). The firstborn of a kosher animal has a certain sanctity, and must be given to a *kohen*. If an animal is bought from a stranger, and its history is therefore unknown and that animal later has an offspring, the question arises as to whether that offspring is a firstborn. The *Gemara* gives a simple rule for a cow: If the cow is three years old, the offspring definitely belongs to the *kohen*; if it is older, then the status of the offspring is in doubt. The point of this ruling, apparently, is that a cow younger than three years of age cannot give birth. *Tosafot* raise a difficulty at this point, by noting that *their* cows often give birth at two years of age. Once again, we have a conflict between science and *Halakhah*. The *Halakhah* tells us that the first calf born to a cow after it reaches the age of three must be a firstborn, but science tells us that two-year-old cows also give birth. *Tosafot* do not try to force an interpretation. Instead, they offer an entirely different explanation: "times have changed," and the behavior of nature is different now from the time of the *Gemara*. Similar ideas are expressed by *Tosafot* in *Moed Katan* (11a) and in *Chullin* (47a). It would have been possible for either Rashi or Rambam to have applied this idea to our *Mishnah*, but neither of them chose to do so. I might add that Rabbi Moshe Feinstein discusses Rambam's rejection of the possibility that the woman survives, and notes that nowadays the survival rate is very high. He suggests, in fact, on the basis of the *Tosafot* in *Moed Katan*, that nature has changed.⁴

Strictly speaking, the case of the *yotzeh dofen* is not a good illustration of

the issue under discussion. No *Halakhah* was questioned as a result of new medical findings. I do not believe that there is any *halakhic* doubt as to whether a child born by C-section requires a *pidyon ha-ben*.^{5,6} It does, however, give us a chance to explore the attitude of the *halakhist* when confronted by a seeming disparity between what science proposes and what *Halakhah* demands. Rashi and Rambam both lived in an era when it was considered medically impossible for a woman to survive a C-section. Both of them were faced with *Mishnayot* that implied differently, and both chose to give an interpretation of those *Mishnayot* which, although somewhat forced, was consistent with the scientific knowledge of the day. It is interesting to note that, although the *Halakhah* regarding the *yotzeh dofen* is still in effect, the scientific view of the chances of surviving a C-section has changed dramatically. The inconsistency of science as opposed to the durability of *Halakhah* is one of the main differences between the two, but that is the subject of another discussion.

The problem facing *Tosafot* was of a similar nature. The *Gemara* assures us that the first calf born after a cow has reached the age of three is a firstborn, with all the *halakhic* implications that follow; yet we see that cows give birth earlier. Once again, there is no practical problem. If a calf is born to a two-year-old cow, we will treat it as a firstborn anyway, so *lema'aseh* there is no issue. What is interesting is that *Tosafot* have given us a second way of dealing with a contradiction between science and *Halakhah*. It is possible to say that the nature of things has changed since the time when the *Halakhah* was fixed.

4. THE CASE OF MICROBES

Let me now cite another example that is more to the point. It is a well-known *Halakhah* that there are many types of crawling things, such as worms and insects, that we are forbidden to eat. From the 17th century on, scientists began to examine the world with microscopes and found that it was inhabited by microbes. Indeed, even ordinary water was found to be full of small living creatures. Up until then, the accepted *Halakhah* was that one was permitted to drink clean water. Suddenly science declared that "clean" water was swarming with life. What do we do in such a case? Do we change the *Halakhah* because of the new discovery or is there a different approach?

One of the first sources to discuss the problem was the *Sefer Habrit* by Rabbi Pinchas Eliyahu ben Meir Horowitz, a pupil of the Vilna Gaon. This work was an attempt to present the most recent scientific developments from a Jewish point of view. The *Sefer Habrit* points out that scientists had discovered that it was impossible for wine to turn into vinegar without the

presence of tiny "worms," and that if one looks with a microscope, one can see them in the vinegar. He goes on to say that such vinegar is forbidden until it is first boiled and then filtered through a very fine cloth. Needless to say, the same would apply to ordinary water. We see here that the approach was, in fact, to change the accepted *Halakhah* in view of this more recent, and improved understanding of the world. This, in fact, is a third way of dealing with a contradiction between science and *Halakhah*.

As it turns out, this opinion of the *Sefer Habrit* was not accepted by other authorities. In fact, a contemporary of Rabbi Horowitz, Rabbi Avraham Danziger (1748–1820), who lived in Vilna at the time of the Vilna Gaon, strongly objected to this point of view. In his book, *Chochmat Adam* (section 34, § 49), he argues that in speaking of one who took the vows of a Nazirite, the *Torah* specifically states:⁷ "wine vinegar...he shall not drink." The implication is that everyone else is permitted to drink wine vinegar. Similarly, in the book of Ruth it says:⁸ "and you will dip your bread in vinegar." If there were any special treatment required of the vinegar before its use, surely the *Torah* and the *Talmud* would not have remained silent on such an important issue, which involves the transgression of a negative commandment. Thus, says the *Chochmat Adam*, it must be that the *Sefer Habrit* was referring to worms that are small, but large enough to be seen with the naked eye when the vinegar is held up to a strong light. If they are smaller than that they are not forbidden, since, in those cases where inspection is required, the *Torah* forbids only those things that are visible to the naked eye. This, in fact, is the accepted *Halakhah*.⁹

What we see here is a case where the previous custom of drinking water without filtration was retained, but the *halakhic* framework was reinvestigated, and it was concluded that the law applied only to things large enough to be visible to the naked eye. I do not, of course, mean to imply that the *Halakhah* was in any way changed. The law as laid down in the *Shulchan Aruch* and other sources remains. What was done here was simply to inquire whether that law applied in this new case. A careful *halakhic* investigation concluded that it did not.

5. THE COMPUTATION OF THE *TEKUFÁ*

I would now like to cite a further example, or actually a set of examples, which, as far as I know, have not been dealt with in the *halakhic* literature to any extent. The first two are based on a statement in the *Gemara*:¹⁰ "If one sees the sun in its turning point (*tekufa*), the moon in its strength (*gevurata*), the stars in their paths (*mesilotam*), and the constellations in their order (*kesidran*), he should say the blessing...." The meaning of the

words *tekufa*, *gevurata*, *mesilotam*, and *kesidran* is by no means clear, so that one could argue about the intent of the *Gemara*. Rather, I will give the interpretation of the Rambam, which is accepted by most *rishonim*, and quote the *Halakhah* as fixed by him:¹¹

If one sees the sun on the day of the vernal equinox (*tekufat Nissan*) at the beginning of the 28-year cycle, so that the equinox falls in the first part of a Tuesday night, on seeing (the sun) on Wednesday morning he says the blessing "Blessed art Thou...Who made the Creation." In addition, when the moon returns to the first part of the constellation Aries at the beginning of the month, and has not deviated to the north or to the south; similarly, when each star of the five remaining "moving stars" (i.e., planets) returns to the beginning of Aries and does not deviate to the north or to the south; in addition, any time when you see the constellation Aries rising at the very easternmost point. At all these times you say the blessing "Who made the Creation".

It is clear from this passage that Rambam imposed a particular interpretation on the statement in the *Gemara*. What is not yet completely clear is what that interpretation is. I would like first to concentrate on the middle section, about the moon and planets being at the beginning of Aries, and not deviating to the north or to the south. The sky, as we see it from the Earth, appears as a great shell surrounding our world. Astronomers refer to this apparent shell as the "celestial sphere." If we imagine the Earth's equator as projected on the shell of the sky, it would appear as a circle on the celestial sphere. We call this imaginary circle the "celestial equator." It turns out that the motions of the sun, the moon, and the five visible planets are limited to a particular part of the celestial sphere, a belt of sky tilted at an angle of 23.5 degrees to the celestial equator. This belt is known as the "zodiac," and the 12 constellations lying along this belt are the constellations of the zodiac. When the sun reaches the northernmost point of the zodiac (the summer solstice) we have the middle of summer (in the northern hemisphere), what the sages called *tekufat Tammuz*. The middle of winter occurs when the sun reaches the southernmost point (winter solstice — *tekufat Tevet*). On two occasions during the year the sun crosses the celestial equator; the vernal equinox (*tekufat Nissan*) on its northward journey, and the autumnal equinox (*tekufat Tishrei*) on its southward journey. Some two thousand years ago the point of the vernal equinox was located near the beginning of the constellation Aries and was known among the ancient astronomers as "the first point of Aries."

In the definition given above, Rambam uses both criteria for defining the

time that the blessing “Who made the Creation” is to be said for planets: 1. that the planet return to the first part of the constellation Aries (the first point of Aries) and 2. that the planet not deviate to the north or south (i.e., be on the celestial equator). The zodiac and the celestial equator can be thought of as two rings in the sky, one tilted with respect to the other. It had been discovered, apparently by the Greek astronomer, Hipparchus (c. 146–27 BCE.), that these rings precess; i.e., that the two points at which the rings touch move with respect to the background stars. The motion is very slow and therefore difficult to measure. Ptolemy (c. 2nd cent.) put it at one degree of arc per 100 years, while Rambam¹² puts it at approximately one degree of arc per 70 years. The modern value is one degree per 72 years. As a result of this motion, the points where the rings cross — the vernal and autumnal equinoxes — move by that amount. Whereas the vernal equinox was at the first point of Aries 2000 years ago, it has since moved some 30 degrees into the constellation Pisces. My point is that the two criteria given by the Rambam can no longer be fulfilled simultaneously! If a planet is at the first point of Aries, then it must be north of the celestial equator. If it does not deviate to the north or the south, then it must be in Pisces, not in Aries. Here we have a conflict between science and *Torah* where the outcome has a very real result: How are we ever to make the blessing “Who made the Creation” over planets? Actually I am exaggerating. In reality the precession of equinoxes is still proceeding, and there will come a time when the vernal equinox will return to the first point of Aries. Then we will be able to make the blessing as prescribed by the Rambam. That will happen in approximately 24,000 years. What about those who now say the blessing? Are they saying it at the wrong time? In fact there is no real problem, as the custom for many years has been that we do not say the blessing over the planets or the moon. Since only an expert in astronomy can calculate precisely when the blessing is to be said, the custom is not to say it at all.¹³

Although there is no real *halakhic* problem with the planets, there is a problem with the sun. Rambam says, on the basis of the *Gemara*,¹⁴ that the blessing should be said every 28 years. The reason for this is as follows: The earth moves around the sun once in 365.25 days. This is called the *tekufa* of Shmuel.¹⁵ Thus, a year consists of 52 full weeks plus 1.25 days. If, at creation, the sun was placed in the sky at the first point of Aries at the beginning of Tuesday night, then the next year it would have returned to the same place on Wednesday at midnight. After four years the difference would have been five full days. The sun would have returned to the first point of Aries at the beginning of the night, but it would have been Sunday night. After seven times four, or 28 years, the sun would have been at the right place at

the beginning of the Tuesday night, as it was at the time of creation. Then we say the blessing. All this is fine if a year is exactly 365.25 days. However, this is not so. The tropical year is 365 days, 5 hours, 48 minutes, and 49.3 seconds and so differs from the *tekufa* of Shmuel by 11 minutes and 10.7 seconds. This is not much, but it means that after 28 years the sun does not return exactly to the place it originally occupied but, rather, one needs to wait 28 years, 5 hours, and 13 minutes. What is worse, the discrepancy increases by that amount every 28 years. After 280 years we are more than two days off, and it just gets worse!

Let me present another problem that stems from the same source. We compute each of the four *tekufot* of the year using Shmuel's value for the tropical year. These are important for at least two reasons. Firstly, there is a custom not to drink water at the time of the *tekufa*.¹⁶ Secondly, in places outside Israel we begin praying for rain 60 days after *tekufat Tishrei* (the autumnal equinox). According to *Shana be'Shana*, the yearly calendar published by the Chief Rabbinate of Israel, the *tekufat Tishrei* for the year 5755 occurred on the 7th of October at 3 p.m. This meant that everyone outside Israel started praying for rain on the night of December 5. The date of the *tekufa* is calculated using the value of Shmuel. Observation shows, however, that in fact, the equinox occurred on September 23, a difference of two weeks! If praying for rain outside Israel began 60 days after the equinox, then it began two weeks late. Here we have a real problem.

I would like to turn for a minute to Rambam. In his *Hilchot Kiddush Hachodesh* (ch. 9), he says that there are some Jewish sages who say that a year is 365.25 days, and some who say it is slightly less. A similar argument, he says, exists among the sages of Greece and Persia. He then proceeds to explain how the time of the *tekufa* should be computed according to Shmuel. In the next chapter he gives a different value for the tropical year, 365 days, 5 hours, 55 minutes, and 25.44 seconds. This value is attributed to Rav Adda, and is much more accurate than Shmuel's value. Whereas Shmuel's value is too large by more than 11 minutes a year, Rav Adda's value is off by only seven minutes. The interesting thing is that because the Rambam's purpose is to decide the *Halakhah*, he does not usually mention conflicting opinions. Rather, he cites only the one he feels is to be accepted as the law. In our case, he does not decide between Shmuel and Rav Adda, but instead devotes a full chapter to explaining each calculation. This is especially surprising since at the end he points out that both of the calculations are approximate!

And the two methods of computing the *tekufa* that I have presented are approximate, and deal with the mean motion of the sun, and not its true position. Using the true position of the sun, *tekufat Nissan*, in

these days, would be some two days before the two *tekufot* that come out of these computations, whether it is with the method of him who uses exactly a quarter day, or whether it is with (the method of) him who uses less than a quarter day.

First, let me explain what Rambam means by the mean motion of the sun as opposed to its true position. The orbit of the Earth around the sun is not exactly circular, but slightly elliptic. For this reason, the time taken to travel from the autumnal to the vernal equinox is somewhat less than the time to return from the vernal to the autumnal equinox. The *tekufot* of Shmuel and Rav Adda are based on the average of the two times, so that if the *tekufot* of *Tammuz* (summer solstice) and *Tevet* (winter solstice) come out correctly *tekufat Nissan* falls some two days earlier than the calculations indicate, and *tekufat Tishrei* some two days later.

This is not the problem to which I have alluded, but it still presents a difficulty. In the case given by Rambam, *tekufat Nissan* falls two days earlier than the computed date, and *tekufat Tishrei* two days later than the computed date. This means that a person following the calendar will drink water on the *tekufot* of *Nissan* and *Tishrei*. It also means that those who live outside Israel and who start praying for rain 60 days after *tekufat Tishrei* will start their prayers at the wrong time. Rambam, however, ignores these problems. He simply points out that both computational methods give an approximate answer, and leaves things at that.

That is not all, however. As we have seen, we ourselves use Shmuel's calculation to decide when to make the blessing on the sun, but we use Rav Adda's calculation to fix the calendar. Let me explain: The lunar month is (on average) 29 days, 12 hours, 44 minutes and 3 seconds (*Rosh Hashanah*, 25a), essentially equal to the modern value of 29 days, 12 hours, 44 minutes, and 2.64 seconds (the decrease in the length of the month, 0.2 seconds per 1000 years, only makes the numbers even closer). Twelve lunar months add up to 354 days, 8 hours, 48 minutes and 40 seconds, some 11 days less than a solar year. To allow for this difference, we add an additional month every few years, the second *Adar*. It turns out that a cycle of 19 lunar years, some of 12 months and some of 13, differs from 19 solar years by only 1 hour, 26 minutes and 56.7 seconds. If we take 19 lunar years and assume that they are exactly equal to 19 solar years, then we find that the length of the year is the value given by Rav Adda. Presumably, it is this value of Rav Adda that is used in constructing the 19-year cycle, and it is this cycle that is the basis of the calendar used today. This means that we are not being consistent; one calculation is done using Shmuel's value, and one using Rav Adda's value.

This is probably why Rambam saw fit to discuss both values in his work.

Let me make things just a little more confusing by pointing out that Rambam was aware of the precise length of the tropical year. In *Hilchot Kiddush Hachodesh* ch. 12 hal. 1, he gives the motion of the sun in a period of 10,000 days. The result is essentially identical with the modern value! This is even more surprising since his contemporary, and fellow astronomer, Rabbi Avraham ibn Ezra, in his commentary on Leviticus (25:9) cites a dispute among astronomers over the precise value. If Rambam knew that both Shmuel's and Rav Adda's computations were not in accord with observation, why did he cite them as *Halakhah*?

6. A PROPOSED SOLUTION

I believe the answer lies in a basic difference between science and *Halakhah*. The goal of science is to understand nature, and so it is nature that defines the situation, and science can only try to decipher it. In *Halakhah* the situation is very different. We have the *Torah*, but the interpretation of that *Torah* is in the hands of the Rabbis. Granted, they must be true to the written text and to the received tradition, but the final interpretation is fixed by them. Thus, in the famous dispute between Rabbi Eliezer and the Rabbis with regard to the oven of *Achnai*¹⁷ the Rabbis ruled against Rabbi Eliezer in spite of the fact that a heavenly voice spoke out in his favor. The reason given by Rabbi Yehoshua was *lo bashamayim hi* ([the *Torah*] is not in heaven) i.e., heaven can no longer fix the interpretation. This is especially true in the case of calendrical decisions. Originally, the new month was established by the testimony of witnesses. Since a lunar month is approximately 29.5 days, the new moon was sometimes visible after 30 days, and sometimes after 29. If witnesses reported seeing the new moon on the 29th day, then the rabbinical court (*beit din*) could accept their testimony, declaring the 30th day as the first day of the new month. The court could also decide not to accept the testimony (even if it was accurate), and delay the start of the new month for one day. In other words, the start of the month was not fixed solely by an astronomical event, but also by a decision of the rabbinical court. This would appear to be a problem with *Pesach*, for example. A delay in starting the month of *Nissan* means that we keep *Pesach* a day later than we should, and we eat *chametz* when it is forbidden. In fact, this is not so. The correct time for *Pesach* is determined by the decision of the *beit din*, not by some astronomical event.¹⁸

The *beit din* has even more power than this. It can decide to add an additional month to the year. Granted, this decision was usually based on

astronomical considerations, such as the requirement that *Pesach* indeed come out in the spring.¹⁹ If the *beit din* saw that spring was too far off, it could delay things by adding a second *Adar*. In the final analysis, however, the decision was in its hands alone. This decision, incidentally, also affected the time when a child became an adult, when he or she could be married, carry out business transactions, and so on. The fixing of the calendar was a complicated business, and was the province of only the greatest sages of each generation. They could be relied upon to make the requisite computations to determine the true astronomical situation, which, of course, strongly influenced their decision. They could also be relied upon to judge the other factors objectively before declaring a new or additional month. The *mitzvah* of making a blessing on the sun is different, however. It is something that is left to the individual. Not every individual is sufficiently expert in mathematics and astronomy to compute precisely when the sun returns to the first point of Aries, or when a *tekufa* occurs. To remedy this, Shmuel introduced an approximation that was easy to use, and still quite close to the correct number (there are several hints that the correct number was indeed known to the sages of the *Talmud*). Thus, *halakhically*, we act as though there is a *tekufa* every 91 days and 7.5 hours, even though the corresponding astronomical event occurs at a slightly different time. Every action that is required by *Halakhah* to correspond to the *tekufa*, is required to correspond to the *halakhic tekufa* as defined by Shmuel. A similar event occurred with the fixing of the calendar. When the conditions no longer allowed for the new month to be determined by the *beit din*, the sages established a fixed 19-year cycle as an alternative. It had the advantage of being both simple and accurate, and the cycle is still in use today. The Jerusalem *Talmud* (end of *Sukkah*) mentions a cycle of 1176 years used by Rabbi Abbahu. This cycle differed from astronomical fact by 18 hours at the end of the 1176 years. Indeed, there is speculation²⁰ that if the cycle were applied differently, the discrepancy could be reduced to as little as 16 hours every 29,400 years! An additional point is that Rabbi Abbahu was not the inventor of this cycle; it is actually attributed to King David and the Prophet Shmuel. The trouble with Rabbi Abbahu's cycle is its length. It is one thing to use a perpetual calendar that is 19 years in length; it is quite another to use one that is 1176 years long. Thus, although a more precise value was known, the simple value was chosen merely because it was simpler.²¹ Possibly it was hoped that the fixing of the calendar would be returned to the hands of the *beit din* in a sufficiently short time so that a significant discrepancy would not be felt.

7. CONCLUSION

We see, then, that when it comes to *Halakhah* there are considerations other than the external physical world that come into play. The apparent difference between a situation as perceived by the scientist and as understood by the *halakhist* is largely due to the fact that the *halakhist* is concerned with other factors as well. In some respects, it is the scientist who is more limited. He deals only with nature. The *halakhist*, on the other hand, deals with a more complete realm that includes the subjective aspect of man's interaction with the world. It is this subjectivity, which is excluded from the scientific approach, that is the source of the differences between the views of science and those of *Torah*. Science is truth, but in a very simple, objective form. *Torah* is truth, but because it includes other, sometimes subjective, factors, it allows for a deeper truth.

NOTES

- * Lecture to the Third Torah and Science Conference, March 1996.
- 1 See Leviticus, chapter 12.
 - 2 פירוש המשנה להרמב"ם בכורות פרק ח' משנה ב'
 - 3 It is interesting to note that Dr. Avraham Sofer Avraham, in his סימן יו"ד אברהם, points out that modern medicine has difficulty with Rambam's interpretation, because after the C-section is performed, the womb cannot contract in the normal manner, and the second child cannot be delivered in the usual way.
 - 4 אגרות משה יו"ד חלק ב' סימן ע"ד. A very thorough discussion of the concept of changes in the nature of things can be found in the book מכון גושל, השתנות הטבעים בהלכה, ירושלים, תשנ"ה.
 - 5 It would seem that, according to Rashi's interpretation of *yotzeh dofen*, even a child born as a result of a drug-induced labor might be *patur* from a *pidyon ha-ben*, but I have not seen any discussion of this point.
 - 6 נשמת אברהם שם ס"ק ה' שו"ע יו"ד סימן ש"ה סעיף כ"ד.
 - 7 במדבר ו:ג
 - 8 רות ב:יד
 - 9 שו"ת יחיה דעת חלק ו' סימן מ"ז: אגרות משה יו"ד חלק ב' סימן קמ"ו. Additional discussion of the permissibility of eating forbidden things too small to be visible to the naked eye may be found in כרמל, תלמוד ירושלמי עם פירוש קב ונקי מס' תרומות, ירושלים תשמ"ט ע' תקס"ב.
 - 10 ברכות נט ע"א
 - 11 משנה תורה, הלכות ברכות פרק י', הלכה י"ח
 - 12 שם, הלכות יסודי התורה פרק ג', הלכה ז'
 - 13 ערוך השולחן סימן רכ"ט סעיף ד'
 - 14 ברכות נט ע"ב
 - 15 עירובין נו ע"א
 - 16 רמ"א, סימן תנ"ה סעיף א'

- 17 בבא מציעא נט ע"ב
- 18 An interesting discussion of this point can be found in שו"ת בצל החכמה ח"ה ס' צ"ו.
- 19 For a recent discussion of this point, see 'ע' 1, חוב' בד"ד חוב' 1, ע' 1, חוב' בד"ד חוב' 2, ח' הלפרן "תשובה לתגובה" שם מרצבך, תגובה ל"הלוח העברי הקבוע" בד"ד חוב' 2, ח' הלפרן "תשובה לתגובה" שם
- 20 *Encyclopaedia Judaica* "Calendar," vol. 5, p. 49.
- 21 The use of approximation in determining *halakhically* important parameters is found in a number of places. A particularly interesting source is ספר התשב"ץ חלק א סימן קסה.