CHAPTER XX

מסכת ברכות · פרק ראשון · משנה א

מֵאֵימָתַי קוֹרִין אֶת שְׁמַע בְּעַרְבִית; מִשָּׁעָה שֶׁהַכֹּהֲנִים נִכְנָסִים לֶאֱכֹל בִּתְרוּמָתָן, עַד סוֹף הָאַשְׁמוּרָה הָרִאשׁוֹנָה ; דִּבְרֵי רַבִּי אֱלִיעֶזֶר. וַחֲכָמִים אוֹמְרִים : עַד חֲצוֹת. רַבָּן גַּמְלִיאֵל אוֹמֵר : עַד שֶׁיַּעֲלֶה עַמּוּד הַשָּׁחַר.

"From when may one recite the Shema in the evening? From the time that the Kohanim enter to eat their terumah, until the end of the first watch – [these are] the words of Rabbi Eliezer. But the Sages say: Until midnight. Rabban Gamaliel says until the break of dawn."

Why does the sky light up before the sun has risen?

Dawn (עמוד השחר) marks the beginning of the daytime. It happens more than an hour before **sunrise**, when the first rays of sunlight become visible in the eastern sky (Mishnah Berurah 89:2). Dawn marks the beginning of "twilight," the time of day when it has begun to get light, but before the sun has risen.

Fig XX.1. The Kotel sometime after dawn, before sunrise.

We have all enjoyed the wonder of the dawn. It is one of the most beautiful, peaceful times of the day. But have you ever wondered where the light of dawn comes from? It's not at all as simple as you may have thought. For example, there is no such thing as dawn on the moon or on a planet like **Mercury**. So why is here such a thing as עמוד השחר here on Earth, and how does it happen?

Hashem custom-made our planet Earth with love in every way. One of those ways was to wrap it in a blanket of air. It may sound strange to compare the air around us to something as thin as a blanket, but it shouldn't. The layer of air surrounding us is actually much thinner than you probably thought. It hardly takes a minute before a rocket launched from earth leaves this layer and is no longer surrounded by any air at all—just empty space. And as we shall see, empty space is very different from air!

Fig XX.2: About one minute after takeoff, a rocket will have travelled through the 100 km (about 62 miles) of Earth's atmosphere and be in empty space

The layer of air around us isn't just thin like a blanket. It also works like a blanket, ensuring that we never get too hot or too cold. This layer has a special name: The Earth's **atmosphere**.

Fig XX.3: Canada, Alaska, and the **Arctic** Ocean on the surface of the earth, and above them the atmosphere appears light blue. Where the atmosphere ends, the blackness of space begins.

Our atmosphere does a lot of things. Perhaps the most obvious one is that it provides us with the air we breathe. But it does other things as well. Imagine you were on the moon. You would need a spacesuit to provide you with air to breathe, since there is no atmosphere on the moon. Picture yourself looking out of your moon home's window: It is nighttime and completely dark outside, except for the faint starlight. Without warning, a moment later, the edge of the sun appears over the nearby mountains. Sunrise! Everything lights up as bright as day—because it is day! On the moon there is no such thing as dawn. No עמוד השחר. One moment it is black night and hardly a moment later it is bright day.

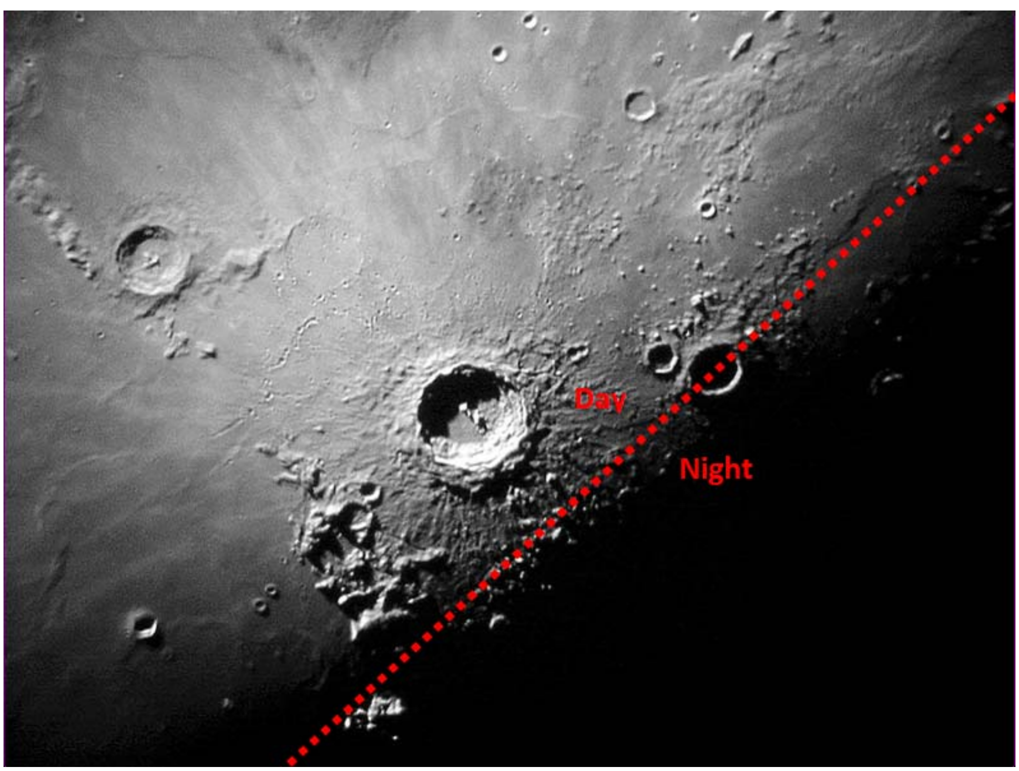

Fig XX.4. The dotted line shows where sunrise has occurred on the moon

So why is there a dawn every day on Earth, but never on the moon? Because of our atmosphere!

Recall that the atmosphere is very different from empty space. The atmosphere is space filled with air. When we look at air, we don't see anything, but that doesn't mean that nothing is there. Air (like almost everything) is made of countless very tiny pieces called **molecules**. Even if you can't see air molecules, you can feel them simply by moving your hand quickly and feeling a gentle wind of air molecules press against your hand. You wouldn't feel that on the moon.

One way to imagine light is as countless extremely little balls (scientists call these balls **photons**). When these little balls bump into something, they usually bounce off it. For example, look in a mirror and you will see a reflection of your face. What you are seeing is light that bounced off of your face onto the mirror and then bounced off the mirror and into your eyes. Light bouncing off of something is called **reflection**.

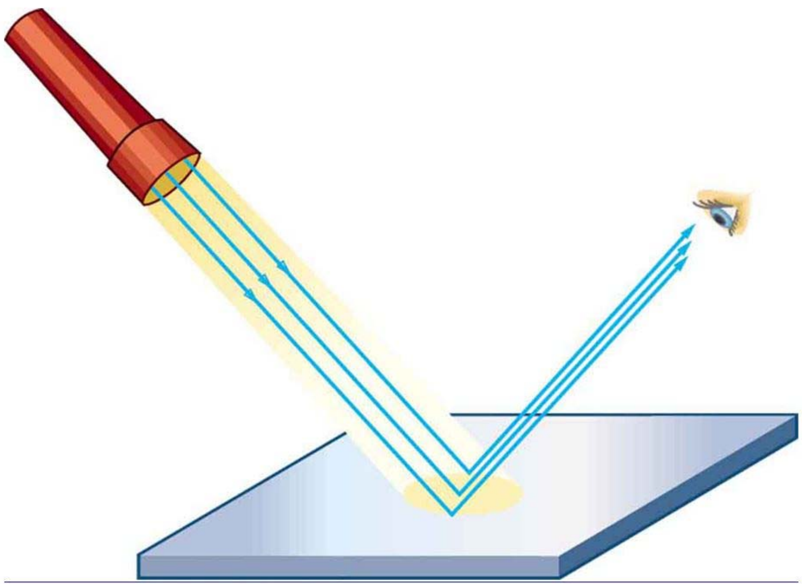

Fig XX.5: We can see the flashlight in the mirror, even though we are not looking directly at the flashlight, because the light coming from the flashlight "bounces" off the mirror's surface. [*Need picture that 1) shows photons, not lines, and 2) matches the text with photons coming from a light source onto a face, bouncing onto a mirror, and then entering the eyes*]

The reflection of light off of a mirror is something like a ball bouncing off of a smooth wall. When you throw a ball against a smooth surface, it bounces back in a very predictable direction. If you have good aim, you could probably throw a ball against a wall ten times and catch it again each time without ever moving your feet. Now imagine that instead of a wall, you were throwing a small bouncy ball against a basketball. Do you think you could guess which direction it would bounce back? If you think you could, why not try it? Throw a small ball a few times against a basketball and see just how unpredictably it rebounds. If you threw a thousand small bouncy balls against a pile of basketballs, can you picture how the balls would bounce back, scattering in every direction?

A simplified way of looking at what happens when the sun's light passes through our atmosphere is to imagine the light from the sun as being made of countless tiny bouncy photons and of the atmosphere as countless air molecules, each like a basketball. In our atmosphere, there is a lot of empty space between each molecule, so most of the photons coming from the sun pass straight through the atmosphere without bumping into any air molecules. However, some of the photons from the sun do bump into the atmosphere's air molecules. When this happens, the photon is knocked into a totally different, unpredictable direction. Every time this happens, a photon bounces in a different direction just as a small bouncy ball would bounce unpredictably off of a basketball. Since there are actually many, many photons bouncing off the molecules in the atmosphere, the overall the effect is to spread some of the sun's light over the entire sky. This is called **scattering** of the light.

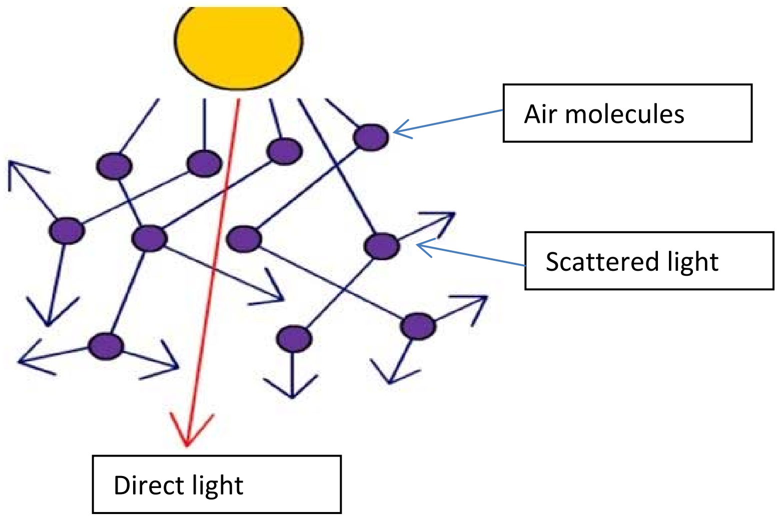

Fig XX.6: Most of the sun's light goes straight through the atmosphere (the red line). Some is scattered by the air (the purple lines) *[Need customized image]*

The light that we see in the sky before sunrise is scattered sunlight that spreads around the atmosphere, almost "sneaking around the corner." It is probably easier to make sense of this with an illustration. Look at Figure XX.7. The person standing at position A on the Earth's surface will not be able to receive sunlight directly. In other words, sunrise has not yet occurred where he is standing. If he looks at the sky in the direction of the sun, around this time he will be able to detect the break of dawn (עמוד השחר) as the sky begins to fill with scattered sunlight. As the Earth rotates and he moves towards position B, the sky will brighten with more and more scattered light. When he finally reaches position B, the Sun will be in a direct line of sight and sunrise will occur as the ball of the Sun appears on the **horizon**[1].

[1] Technical point: There is another atmospheric effect called "refraction", which slightly bends light from the sun towards the Earth. Refraction bends light uniformly in a single direction; it is something entirely different from the scattering we have been discussing, in which light spreads out in all directions. When we view light refracted through our atmosphere, it retains a coherent image (e.g. the sun can still be seen as a sharply defined ball, despite the refraction). This is in contrast to scattered light, as we have described above. Refraction's net effect is to make sunrise visible about two minutes earlier than it would have been, if the Earth had no atmosphere. The precise amount of refraction that occurs depends on latitude, elevation, temperature, and humidity at the time of sunrise.

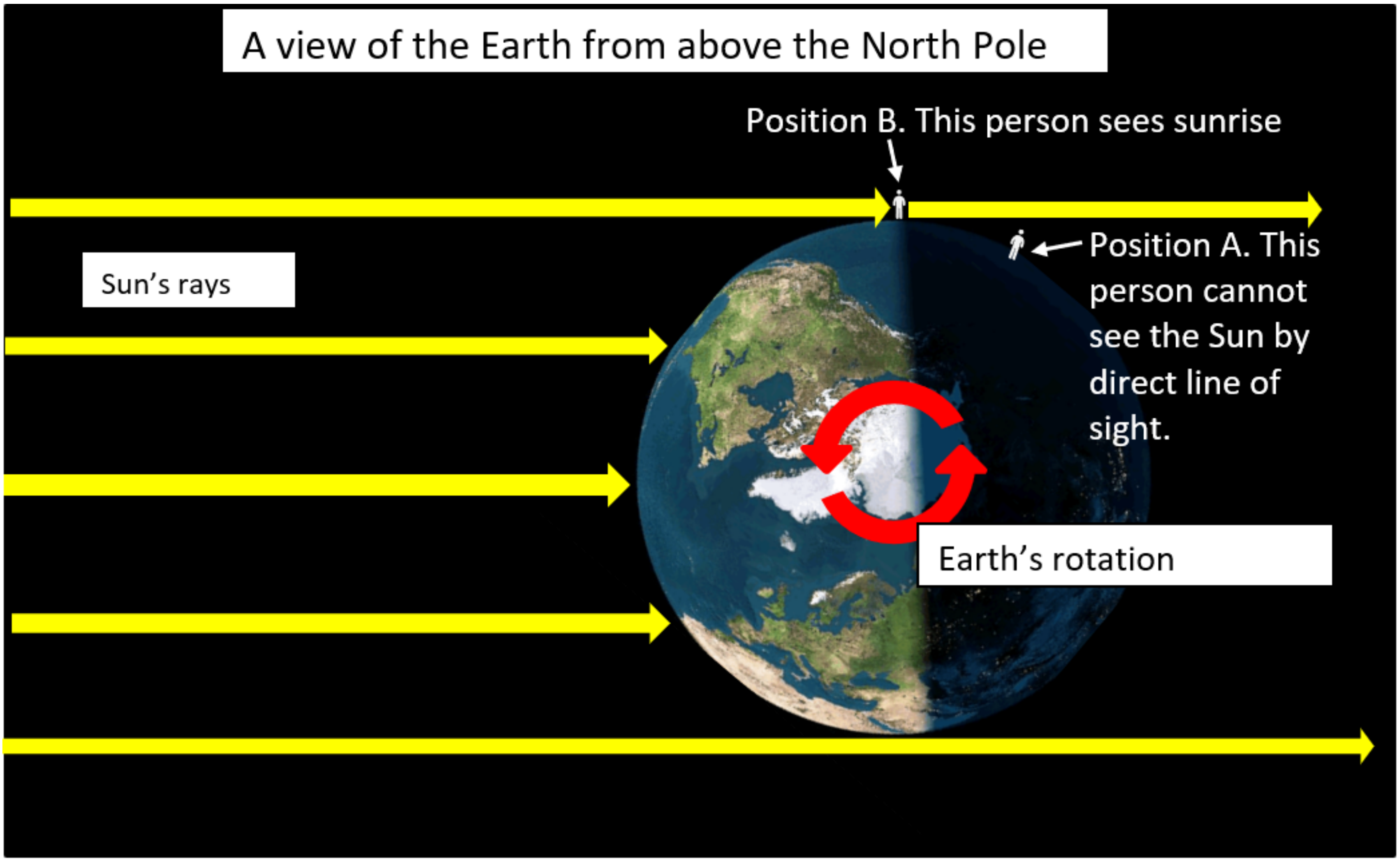

Fig XX.7: A view from above the **North Pole** of the Earth's rotation and illumination by the Sun

We now can also better understand the answer to the age-old question, "Why is the sky blue?"

We just established that the scattering of light through our atmosphere is what allows the sky to be filled with the sun's light. Not all of the sun's light scatters in the same way. Blue light is made up of higher energy photons than red light, and blue light scatters much more readily than than red light does.

The strong scattering of blue photons means they travel very far around the atmosphere, so blues are the first colors we see at עמוד השחר and the last colors we see around צאת הכוכבים (Fig XX.8). During most of the day, when the sun is high up in the sky, its red light doesn't travel through enough atmosphere to be scattered significantly. At the same time, a lot of blue light is scattered and spreads around the atmosphere. This is the source of our blue sky (Fig XX.9).

	
Fig XX.8. Around twilight, only some of the sun's blue light is scattered this far from the sun and the sky is a deep blue.	Fig XX.9. During most of the day, only some of the blue light is scattered around the sky. Most of the rest of the sun's light goes straight through the atmosphere, combining to make the yellow-white color we see when

	we look directly at the sun. (Caution: you should protect your eyes and avoid looking directly at the sun!)

Since red light is more difficult to scatter, the only time we see red in the scattered light in the sky is when the sun is low in the sky and its light must go through a much thicker section of atmosphere before reaching us (Fig XX.10). This happens around **sunset** and sunrise (Fig XX.11). The red light is only scattered a short distance around the sun while the blue light has been scattered much further around the atmosphere, so the blue light has a limited effect on the color of light we see, giving rise to the reds we see at these times.

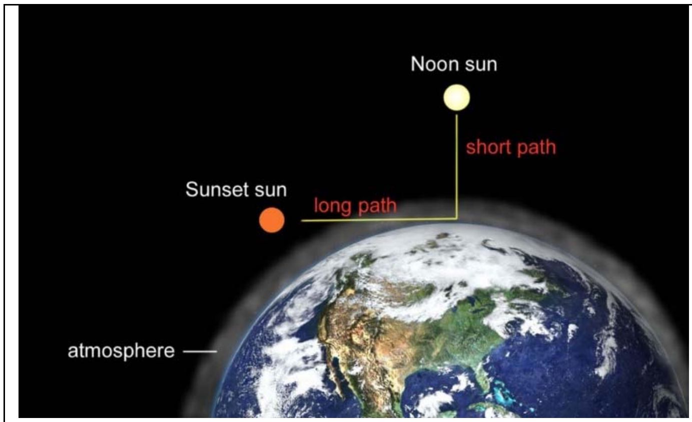	
Fig XX.10. Why the sun's rays must travel through a thicker section of atmosphere at sunrise and sunset (when the sun appears low in the sky) than during the middle of the day	Fig XX.11. At sunrise and sunset, when the sun is low in the horizon, red light is scattered as well.

Picture references

Dawn https://homecomingbook.files.wordpress.com/2011/04/civtwiend41111.jpg
Sun's rays path length: https://scienceblogs.com/startswithabang/2013/02/13/the-physics-of-sunsets

בס"ד

Chapter XX

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הֶקְטֵר חֲלָבִים וְאֵבָרִים – מִצְוָתָן עַד שֶׁיַּעֲלֶה עַמּוּד הַשָּׁחַר.

"…[Regarding the] burning of the fats and limbs [of offerings]— the [deadline for] the mitzvah is until the break of dawn."

What are חלבים "fats"?

At the end of the "*asher yatzar*" blessing that we say after using the bathroom, we thank Hashem for the wonderous acts performed by our body (ומפליא לעשות). One explanation given by the Shulchan Aruch (O.C. 6:1) is that this refers to the body's amazing ability to sort through the food we eat, getting rid of the waste, while retaining the food's nutritious parts.

One of those nutritious parts of food is **fat**. We all have fat in our bodies. This is a very good thing. When the food we eat contains more energy than we need, Hashem designed our bodies to cleverly save this extra energy for later use. The way which that energy is stored is in the form of fat. Later, if we can't get enough fuel from the food available to us, the body can get the energy it needs from its stores of fat.

Farm animals, such as cows, goats, and sheep, use the same system of energy storage that we do. The two main places fat is stored are (1) in and around the muscles, especially between the muscle and the skin and (2) around the internal **organs**, such as the heart, stomach, and kidneys. The fat stored around the internal organs tends to the thicker and harder. It is this organ fat, which is the *chailev* (חֵלֶב), that we are forbidden to eat (see Fig.XX.1). These fats are also included in the parts of every offering brought on the altar in the Temple, which are collectively called "*aimurim*". It is the burning of these fats to which this Mishna refers.

The other type of fat, which is stored around and inside the muscles and skin, tends to be softer than חלב. This fat in animals is called *shuman* (שומן) if it is in large lumps, or *sha'main* (שמן) when it is marbled inside the muscles (see Fig.XX.2). These fats are kosher, and they make our food taste delicious. Just be careful not to eat too much, or your body may end up storing more fat than you might like!

	
Fig.XX.1 The picture shows the white fat that has been removed from around a sheep's kidney (the deep red object). This fat is *chailev*.	Fig.XX.2 The picture shows white fat in and around cow muscle (beef). The thick white blocks of fat are called *shuman*, and the marbling in the meat is called *sha'main*.
https://grassfood.me/2014/01/21/fat-lard-suet-tallow-leaf-lard-back-fat-caul-fat-kidney-fat/	https://greatbritishmeat.com/recipes-and-tips/miscellany/animal-fat-is-good-for-you