

**Beyond the Physical Universe:
Lectures on Modern Physics**

The Torah and Science Series

Beyond the Physical Universe: Lectures on Modern Physics

by

Rabbi Yitzchak Ginsburgh

Los Angeles, CA • March 18-20, 2007

Transcribed, edited, and annotated
by **Rabbi Moshe Genuth**



Gal Einai

THE TORAH AND SCIENCE SERIES

**BEYOND THE PHYSICAL UNIVERSE:
LECTURES ON MODERN PHYSICS**

Rabbi Yitzchak Ginsburgh

Edited by Rabbi Moshe Genuth

Printed in the United States of America and Israel
First Edition

Copyright © 5773 (2013) by GAL EINAI

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without written permission, except in the case of brief quotations in critical articles and reviews.

For information:

Israel: GAL EINAI
PO Box 1015
Kfar Chabad 60840
tel. (in Israel): 1-700-700-966
tel. (from abroad): 972-3-9608008
email: books@inner.org
Web: www.inner.org
Blog: www.rabbiginsburgh.com

GAL EINAI produces and publishes books, pamphlets, audiocassettes and videocassettes by Rabbi Yitzchak Ginsburgh. To receive a catalog of our products in English and/or Hebrew, please contact us at any of the above addresses, email orders@inner.org or call our orders department in Israel.

ISBN: 978-965-7146-71-2

”נכון שיכתוב בצורת ספר השיעורים שלומד.
בברכה להצלחה”

“...It would be proper to publish your classes in book form.
With blessings for success...”

— *from a letter from the Lubavitcher Rebbe
to the author, Elul 5741*

Table of Contents

Preface	9
Lecture 1 Counter-intuition.....	11
Lecture 2 Limits and the equivalence principle	35
Lecture 3 Symmetry	47
Lecture 4 Unity	65
Lecture 5 Symmetry II	73
Lecture 6 Uncertainty and its origins.....	87
Lecture 7 Elementary particles	103
Lecture 8 Wave-particle duality.....	117
Lecture 9 Photons and vacuum	133
Lecture 10 Determinism, black holes, and information	145
Lecture 11 Wormholes.....	159
Endnotes	163

Preface

The lectures appearing in this volume were given by Rabbi Yitzchak Ginsburgh in Los Angeles, at the then Ahavat Shalom Synagogue, over the course of 3 days, March 18-20, 2007. The 3 day seminar was titled “Beyond the Physical Universe” and it focused on the relationship between modern physics and Torah.

Following the seminar, transcripts were made from recordings of the lectures and both video recordings and the transcripts were posted on Gal Einai Institute’s website (www.inner.org).

The present volume is a lightly edited version of those transcripts. Rabbi Ginsburgh did not edit these transcripts and they did not go through the rigorous and in-depth process that our publications usually do. We believe that even prior to an in-depth review and expansion, the material Rabbi Ginsburgh presented at this seminar is invaluable and should be made available to readers interested in the relationship between Torah and science.

Where relevant, the original Hebrew of verses or idioms is noted. When a Hebrew word appears in bold-print, it indicates that the numerical value (*gematria*) of that word is being considered.

In order to avoid confusion, God’s Names in Hebrew appear using the proper spelling, with a dash separating the letters, for halachic reasons. We follow the halachic convention of writing out God’s Name in English without a dash. Some, but not all of the sources noted in the lectures have been cited in endnotes, as well as some explanatory points on the discussion.

We have made an effort to retain Rabbi Ginsburgh’s speaking style in this volume and very little has been changed.



Rabbi Ginsburgh has a unique place among the Torah scholars and leaders of our generation, part of it due to his ability to clearly see where Torah and science do indeed unite. Perhaps even more incredible is his ability to recognize those points in which the Torah can guide science in mankind's quest to understand the secrets of the physical universe.

We pray the Almighty provide us with the ability to continue publishing Rabbi Ginsburgh's voluminous works on Torah and science, covering practically all fields of scientific inquiry.



During 2007-8, Rabbi Ginsburgh was able to visit Los Angeles every 3 months, thanks to the founding of the Los Angeles Inner Torah Institute by his students: Rabbi Shaya Eichenblatt, Mrs. Chana Rachel Schusterman, and Mrs. Olivia Schwartz, all well-known and active members of the Chabad-Lubavitch community in Los Angeles.

The Inner Torah Institute and hence Rabbi Ginsburgh's regular visits to Los Angeles that year, were made possible by a generous donation from Mr. David Kaplan. We would like to take the opportunity to thank everyone who put in a great deal of hard work to make these visits possible. They all have a part in bringing the Torah's inner light to the edge of Western civilization.

10

Special thank to Mrs. Rachel Gordon for proofreading the transcripts.

May the Almighty indeed open our eyes to see the wonders of His Torah, allowing us to see beyond the physical dimension of our universe.

Moshe Genuth
Chanukah 5773

Lecture 1

In this series of lectures we will connect the issues of modern physics with the inner dimension of the Torah. One of the benefits to be gained from this unification is that the concepts and ideas that form the foundation of modern physics, which appear at first glance to be far removed from our everyday lives, are actually most applicable.

Modern physics is counter-intuitive

The first topic we will address is counter-intuition. It is a simple and well-known fact that all of the most important and successful theories presented and used in modern physics are counter-intuitive. The fact that the accepted scientific narrative of the past century has been utilizing counter-intuitive ideas is a very significant one, indicating that humanity in general is approaching a level that is above and beyond the style of human logic that has been applied since time immemorial.¹

On a different front, the realization of our long anticipation of the complete and true redemption by Mashiach is imminent. Like science, the redemption that awaits us is counter-intuitive to the redemption that we have been expecting, so much so that the Alter Rebbe of Chabad was known to say that the Mashiach that everyone is waiting for will never come, and the Mashiach that will come, nobody is waiting for! So now, let us begin our journey into counter-intuition and try to see how counter-intuition applies in our lives.

II

Counter-intuition in Kabbalah

Kabbalah supplies us with the tools for understanding counter-intuition in a much more sophisticated way than does science. By counter-intuition, science means anything that runs against the grain of our common-sense. Special relativity, general relativity, quantum mechanics, and string theory (to a degree), are all theories that run against our common-sense and are therefore considered by science to be counter-intuitive.

The first insight that Kabbalah offers is that everything is relative. This is similar to the conclusion of the first major theory of modern science, relativity. Of course, if “everything is relative” then counter-intuition is relative as well. This means that the blanket statement that counter-intuition is anything that goes against common-sense is not accurate, because common-sense itself is relative!

In the language of Kabbalah, every mind-space, or level of consciousness, is called a World and every World has its own “common-sense”² [we capitalize “World” in the Kabbalistic sense, in order to differentiate it from the word’s more common meaning; ed.] Thus, given the particular mind-space that I currently inhabit, I would consider the common-sense found at the level above mine to be counter-intuitive to my own. As we progress through each level of consciousness, from Kabbalistic World to Kabbalistic World, our common-sense undergoes a transformation and what is perceived as common-sense in one World becomes absolutely counter-intuitive to common-sense in another World. When we progress from World to World, which are actually levels of consciousness everything that we held to be true previously transforms into something new.

Those readers familiar with our method of teaching know that as we survey a new subject, one of our goals is to describe the appropriate Kabbalistic models that correspond with the particular topic at hand. If the model indeed fits and corresponds correctly,

then not only do we gain insight into the model, but we immediately improve our understanding of the topic under consideration.

The model that we have chosen to use to enhance our understanding of counter-intuition is indeed based on the model of the Kabbalistic Worlds, specifically the three lower Worlds which are known as Action, Formation, and Creation. Or, in Hebrew: *Asiyah*, *Yetzirah*, and *Beri'ah*.

The basic state of human consciousness is in the World of Action or more specifically, in the physical dimension of the World of Action. Above our World is the World of Formation and above that is the World of Creation. The common denominator of these three lower Worlds is that in them everything has some degree of self-consciousness, causing it to feel separate from the Almighty; the absolute and unique One.

Above these three Worlds is the World of Emanation (*Atzilut*) in which there is no distinct self-consciousness at all; everything is purely Divine and there is no separation (or feeling of separation) possible from the Creator.

As mentioned above, every World has its own version of what is intuitive and what common-sense is and anything that contradicts it is considered "counter-intuitive." When an apparently counter-intuitive insight is attained in any of the three lower Worlds, first we should ascertain that it is indeed counter-intuitive relative to that World's common-sense.

The picture that we should have in mind as we consider how new insights are attained is that light (i.e., energy, in this case the energy that makes up the counter-intuitive thought or idea) from the World of Emanation has descended and permeated a lower World. Each of the physical theories of the 20th century that has been successfully incorporated into modern science is like a ray of light that has filtered into human consciousness from a higher level of reality. Yet,

even though it seems that these theories run against the grain of our common-sense, if you ask a student of Kabbalah and Chassidut, one who is truly versed in the wisdom of the World of Emanation, whether these “counter-intuitive” theories make sense or not, he will tell you that they are in perfect harmony with what is described in the holy books about the reality of the World of Emanation. We hope that this point will be made very clear through the scientific examples we will now consider.

“The opposite makes sense”

The message that scientific progress has delivered in the last century is that the more our understanding of nature increases, the more our common-sense is challenged. In other words, scientific progress means challenging our common-sense about physical events in the world.

If this message about changing our common-sense is indeed true, we would expect to find it echoed in a verse from the Bible or in the literature of the sages. Indeed, there is an idiom the Talmudic sages use to express exactly this idea. In the original Aramaic it is pronounced, “*ipcha mistabra*” (אִיפְכָא מִסְתַּבְרָא). This phrase literally means: “the opposite makes sense,” or in other words, the truth—
14 what truly makes sense—is exactly the opposite of what you initially thought makes sense. This idiom appears exactly 19 times in the Babylonian Talmud, and we will have more to say about this phenomenon later.

The initial letters of this idiom spell the Hebrew word for “mother” (אִמָּה), hinting at its connection with what in Kabbalah is known as the mother figure, or *partzuf Ima*. The mother figure is associated with the *sefirah* of understanding, which is related to common-sense and the analytical skills it employs. The initials of this

idiom thus echo the concept of common-sense, that which it is in fact challenging.

Having explained the mother principle, let us add something that will be useful later on. The father figure in Kabbalah is a connotation for the *sefirah* of wisdom, which represents direct intuition, a state of intellectual insight in which it is impossible to experience that the opposite might be true. Thus, the father principle in Kabbalah represents an insight that can never be refuted.³

What is the function of the Talmudic idiom, “*ipcha mistabra*?” In a Talmudic debate one sage will suggest that, “Given that x is true, such and such follows.” Another sage may then argue “*ipcha mistabra*”—“Given that x is true, the opposite is the case.” *Ipcha mistabra* is thus a rhetorical tool that challenges not only conclusions, but the very reasoning being used to arrive at those conclusions. In a certain sense, it is not the facts that are being challenged but their correct interpretation. This therefore exemplifies the idea stated above that the manner in which I am used to perceiving reality defines my “common-sense,” but someone in a different mind-space will find my interpretation a challenge to his perception of reality and hence to his notion of what common-sense is.

The sages compiled two great anthologies of their knowledge called the Babylonian Talmud and the Jerusalem Talmud (the latter is also known as the Talmud of the land of Israel⁴). Many of the same sages appear in both editions of the Talmud, and of course the discourse in both focuses on the same basic text, the Mishnah. Yet, despite the many parallels between the two Talmuds, interestingly, the idiom *ipcha mistabra* appears only in the Babylonian, but not once in the Jerusalem Talmud. What is the reason for this?

The difference between these two works is that the discourse in the Jerusalem Talmud is concise and promptly arrives at its conclusions, whereas the Babylonian Talmud’s discourse is drawn-

out and argumentative in its style. Many arguments and counter-arguments are presented in the Babylonian Talmud before a final conclusion is reached, which is why it is so much longer than the Jerusalem Talmud.

Both the Jerusalem Talmud and the Babylonian illustrate the refined intellect, but the differences between them, such as this one, indicate that a refined intelligence has two different aspects. In Kabbalistic terminology, the two aspects of the intellect (there is also a third, which connects the intellect with the emotions) are identified with the two *sefirot* called wisdom and understanding and corresponding with the father and mother principles, respectively, as mentioned earlier.

The Jerusalem Talmud echoes the insightful intelligence of the father principle, the *sefirah* of wisdom. In the model of four Worlds, wisdom corresponds to the World of Emanation, where God's Presence is absolutely clear and therefore there is no experience of being separate from God. Because of the constant experience of God's all-encompassing omnipresence inherent in the mind-set of Emanation, the *sefirah* of wisdom is clear, concise, and most importantly for our purposes here, intuitively secure. The discourse in the Jerusalem Talmud leaves no room for challenges to its conclusions, because they are not arrived at by a critical methodology—they simply are!

16

But the Babylonian Talmud echoes the mother principle, the *sefirah* of understanding. As we touched upon earlier, this *sefirah* reflects the mind-set of the World of Creation (one level below the World of Emanation), where consciousness does include the relative experiences of selfhood. The more the person inhabiting this mind-set is aware of his own being, the more open he is to seeing how relative his methodology and conclusions seem to the subjective experiences of others.

The mind-set of Creation includes relative statements about right and wrong. Therefore, it leaves room for actually being wrong, even in intuitive matters—those things that seem to just be plain common-sense. What follows is that if you inhabit the mind-set of Creation, your first intuition might be correct, or it might be incorrect; in fact, it is often incorrect.

This does not imply that the sages of the Babylonian Talmud were at a lower level than the sages of the Jerusalem Talmud and that therefore their intuition can be challenged. Anyone designated a sage in either Talmud lived in the mind-space of Emanation. Like we said before, many of the sages are mentioned in both editions of the Talmud. It is rather that because the Babylonian Talmud was written outside the land of Israel, its editorial style reflects the mind-set of the World of Creation. Therefore, in the context of the dialogue recorded in the Babylonian Talmud, even the intuition of a great sage may be challenged. It may even be found, in the course of a Talmudic argument, to be incorrect; even completely opposite from the truth, “*ipcha mistabra*.”

The feminine and counter-intuition

Let’s take another step in looking at *ipcha mistabra*, the idiom that represents counter-intuition in Judaism. If we search the entire Babylonian Talmud, we find that this idiom is used exactly 19 times; the numerical value of the name “Eve” (חַוָּה), in Hebrew.⁵ Eve was the first woman and is referred to in the Torah as the “mother of all life.” This is especially significant when we recall that the initials of *ipcha mistabra* spell “mother,” in Hebrew.

What this reveals is an implicit but essential relationship between counter-intuition and the Torah’s first female figure, who more than any other character in the Bible, represents the mother principle. The first thing we learn from this connection is that indeed the

woman is the *ipcha mistabra* of the man—female understanding posits a counter-intuitive alternative to male common-sense.⁶

But, more deeply, we often refer to *feminine intuition*, which is sometimes even hailed as being more potent than its masculine counterpart. Yet, unlike the adamant male intuition, a woman's intuition is capable of suddenly and completely reversing itself, not only as a response to changing circumstances, but more importantly because the woman who originally expressed the intuition suddenly feels that the exact opposite is true. In a sense, the feminine mind is tuned into intuition (the faculty that is the father principle) and adopts an intuitive stance towards life. But, this is also the reason why feminine intuition knows that it is not always correct. The female mind is thus both open to trusting its intuition, but just as open to completely reversing it by 180 degrees.

Counter-intuition and teshuvah

Those familiar with our methodology know that there is great deal of insight to be gained from looking at the numerical value, called the *gematria*,⁷ of Hebrew words.⁸ The *gematria* of the idiom *ipcha mistabra* (איפכא מסתברא) is 815. This is also the *gematria* of the predicate *ba'al teshuvah* (בעל תשובה), which literally means: “a master of repentance.” A *ba'al teshuvah* is someone who has returned to the Almighty through the Torah, someone who has decided to master the art of self-transformation in order to manifest a bond with God. Self-transformation requires a switch in one's consciousness. A *ba'al teshuvah* has to embrace ideas and actions that are counter-intuitive. To seek God from his or her present context, the *ba'al teshuvah* has to rise to a new level of understanding that is counter-intuitive to his or her current, common-sense approach to life.

Teshuvah—return to God—applies differently to individuals with different levels of religious observance. The more religious a person is, the more his *teshuvah* can be charted along a straight line, measuring increased attention to the details of observance and the time spent studying Torah. For the observant Jew, *teshuvah* may not involve the same type of counter-intuitive leap that it does for the Jewish returnee, the *ba'al teshuvah* of our times. Therefore, most observant Jews will point to the month of *Elul*, known as the month of *teshuvah*, as an auspicious time for the observant individual to “do” *teshuvah*.

But, a cornerstone of Chassidic teachings on spiritual consciousness is that regardless of an individual’s level of observance or commitment to Torah as a way of life, he should always seek to become a full-fledged *ba'al teshuvah*; meaning that he should always see himself as still distant from God. In the words of one Chassidic master,⁹ the more a person feels a sense of spiritual accomplishment and nearness to God, the more spiritually distant he actually is. This foundation of Chassidic guidance is based on the philosophical adage that a person should be practicing *teshuvah* every single day of his life.¹⁰ Chassidic masters interpret this to mean that relative to God’s absolute nature, we are all equidistant from Him. Therefore, we are all equally in need of a counter-intuitive switch in our thinking in order to better our actions. The path to spiritual progress is not traversed by a series of successive, forward-facing steps that follow a straight line, but rather by a series of mind-spinning and consciousness-altering steps up the landings of a winding, spiraling staircase. At each point in life a person must embrace counter-intuition, i.e., *teshuvah*, in order to advance spiritually.¹¹

Chassidut teaches us that there are two types of *teshuvah*, which correspond to the two Talmudic opinions regarding whether or not *teshuvah* is a prerequisite for redemption.¹² Rabbi Eliezer’s opinion is

that the future redemption is dependent upon *teshuvah*, whereas Rabbi Yehoshua is of the opinion that the future redemption does not depend on our doing *teshuvah*. Maimonides rules like Rabbi Eliezer, that redemption is dependent on *teshuvah*.

This Talmudic dispute is echoed in another dispute between Rabbi Eliezer and Rabbi Yehoshua,¹³ in which Rabbi Eliezer is of the opinion that the future redemption will take place in the month of *Tishrei*, while Rabbi Yehoshua's opinion is that the month of *Nisan*—the month of our deliverance from bondage in Egypt—will be the month of the future redemption by the Mashiach.

It is thus explained in Chassidut that the *teshuvah* that Maimonides is referring to is a particular type of *teshuvah* that is uniquely relevant to the month of *Nisan*. This type of *teshuvah* is different from the *teshuvah* that we do during the month of Elul and the High Holy Days in the month of *Tishrei*. The *teshuvah* of *Tishrei* is based on strengthening (*hitchazkut*) and improvement (*hishtaprut*); we try to rectify ourselves based on what we know to be wrong in our lives. A person makes an account of his actions and knows that there are things that he should be doing differently. The normal sense of *teshuvah* is to look at myself and ask whether what I am doing is right, and then deciding to improve based on my knowledge of what is right.

20

But, the *teshuvah* of *Nisan* is based on renewal (*hitchadshut*). In *Nisan* we seek a new life, a complete metamorphosis, not just a rectification of the past; we are looking for a new mindset. In *Nisan*, I come to the revolutionary realization that I have never truly known what is right and what is wrong.

Similarly, the *ba'al teshuvah* of today is completely different from the *ba'al teshuvah* of past centuries. A hundred or two-hundred years ago, a Jewish individual would have had a basic Jewish education that imbued him with the knowledge of what constitutes

proper and improper behavior. Equipped with this knowledge, he would have been aware of his misdeeds and could decide to improve his actions through *teshuvah*. But, in our generation, *teshuvah* often entails actually being reborn and taking on an entirely new understanding of the world. Indeed, seeing things from a completely different perspective is the true essence of *teshuvah*. This is the type of *teshuvah* that is required to bring the Mashiach.

As the sages state: “In [the month of] *Nisan* we were redeemed, and [in the month of] *Nisan* we will be redeemed.” Clearly, this means that the redemption is a counter-intuitive process. The *teshuvah* necessary for redemption is a counter-intuitive type of *teshuvah*. It requires us to rethink everything that we know, our entire perspective on life. I have to understand that my whole perspective on life was wrong. This is the *teshuvah* of Mashiach. So that is our first *gematria*. The phrase “*ipcha mistabra*” teaches us about the essence of the true *ba'al teshuvah*.

Silence

Now let us turn our attention to a second *gematria* for 815. This time it is one word whose *gematria* equals 815, “silence” (שְׁתִּיקָה). Now, at first glance, silence may not seem to reveal very much about counter-intuition, *ipcha mistabra*. So, to help us understand the relationship between the two, let us start by quoting the sages’ saying about the function of silence: “The fence around wisdom is silence.”¹⁴ Since in Torah, wisdom refers to the ability to intuit correctly, according to the sages, it follows from this adage that if a person wants to arrive at true intuition, he has to be totally quiet, totally silent. Silence is the fence that surrounds true intuition.

In Chassidut, silence is further related to the word “*chash*” (חַשׁ), the first stage in the three stage process taught by the Ba'al Shem Tov as the cornerstone of all spiritual transformation.¹⁵ Silence allows

you to give up your previous understanding in order to ascend to a higher level of consciousness.

When Einstein first taught his special theory of relativity, some older scientists said that it looked good on paper, but that they were too old to get into it and adopt its new way of thinking about the universe. In other words, they were already too entrenched in the old perception of the universe and could not counter their common-sense to adopt Einstein's new intuitions.¹⁶ Given that Einstein's theory turned out to be a tremendous success, these scientists would have agreed that the moral is that you should never become too old to adopt new ways of thinking.

How can we retain our minds' youthful virility? By making use of silence—the instrument for embracing counter-intuition! Silence allows us to give up our old way of thinking about the world and accept a new one.

Counter-intuition is the most important faculty that modern science has taught us to exercise. Scientists have to be willing to make existential leaps (existential because for a scientist the paradigm by which his common-sense functions is the essence of his self). They have to be willing and able not just to surrender their common-sense, but to also be willing to abandon what everyone else thinks is true. Uprooting the paradigms of their own intuitions was a prerequisite for scientists to transcend and go beyond the accepted Newtonian and Hamiltonian mechanics of their time. And as it turns out, without these leaps they would not have been able to advance our understanding of nature.

This is the spiritual moral of the scientific story of the last few generations. We have to open our minds, to be willing to change our mind-set in order to open up to a new spring, a new birth, which vis à vis everything we have thought until now, is entirely counter-intuitive.

Now, let us turn to the three great theories of the 20th century—special relativity, general relativity, and quantum mechanics—and see what aspect of our common-sense each challenges. But first, let us note an important distinction between these three theories and the relative newcomer, string theory, in relation to counter-intuition.

Counter-intuition in physical theories

Both special and general relativity were developed by Einstein in the first years of the 20th century. Though their names suggest they are two developmental stages of the same theory, to this day, scientists consider them to be two distinct theories. Special relativity was introduced into scientific consciousness in 1905, the year Einstein presented three ground-breaking papers that literally turned the world of physics upside-down.

Quantum mechanics, on the other hand, was a group effort, developed by many scientists who collaborated over the first quarter of the 20th century.

Finally, string theory was first explored in the late 60s and early 70s, but did not really take-off until the 90s. Like quantum mechanics, string theory is the product of collaboration between many scientists.

But, what string theory clearly lacks is the same degree of counter-intuitive challenge to our common sense that special and general relativity and quantum mechanics pose. String theory's challenge to our common-sense is quite weak, in spite of the fact that it contains strange sounding ideas like the universe having 10 or 11 or 26 dimensions. It can be compared to a gentle giant that has the power to lift us up high, but in a calm and non-disruptive fashion. The excitement it has generated is not because of its counter-intuitive principles, but more because of its ability to unify the already

counter-intuitive realities described by relativity and quantum mechanics.

It is important to note that the first three theories are pretty much accepted across-the-board by scientists, whereas string theory is not. A minor reason for string theory's relatively weak standing is its relative youth, but the major reason is that string theory is currently unable to produce testable predictions. Indeed, the criticism of string theory does not focus on how counter-intuitive it is, but on its inability to produce testable predictions.

Let us now look at the three main physical theories of the twentieth century and analyze each one's particular attack on our common-sense, both scientifically and in the language of Kabbalah. Clearly, each of these theories is complex and can be described in many different ways. We will try to focus our attention on each theory's most surprising counter-intuitive component.

In order to help us orient ourselves, before we begin we will present a bird's-eye view of what follows. Special relativity is counter-intuitive to the mind-set of the World of Action, general relativity is counter-intuitive to the common-sense of the World of Formation, and quantum mechanics challenges the common-sense of the World of Creation.

theory	challenges mindset of World of
quantum mechanics	Creation
general relativity	Formation
special relativity	Action

The counter-intuitive aspect of special relativity

In the World of Action, the lowest of the three Worlds that our consciousness inhabits, we sense that we are moving; we are advancing in life. The most intuitive thing about the World of Action is that we think that everything is progressing. If someone would tell you that you are actually standing absolutely still, that would be totally counter-intuitive. At this level, our consciousness feels that everybody and everything is active. Everyone is on the move, going to work, doing something.

Enter special relativity, which claims that our sense of motion is really just a subjective illusion that our mind (our consciousness in the World of Action) tells us is happening. Obviously this is really counter-intuitive.

What is special relativity's argument? It starts from the basic idea that motion is always relative. We judge our motion in relation to another physical body we deem to be at rest. But, in fact, even though that other physical body seems to be at rest, it is only at rest relative to us. But, relative to a third object, it is actually in motion. If we continue to follow this chain of relative motion all the way, we find that there is only one thing that is constantly, absolutely moving in respect to everything else. That one thing is light.

Special relativity challenges our basic intuition about the role that space and time play in everyday action and events. Not only does special relativity merge space and time into a single entity (meaning, that from the standpoint of relativity you are always in relative motion, whether it be through space or through time), but it also casts them in a different role.

Until Einstein developed special relativity, our intuition told us that space and time were both constant and absolute, meaning that all observers should measure distances and time in the same way. In other words, 5 hours really do not take any longer whether you are

on the red-eye flight from Los Angeles to New York, or whether you are sound asleep in your bedroom. This was the way Newton understood space and time. His (and our everyday) intuition is that space and time serve as the backdrop to events and actions that happen within their framework and context. Space and time neither contribute to nor change because of the events that take place in them.

But, special relativity challenges this so common part of our common-sense. Einstein's innovation was that space and time are not a context at all, but that they actively participate and are affected by events. If you are traveling at a very high velocity time dilates and space gets shorter (the Lorentz effect). Time and space are variable, not constant.

In his theory of special relativity, Einstein hypothesized that the only constant and absolute motion in nature is that of light. It does not matter how fast you are going, light will always be moving away or towards you at exactly the same speed: about 300,000 kilometers per second. Everything else, including space-time itself, is relative to the observer. This means that while our common-sense treats space and time as purely objective entities, special relativity makes them purely subjective. This is another way of rephrasing how special relativity challenges the common-sense mind-set of the World of Action.

Incidentally, by challenging our common-sense notion of space and time as constant and objective, special relativity requires us to reframe (and perhaps even discard) many seeming contradictions between scientific theory and the Torah. For example, consider the age of the universe. Since we can no longer refer to some absolute reference for the passage of time, we have to get used to the strange counter-intuitive notion that time can move faster or slower depending on our motion. Indeed, if we measure time from the

point of view of a beam of light, there is no passage of time whatsoever. According to special relativity, without unambiguously defining “the observer” in the Torah’s account of creation and the observer in the scientific theory of creation, one cannot compare or contrast the two, because they lack a common frame of reference.

As explained earlier in this lecture, the three major theories of modern physics imbue a higher understanding into our lower consciousness. The higher understanding formulates as the counter-intuitive elements in the theory, while our common-sense attitude towards reality represents the lower consciousness that these elements are challenging. The source of this higher understanding, in the language of Kabbalah, is in the World of Emanation. In a certain sense, we can say that these theories not only elevate our consciousness of the universe and our place in it, but more importantly, they change how we imagine our relationship with God.

The role of mathematics in countering common-sense

We will see how this is in a moment. But, the question first has to be asked: What is the true nature of reality? Is it what our common-sense tells us it is? Or, is it what Einstein and his theory of relativity tell us it is? This is also related to another question: How is it possible that Einstein and other scientists so intuited such counter-intuitive notions?

Above we used the image of a ray of light descending from the World of Emanation and permeating our lower consciousness. Now let us add that the Magid of Mezritch, the Ba’al Shem Tov’s successor, was fond of saying (in Yiddish) that “*Atzilus is auch da!*” meaning that, “Emanation is also here!” What the Magid meant is that there really is only one reality and it is only different modes of consciousness that cause us to see it in different ways. The mode of

consciousness of Emanation depicts reality in the brightest light, without severing it from the Creator. So, if you have attained the consciousness of Emanation, you will see that it is here too. But, if you have not yet, then you can only catch a glimpse of reality through the eyes of Emanation, whenever Emanation-consciousness descends into your own mind-frame.

When it comes to understanding the universe's mechanics, it is with the aid of mathematics that we can attain the consciousness of Emanation. For this reason all three theories (quantum mechanics and general and special relativity), even though they counter our experiential intuition, were discovered using mathematical considerations and reasoning. When it comes to physical laws, it is mathematics that carries the consciousness of Emanation down into our consciousness. Mathematics is like the ray of light that brings the consciousness of Emanation down into the three lower Worlds.

The value of challenging our common-sense

At this point, we have to take a step back and ask: What is the value of having lower consciousness in the first place? Why did God not just create our minds and senses in a way that they would experience reality as special relativity says it is? Clearly, this is not a scientific question but a religious one requiring us to find an answer in the Torah. So, let us rephrase this question by going back to the idiom *ipcha mistabra*, which refers to counter-intuition.

28

As noted, the Jerusalem Talmud makes no use of this idiom because, as we explained, its intuition is correct from the outset and does not require challenges. But, the Babylonian Talmud does, implying that its intuitive understanding is sometimes mistaken and requires corrections attained through the discourse between the sages. The sages described their state of consciousness in Babylon as that of one who dwells in darkness.¹⁷ Like a person trying to judge

what objects are in the dark, their initial intuition may be incorrect, until the lights are turned on, so to speak. So which is better? Is it better to always have higher intuition, like the Jerusalem Talmud, or is it better to first err and then be corrected by the light of higher understanding?

The essence of this question is disputed in the Talmud in a different context.¹⁸ There is a question of who is greater: the *tzadik*, who never transgresses from the start, or one who transgressed and then did *teshuvah* (repented)? One opinion is that the *tzadik* is always greater than the *ba'al teshuvah* (Maimonides does not rule this way in his code of law). Following the logic of this opinion, the Jerusalem Talmud, which never needs to have its intuition challenged, is greater than the Babylonian Talmud, which often has to do exactly that. But, according to a second opinion, it is the *ba'al teshuvah* who is greater than the consummate *tzadik*. The *ba'al teshuvah* has arrived at the correct conclusion after having spent time living with mistaken intuitions about life. Indeed, his experience has led him to a more profound understanding regarding the depth of the Torah's advice than the *tzadik* who has never overstepped the boundaries of the Torah. Maimonides and others rule according to this second opinion, which when applied to our question implies that countering one's intuition and forging a corrected common-sense is in the end more rewarding and revealing than having the right intuition from the outset.

In Chassidic teachings a similar idea is stated with regard to light: light that comes out of darkness is greater than light that did not come from darkness.¹⁹ In retrospect, it is a positive thing that your initial common-sense was wrong and that you spent some time in relative darkness, as long as you had enough courage to silence your own mind and counter your intuition when it became clear that this was the right thing to do. In that case, the entire journey was

worthwhile, because the light that comes from the metamorphosis of one's heart and mind is the light of *teshuvah*, which allows the *ba'al teshuvah* to attain levels that even a perfect *tzadik* cannot. So this is an example of how the World of Emanation illuminates the relative darkness of each of the three lower Worlds.

Let us restate what we have seen:

Special relativity is a total reorientation of our approach towards the universe. It does two things: it connects and unites matter and energy, by the most famous equation in all of science: $E = mc^2$. And, not only does it do that, but it also makes space and time part of the events and not just the backdrop in which they occur. This means that space and time are relative concepts, relative to the observer, while the only thing that is absolute is the speed of light.

Interestingly, one of the most recent scientific developments is that perhaps even the speed of light itself, Einstein's one and only absolute, changes with time. Scientists conjecture that at the beginning of creation, the speed of light was much faster than it is now. This is an idea that is gaining popularity, even though it still cannot be proven. In a similar vein, scientists have hypothesized that the fine-structure constant may also have changed.

30

These new discoveries could also explain many things in accordance with the Torah. Indeed, the Rebbe taught us that none of the laws of nature should be assumed to be necessarily constant. What this means is that contrary to the assumption that nature is and has always been uniform, we cannot extrapolate about the speed of light in the past based on our current measurements.

To summarize, special relativity states that everything depends on the observer, but this is counter-intuitive to the normal mind-set of the World of Action. What this boils down to is that a person could be running his entire life and in the end realize that he has gone nowhere. The only one who is really going anywhere is one who is

attached to light. "Light is Torah."²⁰ If you are on a beam of light you are moving. This is absolutely counter-intuitive to the consciousness of the World of *Asiyah*.

The counter-intuitive aspect of general relativity

Now what about the World of Formation (*Yetzirah*)?

General relativity takes into consideration gravity, one of the four fundamental forces. It is the most elusive of the forces. But what Einstein realized is that from an observer's perspective, the experience of acceleration and the experience of gravity's pull are equivalent. This has very far-reaching consequences. The example that is usually given to demonstrate this is that if you are traveling up in an elevator, when the elevator accelerates you feel yourself being pulled into the floor. The experience of being pulled down is identical to what you would feel if you were suddenly affected by a gravitational field. This insight forms the basis for general relativity and is known as the equivalence principle.

The most important consequence of the equivalence principle is that space is not flat, or in other words, it cannot be described using Euclidean geometry. Until Einstein, everybody envisioned space as being flat. Thanks to Riemann's work, Einstein had the necessary mathematical tools (or "vessels"²¹ to use Kabbalistic terminology) to consider that space might be curved, which means that everything indeed moves in a straight line, while at the same time following the curvature of space created by the masses lying in it. Gravity, as Einstein realized, actually curves space. The idea that space is curved is counter-intuitive to what we normally conceive its geometry to be like. After having studied geometry in high school, general relativity requires us to re-conceive what space is like. Instead of space being flat it is either convex or concave.

What does this symbolize, that you take something that you thought was straight and now it is either convex or concave? In Hebrew, this is described by the idiom, “Like clay in the hands of the artist” (כְּחֵמֶר בְּיַד הַיּוֹצֵר). This is a deep insight into what the word “formation” means. The artisan has a potter’s wheel, on which he places the raw material, the clay, and he curves it. In *Halachah*, a vessel that has no curvature, meaning it does not have an inner space, convex or concave in which it can hold something, such a vessel cannot be defiled (it cannot become ritually impure), thus it is not a vessel at all. The idea that space-time itself has intrinsic curvature is the absolute formative quality in the World of Formation. So what is being revealed here is that space is a malleable material, not at all what we thought it was. Counter-intuition in the World of Formation challenges what formation is really about: curvature (of space-time). Similarly, we may say that in the World of Action the one true constant of nature, the speed of light, is the essence of action, what action really is. In Chassidic thought a good deed (an action, performed in the World of Action) is only one that shines light in the world.

The counter-intuitive aspect of quantum mechanics

32

The counter-intuitive principle introduced by quantum mechanics is Heisenberg’s famous “uncertainty principle.” What it started out as is that we cannot know both the location and the momentum of an elementary particle at the same time. At first people thought this was a limitation introduced by the observer. But, later it became clear that quantum mechanics is saying something far more profound. It is telling us that in truth, in essence, a particle does not have exact position and exact momentum at the same time. Uncertainty is not the result of limited powers of observation, rather it is built into the very concept, the very nature of the particle. This

means that particles are no longer “things,” as Dirac said. Elementary particles, like electrons, are not physical objects, they are wave functions, meaning probability functions. There are many ways to mathematically formalize this.

Feynman, one of the greatest American Jewish physicists used to say that there are perhaps a few people who understand, who grasp, what relativity is saying. But, there is no one at all who can fathom the meaning behind quantum mechanics.

Let us for a moment restate what the counter-intuitions of the Worlds of Action and Formation say about our service of God. In the World of Action, we said that the counter-intuition boils down to changing our comprehension of what motion is, what it means to be in motion. This is what the prophet says that relative to everything else a person is a walker, a mover.²² Relative to everything else, only a human being possessing a Divine soul can really move because he is on a beam of light (the light of the Torah).

In the World of Formation, curvature is a statement about the human heart. The heart is not something flat, it is something that needs to be formed, that needs to be shaped (sometimes, it needs to be broken) in order to become a receptacle. You have to make your heart into a vessel. You have to be a craftsman, an artisan in order to make your heart into a vessel.

Uncertainty, the World of Creation’s counter-intuition, is a statement about the mind. The paradox of the mind is that physical matter is intangible. In Kabbalah, it says that when consciousness reaches the World of Creation, it no longer relates to “things,” there is only raw material, i.e., the potential for things. This can alternately be described as conceiving of the appearance of physical matter and events as they will evolve in the lower Worlds, but not their physical reality itself. At the level of the World of Creation, the mind has to divorce itself from thinking about “things.” The mind has to reform

Beyond the Physical Universe: Lectures on Modern Physics

itself completely around this idea of uncertainty which takes away our notion of things. As we noted above with regard to the World of Formation (and the World of Action), here too, in the World of Creation, counter-intuition—the recognition that things do not really exist as we experience them (only in potential or as mathematical expressions)—is the essence (from the perspective of the World of Emanation) of what Creation (*ex-nihilo*) is.

Endnotes

Lecture I

1. To a certain extent, we are already used to science producing counter-intuitive results. Take for example the counter-intuitive idea that the earth is round and not flat. Or, that regardless of their weight, the terminal velocity of all objects as they fall towards earth is the same. Nonetheless, the physics of the 20th century has been challenging our most basic common-sense attitudes toward space, time, energy, and matter.
2. Every Hebrew word is rich in meaning. In the Bible, the Hebrew word for “world” (עוֹלָם) means “forever.” Only at the very end of the Biblical period did it begin to take on the meaning of “the universe” or “the world.” In the language of the sages, the same word takes on the meaning of “mind-space” or “mind-set,” which are very modern words. For instance, the sages write that a person sees seven “worlds” in his life. As a newborn he is treated like royalty; as a two-year-old he begins to resemble a pig (because he’s always on the ground in the dirt); at ten-years-old he jumps like a kid-goat and so on. Or, they say that King David saw five worlds in his life. He saw the world of his mother’s womb, etc.
3. We have stated that counter-intuition is an example of the World of Emanation illuminating the common-sense intuition on one of the lower three Worlds. Indeed, the father principle corresponds to the World of Emanation, whereas the three lower Worlds, whose common-sense intuition can be countered, originate from the equivalent of the mother principle.
4. Work on the Babylonian Talmud officially ended in the 6th century CE, while the Jerusalem Talmud was finished about a century earlier.

5. In Hebrew, "Eve" is written תָּוּהָ.
The number 19 is part of what in Kabbalah is called the Eve series of numbers. The function describing the n th Eve number is: $f[n] = 2\Delta n - 1$, where Δn stands for the sum of integers from 1 to n . The first few Eve numbers are therefore: 1, 5, 11, 19, 29,...
6. This is attested to by the popularity of books like "Men are from Mars..." that dwell on this difference between the male and female modes of common-sense.
7. For a more complete discussion of the technical aspects of *gematria* see *What You Need to Know About Kabbalah*, pp. 72ff. and our website: www.inner.org/gematria.
8. The scientific revolution of the 17th century was made possible in part by the willingness of reformers like Galileo to give credence to the measurable quantities of physical objects and events (e.g., velocity, weight, dimensions, etc.). Until then, the quantitative attributes of a physical object were thought to be accidental, thus revealing very little insight into either its nature or expected behavior. Language too, especially the language of the Torah or the language of the sages, can be analyzed quantitatively. When this analysis is carried out correctly, it too yields insight into the nature and function of words.
9. One of the main teachings of Rabbi Elimelech of Lizhensk, a master of the third generation of Chassidut.
10. See *Tanya*, ch. 31.
11. But, just as in Escher's famous counter-spatial sketches, if you feel that you are moving up, you are really already on the way down! Instead, humility before God and feeling no better than others are the key to keeping a forward momentum going.
12. *Sanhedrin* 97b.
13. *Rosh Hashanah* 10b-11a.
14. *Avot* 3:13.
15. The three stages of every spiritual process, which are derived from an analysis of the Biblical word *chashmal* (see Ezekiel 1:27), are:

submission, separation, and sweetening. See in length in *Transforming Darkness into Light: Kabbalah and Psychology*.

16. Bertrand Russell once quipped that when a reporter asked him to explain relativity, because only three people in the world really understand it, he replied: "I am aware of Einstein and myself. Who is the third?" The reader is referred to the first chapter of Russell's *The ABC of Relativity* from which we will quote a few lines:

Everybody knows that Einstein did something astonishing, but very few people know exactly what it was....It is true that there are innumerable popular accounts of the theory of relativity, but they generally cease to be intelligible just at the point where they begin to say something important. The authors are hardly to blame for this. Many of the new ideas can be expressed in nonmathematical language, but they are not less difficult on that account. What is demanded is a change in our imaginative picture of the world—a picture which has been handed from remote... ancestors and has been learned by each one of us in early childhood. A change in our imagination is always difficult, especially when we are no longer young. Einstein's ideas... will seem easier to generations which grow up with them, but for us a certain effort of imaginative reconstruction is unavoidable.

17. *Sanhedrin* 24a.
18. *Ibid.* 99a.
19. *Or Torah, Shir Hashirim* 192.
20. *Megillah* 16b.
21. The inner dimension of a "vessel" is a container to absorb spiritual energy/light; the outer dimension is a "tool" for acting in reality.
22. See *Zachariah* 3:7.