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## Threads of Reason

*A Collection of Essays on Tekhelet*

by Rabbi Mois Navon

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About the Book

This collection of essays is the result of research spanning more than a decade, motivated by nothing more than the desire to reach a clear understanding of the issues surrounding the rediscovery of *tebbelet* through the *Murex trunculus*. Is it possible to renew a biblical commandment without a *mesorah* (tradition)? Must religious objects, like *tzitzit*, be made from kosher substances? Does one violate the *melakhah* (Shabbat labor) of trapping when obtaining a snail on Shabbat? Bringing together biology and halakhah, chemistry and *aggadah*, archeology and theology – and applying careful consideration and logical reason – these essays seek to address the numerous questions that arise in the endeavor to revive this unique commandment. And as *tebbelet* is a commandment that has been forgotten for over 1300 years, each essay is colored with the marvel of a lost biblical commandment returned anew to the Jewish people. This collection of essays, then, can be seen as a group of threads – threads of reason – spun into a cord strong enough to bind a new generation in the fulfillment of an ancient commandment.

Rav's Beautiful Ratio: An Excursion into Aesthetics*

The Torah (Num. 15:38; Deut. 22:12) commands that *tzitzit* (tassels), be placed on be placed on four of the corners of a four (or more) cornered garment. The tassels are to serve as a reminder to fulfill all the commandments of the Torah (Num. 15:40). They are also seen to be an insignia of the King of kings, worn by His faithful servants (*Mahzor Vitri* 409).

Regarding how the tassels are made, the Talmud provides sparse few statements, thus leading to a plethora of interpretations. We shall use the description given by Maimonides in the twelfth century CE, in his monumental compendium of Jewish law, the *Mishneh Torah*:

The *tzitzit* tassel is made by placing four strings through a hole in the corner of the garment and folding them in half, thus making a tassel of eight strings. One of these eight strings is *tekelelet* [blue] and the remaining seven are white. The blue strand and one of the white strands are used to wrap around the hanging strands, such that one starts with a white wrap and ends with a white wrap, the rest of the wraps being all blue. The wrappings are to be organized of seven to thirteen *lulyot* [links], wherein each *lulyab* comprises three wraps. The wrapped section of the *tzitzit* is referred to collectively as the *gdil* [braid], and the free hanging section of the strings is referred to as the *anaf* [fringe].

Hilkehot Tzitzit 1:7-8

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The ratio for the proportion of braided string versus the free hanging fringe was defined in the second century CE by the great Babylonian Talmud Sage Rav as follows:

If the greater portion of the *tekehelet* [i.e., *tzitzit* tassel]¹ was braided, it is valid; and even if only a single *hulyah* [out of three wraps]² was braided, it is valid; and the way to beautify (*v'noyei*) the *tekehelet* is one-third *gdil* [braided] and two-thirds *anaf* [fringe].

Menaḥot 39a

Rav teaches that when tying *tzitzit* there is both an upper limit³ and a lower limit for the amount of braiding, as well as an ideal —“beautiful”— amount given in the form of a ratio of braided to unbraided sections. Embedded within these dry details lies the key to understanding the profound nature of aesthetics in Jewish thought. We can appreciate the depth of Rav's teaching by answering the following two questions:

- To what extent does the *halakhah* (Jewish law) demand this ratio and why?
- If the sole reason is simply “beauty,” of what concern is aesthetics to *halakhic* imperative?

Halakhah⁴

Commenting on the word *v'noyei* (to beautify) in Rav's definition, Rashi explains that Rav's ratio of one-third braid and two-thirds fringe is the principal [*ikar*] way to fulfill the commandment of *tzitzit*. Rabbeinu Tam, commenting on Talmud *Bekhorot* 39a, (s.v. *kama*), states that the ratio of one-third braid to two-thirds fringe optimizes (*bidur*) the commandment to tie *tzitzit*.

In *Hilkhot Tzitzit* 1:8, Maimonides echoes Rav's statement that the way to beautify *tzitzit* is to make them according to the thirds ratio. In *Hilkhot Tzitzit* 1:9, Maimonides goes on to explain that when there are no *tekehelet* strings available, maintaining the thirds ratio is not imperative.⁵ Rabbi Yosef Karo, in his commentary *Kesef Mishnah* (ad loc.) picks up on the implication of this last statement by Maimonides and explains his language to mean that when *tekehelet* strings *are* available, one *must* employ Rav's ratio.⁶

The Tur (*Orah Hayyim* 11) is of the opinion that one must maintain Rav's ratio apparently, regardless of the availability of *tekebelet*. The Tur cites Baal Ha'itur who rules that though any ratio may be used, the principal (*ikar*) method of fulfilling the commandment is according to Rav's ratio. Rama, in his *Darkei Moshe* on the Tur, quotes Maimonides' imperative that Rav's ratio must be used.

Rabbi Yosef Karo, in his *Beit Yosef* (*Orah Hayyim* 11:4), discusses the requirement to maintain Rav's ratio and specifies the minimum lengths to be used for the ratio as borne out from the *Sifri*. In his *Shulhan Arukh* (*Orah Hayyim* 11:4), Rabbi Karo simplifies the matter and writes that the minimum required lengths for "the braided section is four thumb-breadths and the fringe section, eight thumb-breadths." Rama comments on this that these lengths can be increased as long as Rav's ratio is maintained.

Hazon Ish (3:1) and *Maharshal* (on *Smag*, positive commandment 26) are of the opinion that the fringe can be lengthened without modifying the braided section, and this would still "beautify" the *tzitzit*. *Mishnah Brurah* (*Orah Hayyim* 11:69) explains that if the *tzitzit* has already been tied in this manner, then all the authorities will accept it as kosher;⁷ conversely, if one is setting out to tie his *tzitzit* he must use Rav's ratio.⁸

To summarize, with the exception of the opinions of *Hazon Ish* and *Maharshal*, the weight of halakhic opinion rests squarely with Rav's ratio and his absolute requirement. It should be noted that the retroactive leniency noted by the *Mishnah Brurah* is applicable only in urgent circumstances,⁹ for if the *tzitzit* lacks the proper ratio, it is relatively simple to correct this by either cutting the fringe (*anaf*) or modifying the braid (*gdil*) by adding or removing winds and knots. If none of these options is viable¹⁰ – it is not difficult to simply replace the strings in question. Thus, the leniency mentioned by the *Mishnah Brurah* is at most of ephemeral efficacy and cannot be relied on for any extended period of time.

Beauty

The overwhelming support for obligating Rav's ratio begs the question: Why? Why is maintaining Rav's ratio so important? Rav himself answers this question in one word: *noy* (beauty). But if the reason is beauty, how can one be obligated to another's definition? Is not beauty, as the eighteenth-century proverb goes, in the eyes of the beholder?

Antinomy

This question brings us into the thick of a great philosophical debate known as “the antinomy of taste.” Antinomy refers to a contradiction between two rational statements arrived at through logical reasoning. The antinomy regarding taste considers whether aesthetic value is subjective or objective. On one hand, most people have a feeling about what they find pleasing; on the other hand, without universal criteria for making aesthetic judgments, appreciation of the aesthetic is reduced to the level of mere gustatory taste.¹¹

There are important arguments to be made for both sides of this debate, however, perhaps the most amenable solution lies in reconciliation.¹² That is, beauty can be defined both as something which is appreciated uniquely by the subject, the object of which nevertheless admits of some aesthetic quality.¹³ Beauty, then, is the integration of subjective aesthetic appreciation and objective aesthetic quality.

Phi

By definition, every person determines for him or herself the subjective part of the equation. But what defines objective beauty? The sixth-century BCE Greek philosopher Pythagoras argued that mathematics quantified the beautiful.¹⁴ The eighteenth-century German philosopher Immanuel Kant stated that “Art can only be called beautiful if we are conscious of it as Art while yet it looks like Nature.”¹⁵ Combining these two concepts, mathematical structures found in nature could be said to represent universally recognized, objective, beauty.¹⁶

Such a phenomenon is found in the extraordinary irrational number known as *phi* (Φ).¹⁷ In his book, “The Golden Ratio,” Mario Livio writes of the number *phi*:

The history of art shows that in the long search for an elusive canon or “perfect” proportion, one that would somehow automatically confer aesthetically pleasing qualities on all works of art, the Golden Ratio has proven to be the most enduring.¹⁸

The number *phi*, though known of earlier,¹⁹ was formally defined in the third century BCE by Euclid in his fundamental opus *Elements*.²⁰ The number emerges from a simple geometric division of a line into two unequal parts, such that the ratio of the longer segment to the shorter segment is equal to the ratio of the total

length to the longer segment. Assume the following line composed of a short line segment s and a long line segment l :



The irrational number ϕ (1.618...) is realized when:

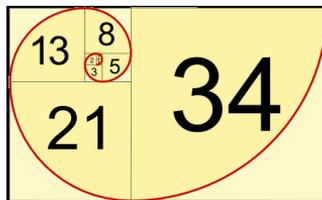
$$(l+s) / l = l/s$$

Beyond expressing this simple ratio, ϕ is intimately associated with the Fibonacci Series. The Fibonacci Series was made famous by the thirteenth century Italian mathematician Leonardo of Pisa. In his *Liber Abaci*, Leonardo of Pisa describes a series of numbers in which the next number is the sum of the preceding two numbers. If a Fibonacci series starts with the two numbers 1 and 1, then the next number is 2, the number after that is 3, and after that is 5, thus giving the series:

$$1, 1, 2, 3, 5, 8, 13, 21, 34, \dots$$

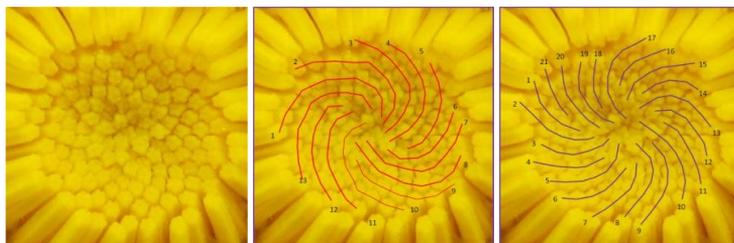
In 1611 the astronomer Johannes Kepler discovered that if we denote the n^{th} number in the series as F_n and its successor as F_{n+1} then F_{n+1}/F_n provides closer and closer approximations of ϕ as n increases.

Kepler's find is also given expression in the geometric relationship between the Fibonacci series and ϕ . Stacking squares with sides measuring F_n in succession (for example, where $n=\{1,..,9\}$, as shown below), the rectangle formed by the combination of n adjacent squares will have its longer side measure F_{n+1} and its shorter side measure F_n – the ratio of the sides being F_{n+1}/F_n . Consequently, Kepler's numerical discovery also applies geometrically. This means that as n increases, the rectangle formed has sides the ratio of which exhibits a closer and closer approximation of the Golden Ratio. A rectangle wherein the ratio of the longer side (l) to the shorter side (s) is equal to ϕ (i.e., $l/s = \Phi$) is known as a Golden Rectangle.



Furthermore, if we were to draw quarter circles from the diagonal corners of each of these squares and connect them, as shown in the figure above, we would achieve a “logarithmic spiral.”²¹ Due to its wonderful property of never changing its shape when it increases in size, this spiral was dubbed the *spira mirabilis* (wonderful spiral) by the seventeenth-century Swiss mathematician Jacques Bernoulli.²² The logarithmic spiral is thus closely connected to the Golden Ratio.

Another important expression of *phi* is in its description of the Golden Angle. This angle is achieved by a 0.618 (i.e., $1/\Phi$) turn around an axis. Calculating this turn in degrees, we simply multiply $1/\Phi$ by 360° , such that $360^\circ \times 0.618$ gives 225.5° and its complementary angle of 137.5° (i.e., 360° minus 225.5°). This angle figures extensively in the study of growth patterns of plants, known in botany as phyllotaxis, where it is found to be the most efficient angle of growth around an axis. Phyllotaxis also shows that not only do leaves grow around a stem using this angle, and not only do the florets on the head of a sunflower grow accordingly, but they also grow in interleaving logarithmic spirals which number according to Fibonacci pairs. The figures below show a typical growth pattern where the clockwise spirals number 13 and the counterclockwise spirals number 21.²³



Thus, the number *phi* in its simplest form is a proportion equaling $1.618\dots$, giving us the Golden Section of a line segment, as well as the proportions of the Golden Rectangle. *Phi* is also expressed in the logarithmic spiral and is the source of the Golden Angle, as well as many other mathematical forms too numerous to mention.²⁴ *Phi*, in all these various forms, has been found so ubiquitously in nature that it has been labeled the “Divine Proportion.”²⁵ In addition to its botanical manifestations, *phi* is found to describe the attack pattern of the Peregrine falcon, the spiral of galaxies, and the spiral of mollusk shells.²⁶ *Phi* was found to hold such aesthetic value that it served as the basis for Western art and architecture.²⁷ (There is a debate as to how consciously the number was applied, especially in ancient art and architecture where close approximations of the proportion are found to be used by peoples who may not have known specifically of the number).²⁸

Finally, a rough approximation of *phi* known as the “rule of thirds” has been adopted by photographers.²⁹ According to this rule, the composition of a photograph is more aesthetically pleasing if the subject/s is/are placed off-center at lines dividing the canvas into thirds. This approximation reminds us of Rav’s ratio of one-third *gdil* to two-thirds *anaf* for aesthetically pleasing *tzitzit!*

This, I propose, is the resolution to our *halakbic* quandary as to how the law can require us to have beautiful *tzitzit* while dictating Rav’s definition of “beautiful.” Applying what we have learned above about aesthetics and *phi*, we see that Rav’s definition is not merely an expression of his own personal taste but rather an echo of a universal chord,³⁰ or even of objective beauty found in creation itself.³¹

Approximations

Regarding the imprecision of Rav’s ratio with respect to the number *phi*, the approximation of thirds (i.e., 1.5)³² simply provides a close enough approximation depending on context, as demonstrated by the rule of thirds in photography. Similarly, the nature of *tzitzit* is such that they are produced in the rough and observed in the rough. Even meeting this ratio precisely appeared too demanding for Hazon Ish, who asked how the sages could require an exact ratio. His brother-in-law, Rabbi Yaakov Yisrael Kanievsky, known as the Steipler Gaon, replied in his “Measurements in the Torah” that Rav’s ratio is not meant to be met precisely but rather in approximation by the naked eye because beauty is beheld by the naked eye.³³

Indeed, while *phi* figures in much of nature on a precise mathematical basis, it is found in much of art and architecture in approximation. The argument between those who consider *phi* to be the basis for works of art versus those who hold such to be wishful thinking centers on whether *phi* is used precisely or not. However, in all the cases of contention, even *phi* detractors agree that, whether created consciously or otherwise, approximations to *phi* exist. Thus, there is consensus that many works of art and architecture successfully use proportions varying within a range of ± 10 percent of the Golden Ratio (i.e., 1.456 to 1.780).³⁴ It can be said, then, that *phi* need not be met to the angstrom in order to bequeath the beauty it manifests but rather it need only be met in rough approximation to provide aesthetically pleasing proportion.

Ultimately, proper proportion is the most highly sought element in aesthetics. In the words of the thirteenth-century Italian philosopher Thomas Aquinas: “The senses delight in things duly proportioned” (*Summa Theologica* I.5.4). Similarly, first-century Roman architect Marcus Vitruvius Pollio said of the importance of proportion, “A magnificent temple cannot be constructed properly, unless it is built in an orderly manner with regard to symmetry and proportion of its parts, as is the case with a well-built man....” (*De Architectura Libri Decem*). Furthermore, Vitruvius is known to have argued for the use of “simple proportion” – i.e., the ratio of two whole numbers (e.g., 3/2).³⁵

Rav's intent was to define an objectively pleasing proportion that was at the same time easy to implement.³⁶ By stipulating “one-third, two-thirds,” his rule is easy to apply while still remaining close enough to express the natural beauty of the Divine proportion.

Beauty in *Halakhah*

Beyond the question of subjective versus objective beauty (i.e., how can *halakhab* presume to “define” beauty), there is a teleological question: Given that Judaism in general, and *halakhab* in specific, is concerned with ultimate goals and ultimate purpose, how can *halakhab* engage in something so seemingly ephemeral as aesthetics? Why should *halakhab* demand beauty in *tzeitzeit*?

In his study on the human condition, Rabbi Joseph B. Soloveitchik provides an answer to the teleological question.³⁷ Rabbi Soloveitchik divides human experience into three “gestures”: intellectual, ethical, and aesthetic.³⁸ The intellectual and ethical are teleological undertakings in which a person endeavors to reach absolute truths, be they of nature or of morality.³⁹ Aesthetic undertakings, on the other hand, are not necessarily so animated. Within the *superficial* aesthetic experience, the aesthete simply strives after subjective pleasure, having no greater goal than to satisfy the self.⁴⁰ When pleasure is the highest goal, sin is the inevitable result.⁴¹ It can be said then, that the aesthetic is ultimately at the root of all sin. Indeed, it was the source of the primordial sin, Eve having decided to eat from the forbidden tree because of its aesthetic allure (Gen. 3:6).

Rabbi Soloveitchik explains that “What caused man's fall is his giving preference to the sensuous, delightful, and pleasing over the true, at both the intellectual and ethical levels.”⁴² That is, on the intellectual level man was told by God, his Creator

and source of wisdom, “on the day that you eat it you will die” (Gen. 2:17); and on the ethical level man was *commanded* by God, his Creator and moral arbiter, “from the tree of knowledge of good and evil do not eat” (Gen. 2:17). Nevertheless, Eve disregarded these considerations in favor of the aesthetic, observing that “the tree was good for food and desirable to the eyes” (Gen. 3:6).

Perhaps Eve’s mistake is the basis for the severity of the Mishnah, “One who walks by the way and breaks off his study and says, ‘How beautiful is this tree...’ makes his life forfeit” (*Avot* 3:7). For if, in the midst of the intellectual/ethical gesture, a person stops to satisfy the aesthetic,⁴³ he performs an act akin to that of Eve’s, which eventuated in death, and thus he “makes his life forfeit.” Interestingly, in both the Garden of Eden account and the example in *Avot* 3:7, the source of natural beauty is a tree.

The aesthetic gesture, however, is not unredeemable; on the contrary, it is essential that humankind harness it to serve God.⁴⁴ And so the same tree for which one made his life forfeit by gazing at in self-indulgence, or at the expense of the intellectual/ethical,⁴⁵ can also be the subject of a special blessing when it is appropriately recognized as a gift from God.⁴⁶ Indeed, a blessing elevates an act from one of selfish pleasure to one of appreciation of, and communion with, the transcendental. Rabbi Soloveitchik explains that for the aesthetic experience to be meaningful, it must aspire to the absolute, to the transcendent: “[It] must always be encountered as a reflection of Divine beauty.”⁴⁷

Redemption of the aesthetic gesture is accomplished by applying the same teleological aspirations that make the intellectual and ethical gestures meaningful. “When the aesthete begins to wonder whether everything which is apprehended as beauty and as pleasant expresses indeed genuine beauty, when he thinks that the aesthetic act can be critically examined and its worth objectively ascertained, in a manner similar to our critical attitude toward cognitive and ethical gestures, then beauty is redeemed.”⁴⁸

As such, just as the intellectual and ethical quests lead to God as the ultimate source of truth and goodness, so too does the *profound* aesthetic experience lead to God as the ultimate source of beauty. “God not only addresses Himself to man through the logos, by emanating wisdom and knowledge to the finite mind; not only through the ethos, revealing to natural man, driven by insensate desires and impulses, a great order of absolute values and ideals—but also through aesthesis,

the immediate sensible apprehension of reality which is beautiful and grandiose.”⁴⁹ And in so reaching God through the aesthetic, a person can realize an ecstatic relationship unattainable through the other gestures. “Only through coming in contact with the beautiful and exalted may one apprehend God instead of comprehend Him...”⁵⁰

This, then, answers the question of why *halakhab* should be concerned with the aesthetic. The aesthetic gesture holds great attraction and is highly prone to abuse. Indeed, it is the very source of man’s downfall.⁵¹ Thus, *halakhab*, which comes to direct our every action to do what is right and good, must also direct us to apprehend God through the aesthetic as well.⁵² In so doing, *halakhab* trains us to attune our aesthetic impulse to the transcendent, where we will find ultimate fulfillment.

As such, though there may be things that one does not find particularly pleasing, if they are said to obtain of aesthetic truth, one must yield to them, knowing that one is thereby redeeming the aesthetic gesture within oneself. Correspondingly, explains Rabbi Soloveitchik, “One must be able to reject certain phenomena even though they please the eye, as ‘false’ manifestations of true beauty.”⁵³ In this regard, Rav’s ratio must be adopted irrespective of whether it appeals to our personal taste or not.

Although I have attempted to demonstrate a basis for Rav’s ratio in its approximation to *phi*, Rav’s ratio must be maintained as an expression of “true beauty” regardless of our discussion. Perhaps one of Rav’s goals in defining beauty was to impart the notion that just as objectivity is essential in ethical judgment, objectivity must also be a part of aesthetic judgment— as our thinking in the one informs our thinking in the other.⁵⁴

Conclusion

The aesthetic, while fraught with potential for abuse, is not only a valid “gesture” but one essential for spiritual self-realization. A person should develop a genuine appreciation of the beautiful as a pathway to encountering the Divine; and at the same time “redeem” the aesthetic experience by seeing it as a reflection of the Divine. In this regard we have seen that, though beauty is in the eye of the beholder, there are things in nature which can be said to have universal, or objective, beauty. Rav’s ratio embodies universal, or objective, beauty which

correspondingly so endows *tebbelet*⁵⁵ *tzitzit*. Thus his ratio adds yet another dimension to the device of the *tzitzit* that reminds us of the Creator⁵⁶ – the Creator of beauty itself.⁵⁷

May this appreciation of beauty serve to inspire yet more Jews to wear *tebbelet tzitzit* and thus merit the enjoyment of Divine beauty, both physically and spiritually. Regarding the physical reward, Rav Huna teaches that: “one who is punctilious in the observance of the mitzvah of *tzitzit* merits a beautiful *talit* (prayer shawl).”⁵⁸ And regarding the spiritual reward, Rabbi Shimon bar Yohai promises that: “one who is punctilious in the observance of the mitzvah of *tzitzit* merits seeing the Divine Presence.”⁵⁹

~ Notes ~

- ¹ The term “*tekbelet*” here is used to refer to the entire *tzitzit* tassel and not specifically to the *tekbelet* strings (See Rashi, *Men.* 39a, s.v. *tekbelet*).
- ² As taught by Rebbi in a *baraita* (*Men.* 39a). See Rashi, *Men.* 39a, s.v. *ela hulyab*.
- ³ Braiding can take up the majority of the tassel, but not its entirety (*Magen Avraham, Orah Hayyim* 11:14:20).
- ⁴ This *halakhic* overview is based on an article by R. Shlomoh Taitelbaum entitled “*Shnei Shlish*,” <http://www.tekhelet.com/pdf/ShneiShlish.pdf>.
- ⁵ Perhaps Maimonides’ position of requiring Rav’s ratio only when employing *tekbelet* strings is based on the use of the term “*tekbelet*” in *Menahot* 39a specifically referring to the entire tassel, thus implying that the rule is only applicable when *tekbelet* is used. Alternatively, Maimonides’ position might be based on the fact that the contrast between *anaf* and *gdil* is only pronounced enough to have an aesthetic impact when the *gdil* comprises blue strings. Although the Shulhan Arukh does not quote Maimonides’ position, nevertheless perhaps this is why the ratio is not strictly adhered to today, since people have become accustomed to using only white strings, wherein the ratio lacks the impact rendered by the inclusion of *tekbelet* strings.
- ⁶ See also *Beit Yosef* (*Orah Hayyim* 11:4).
- ⁷ So too *Be’er Hetev* (*Orah Hayyim* 11:22).
- ⁸ *Mishnah Brurah* (*Orah Hayyim* 11:66) notes that the obligation is rabbinic.
- ⁹ Examples of such circumstances are “*erev Shabbat*” (*Mishnah Brurah, Orah Hayyim* 11:66) and being “*on the road*” (*Biur Halakhab, Orah Hayyim* 11:4, s.v. *yoter*).
- ¹⁰ Modifying existing tassels is not always possible because reducing the tassel length might bring the *tzitzit* under the minimum four and eight thumb-breadth requirements; similarly, removing or adding a *hulyab* might bring the total under the seven *hulyot* or over the thirteen *hulyot* requirement (*Menahot* 39a).
- ¹¹ Gordon Thomas, “*Are Aesthetic Judgments Subjective or Objective?*” <http://www.oswestryschool.org.uk/decimus/aesthet.htm>.
- ¹² *Ibid.*
- ¹³ Avowed subjectivist Kant would say: The object of which is universally *perceived* to admit of some quality.

- ¹⁴ John Hyman, “Is Beauty in the Eye of the Beholder?”
<http://www.oswestryschool.org.uk/decimus/beauty.htm>. Similarly, mathematician Luca Pacioli (Italy, 1445-1514) said, “Without mathematics there is no art.”
- ¹⁵ Immanuel Kant, *Kant’s Critique of Judgement*, translated with Introduction and Notes by J.H. Bernard (2nd ed. revised) (London: Macmillan, 1914). Chapter: § 45.: *Beautiful Art is an art, in so far as it seems like nature*. <http://oll.libertyfund.org/title/1217/97547>.
- ¹⁶ Though Kant argues that a work of art seems unfettered by rules, his point is not that no rules should be applied but rather that the application of rules should be indiscernible.
- ¹⁷ For a treatment of the number ϕ , see Mario Livio, *The Golden Ratio: The Story of Phi, The World’s Most Astonishing Number* (New York: Broadway Books, 2002).
See also http://physicaplus.org.il/zope/home/en/1105389911/livio_1110008665_en;
http://en.wikipedia.org/wiki/Golden_ratio.
- ¹⁸ Livio, p. 10. It should be noted that Livio uses the word “enduring” to mean that ϕ has persisted throughout history to be viewed as a canon, but not that he himself believes it to be such.
- ¹⁹ It is conjectured that the Pythagoreans in the fifth century BCE knew of ϕ (Livio, pp. 34-41).
- ²⁰ “A straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater to the lesser” (Euclid, *Elements*, Book VI, Definition III). See also Livio, pp. 75-78. As an interesting side note, the eighteenth-century Lithuanian scholar R. Eliyah ben Shlomoh Zalman (the Vilna Gaon) said to the translator of Euclid’s work into Hebrew: “To the degree that a man is lacking in the wisdom of mathematics he will lack one hundredfold in the wisdom of the Torah” (quoted in R. Joseph B. Soloveitchik, *Halakhic Man* [Jerusalem: Sefer Ve Sefel, 2005], p. 57). In this vein, the words of the Maharal of Prague (1525-1609) are worthy of mention, “a man ought to study everything that will enable him to understand the essential nature of the world. One is obligated to do so, for everything is God’s work. One should understand it all and through it recognize one’s Creator” (quoted in R. Eliezer Berkovitz, *Essential Essays on Judaism*, [Jerusalem: Shalem Press, 2002], p. 242).
- ²¹ Livio, p. 118.
- ²² *Ibid.*, p. 116.
- ²³ Photos: <http://deepfriar.wordpress.com/2011/05/31/getting-mathematical-on-weeds/>. See <http://www.mathsisfun.com/numbers/nature-golden-ratio-fibonacci.html> for interactive demo of seed packing efficiency using the Golden Angle versus other similar angles.
- ²⁴ For example: the pentagram, Platonic solids, fractal geometry, and certain crystal structures.

- ²⁵ Luca Pacioli wrote a three-volume work on the subject of *phi* in 1509 entitled “*De Divina Proportione*.”
- ²⁶ Interestingly, the shell of the *Murex trunculus* – the snail from which *tekelet* dye is made – appears to follow the *phi*-based logarithmic spiral.
- ²⁷ Artists who applied *phi* include Leonardo da Vinci (1452-1519) [at least for the artwork in Pacioli’s book], Paul Serusier (French, 1864-1927), Giro Severini (Italian, 1883-1966), Juan Gris (Spanish, 1887-1927), Le Corbusier (Swiss, 1887-1965), Salvador Dali (Spanish, 1904-1989). Jacques Villon (French, 1875-1963) enthusiastically pronounced, “As in the Middle Ages one told a prayer before beginning a painting, I rely on the golden section for the surety of ancient times.”
- ²⁸ For example, the Pyramids and the Parthenon (see Livio, pp. 51-61, 72-75).
- ²⁹ In photography 1.5 is used instead of 1.618. That is, dividing a line into thirds gives a ratio of $(l+s)/l = 3:2$, whereas *phi* gives 1.618:1 or 3.236:2. See, for example: http://www.istockphoto.com/article_view_print.php?ID=13; http://www.thinctanc.co.uk/design/photography_tutorial_02.html; http://www.markboulton.co.uk/articles/detail/feeling_your_way_around_grids/; http://photoinf.com/Golden_Mean/Edwin_Leong/Camera_Hobby_-_e-Book_on_the_Golden_Ratio.htm; http://en.wikipedia.org/wiki/Rule_of_thirds.
- ³⁰ Hume (Scotland, 1711-1776) and Kant (Germany, 1724-1804) would argue that though we cannot claim an object to be inherently beautiful, we can, as Man, claim that the object is beautiful for all Man.
- ³¹ Plato (Greece, 428-348 BCE) held that beauty exists objectively and that concrete things can participate in that objective beauty.
- ³² See fn. 29.
- ³³ Quoted in R. Shlomoh Taitelbaum, “*Shnei Shlish*,” p. 3.
- ³⁴ See, for example, the discussion on McManus in Livio, p. 182.
- ³⁵ Livio, p. 161.
- ³⁶ *Tzitzit* are ritual objects that must be produced with relative ease because they undergo the tremendous wear and tear of daily use and thus must be replaced relatively often. This is as opposed to *tefillin* that require a more exacting standard of manufacture (i.e., the boxes must be a perfect square – see *Shulhan Arukh, Orach Hayyim* 32:39). *Tefillin* are produced by experts and built to last a lifetime; nevertheless, even here it is understood that absolute precision is not attainable (see *Mishnah Brurah*, 32:39:176).

- ³⁷ R. Joseph B. Soloveitchik, *Worship of the Heart* (New Jersey: Ktav, 2003), “The Human Condition and Prayer,” pp. 37-50, and “Exaltation of God and Redeeming the Aesthetic,” pp. 51-72.
- ³⁸ *Ibid.*, pp. 40-42.
- ³⁹ *Ibid.*, pp. 42, 53.
- ⁴⁰ *Ibid.*, p. 43.
- ⁴¹ *Ibid.*, p. 46.
- ⁴² *Ibid.*, p. 47. Similarly, R. Samson Raphael Hirsch (Gen. 2:16).
- ⁴³ Bartenura (*Avot* 3:7) comments that even when one gazes at the tree in appreciation of God’s handiwork, one is nonetheless culpable for stopping his engagement in the intellectual/ethical. This view highlights R. Soloveitchik’s explanation of the original sin in which man placed the sensuous over the intellectual/ethical. Not only is it unacceptable to pursue the sensuous in and of itself, but even when one seeks God through the aesthetic, such a gesture cannot come at the expense of the intellectual/ethical.
- ⁴⁴ R. Soloveitchik, pp. 51-64. Indeed, the *yetzer hara* itself is seen by the Talmud Sages as a drive, on the one hand capable of bringing man’s downfall, yet on the other hand essential for man to actualize his potential (see R. Chaim Eisen, “You Will Be Like God,” *Jewish Thought*, vol. 2, no. 1, pp. 45-116).
- ⁴⁵ See fn. 43.
- ⁴⁶ *Shulhan Arukh, Orach Hayyim* 225:10.
- ⁴⁷ R. Soloveitchik, p. 52
- ⁴⁸ *Ibid.*, p. 56
- ⁴⁹ *Ibid.*, p. 57
- ⁵⁰ *Ibid.*, p. 59
- ⁵¹ R. Soloveitchik (*ibid.*, p. 48) explains that as a result of the original sin based on placing the aesthetic above the intellectual and ethical, Man became ashamed of his nudity precisely due to his aesthetic awareness. In this sense, clothing comes to address the abuse of the aesthetic experience. As such, clothing is the ultimate reminder of the original sin. Indeed, the *Zohar (Ki Teitzei* 276a) notes that the word for clothing, “*beged*,” has the same root letters as “*boged*,” unfaithful. In consonance, one of the purposes of the *tzitzit* attached to the corners of our clothes is to remind us not to stray after our eyes.
- ⁵² “The task of Halakhah is to sanctify nature” (*ibid.*, p. 143). R. Soloveitchik explains that *halakhic* man finds God not in the supernal realms but rather in the very midst of our

concrete reality, "... the Divine Presence in dimensions and the glory of God in measurements" (*Halakhic Man*, p. 48).

⁵³ R. Soloveitchik, *Worship of the Heart*, p. 54.

⁵⁴ See Sam Fleischacker, *A Third Concept of Liberty* (New Jersey: Princeton University Press, 1999), ch. 2. See also my paper "Halacha, Ethics and Aesthetics," *Everett Journal of Jewish Ethics* 1 (Winter 2008).

⁵⁵ As noted earlier, Rav's statement refers to *tzitzit* explicitly as "*tebbelet*," and, as indicated by the Rambam, the ratio is most readily noticed when *tebbelet* provides the necessary contrast.

⁵⁶ Num. 15:39. "Upon seeing the *tebbelet* strand one remembers his Creator" (*Tanhuma, Shelah* 15); so too Rashi (*Menahot* 43b, s.v. *v'rakia*). Recanati (Num. 15:37-40) quotes the explanation of the *Bahir* (92-93) that the 32 *tzitzit* strands are a symbolic reminder of the "ways" of the King, and the *tebbelet* is a symbol of the King Himself. R. Isaac Luria says that *tebbelet* is the symbol of God's Kingship (*Pri Etz Hayim*, Shaar Hatzitzit, ch. 4). See also *Sifri, Shelah* 115, *Pesiketa Zutra (Lekah Tov, Shelah* 112b); *Midrash Aggadab* ([Buber] Num. 15:38), *Yalkut Shimoni (Shelah, remez* 750), *Yerushalmi (Brakhot, ch. 1, 3a)*. "Looking at [*tebbelet*] is as if seeing the Divine Presence" (*Mishnat Rabbi Eliezer*, ch. 14, p. 264). "When Israel looks upon the *tebbelet* strand it appears to them as if the Divine presence is amongst them" (*Tanhuma [Buber] Shelah* 30). Similarly *Midrash Tehillim* ([Buber] 90:18), *Yalkut Shimoni (Tehillim, remez* 841). See also *Menahot* 43b.

⁵⁷ Or, according to Kant: the Creator of the human ability to perceive beauty.

⁵⁸ *Shabbat* 23b.

⁵⁹ *Menahot* 43b.