

A Critical Realist Perspective on Beauty in Physics

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Abstract

The statements of physicists about the beauty of physics have inspired philosophers to investigate the nature of such claims from a philosophical perspective. When philosophers look at what physicists say, however, they find a variety of theories and aspects of physics that are identified as beautiful as well as some disagreement. Just using the physicists' statements, it is difficult to determine where exactly the beauty of physics lies. This paper proposes to use the critical realist philosophy of aesthetics as a foundation for examining what scientists say about the beauty of their subject, and the main contention is that critical realist aesthetics best accounts for their assertions.

Keywords: physics, science, beauty, aesthetics, realism.²

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1. Introduction

It is not uncommon to find physicists expounding on the beauty of physics and even, sometimes, claiming that beauty is or has been a guide to finding what is true. Such statements, of course, raise a series of philosophical questions, the most important being whether or not those statements are true. Other questions which arise involve the nature of beauty, the nature of physics, what it might mean for physics to be beautiful, and how the natures of beauty and physics might intersect.

Philosophers have devoted time and energy to such questions (e.g. de Regt, 2002; Ivanovna, 2021; McAllister, 1996; Root-Bernstein, 2002). Many of these studies begin with the data of the statements of the physicists themselves and then begin to piece together what it is they might mean by reference to the beauty of physics and whether or not they line up with each other. In general, they look for a pattern in the writings of the scientists for agreement about particular theories or aspects of theories that might be beautiful. When patterns do not emerge or physicists disagree about particular aspects they find beautiful, it is sometimes concluded that the scientists are, therefore, wrong in identifying beauty (e.g. de Regt, 2002).

Besides the disagreement that can be found among physicists is the fundamental and universal objection to statements about beauty in general, and that is the simple fact that people disagree about what is beautiful, and this disagreement is alarmingly common if there is to be any hope of finding objectivity in claims about what is beautiful (cf. Kovach, 1976, p. 62).

This paper proposes a different way of approaching the situation and attempts to demonstrate the utility of the critical realist perspective on philosophical aesthetics in the attribution of beauty in physics. Essentially, the traditional viewpoint on beauty, as developed by Plato, Aristotle and Aquinas, and synthesized in the work of Francis Kovach gives the best account for the beauty that physicists find in their science as well as a sufficient response to the objection that people disagree about what is beautiful.

The other questions as to the nature of science and, ultimately, whether or not there is beauty in physics, are beyond the scope of this paper, worthy though they are of attention.

2. What the physicists say

It is important to begin with what might be called the “raw data,” the statements of the physicists themselves, so we will take some time now to look at a sampling of some of the things physicists have said about beauty in physics and take note of some patterns. What I would like to look at in particular are the characteristics of beautiful things that

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are identified, rather than what theories or equations are said to be beautiful, although there are a couple of theories which are almost universally regarded as such: Einstein's theory of relativity (Schrödinger, 1996, p. 25; Engler, 2002; Stewart, 2007, pp. vii - viii) and Maxwell's equations (Engler, 2002; Stewart, 2007, p. 180; Lederman and Hill, 2008, p. 68). It is, instead, the aspects of what is found aesthetically pleasing which will be most helpful here.

It would take up too much time here to present a large number of quotes, so the passages cited here are those where physicists describe *why* they find physics beautiful. The most helpful statements are the ones where physicists attempt to describe what it is about a theory that they find beautiful so that a pattern can be discovered. There are a few physicists who have attempted to go into detail, and their comments are very valuable for philosophical analysis.

To begin with, David Bohm identifies *oneness*, *totality*, *wholeness*, and *harmony* (2010, p. 3). Of the four words he uses, the first three appear to be synonymous with each other, while the last, *harmony*, has to do with how something is unified in the way the parts relate to each other and to the whole. Another characteristic identified by Bohm is what is *fitting* (Ibid., p. 127), which seems analogous to *harmony*, the way in which things fit together to form a whole.

Werner Heisenberg's description of beauty fits well with Bohm's, and he calls beauty the "right concordance of parts" (1970). This can be called *harmony* or *fittingness* which is part of what makes a thing whole and entire, a unity. Chandrasekhar agrees with Heisenberg (1987, p. 52).

An idea that is similar to the idea of *harmony* and *fittingness*, is that of *order*, as mentioned by Pierre Duhem (1991, p. 24) and *order* is also identified by Bohm as a fundamental component of beauty (2010, pp. 8, 39, 42, 117). Heisenberg's description of beauty could very well substitute the word *order* for *concordance* (1970).

The physicist John Taylor finds beauty in the reduction of number of principles and laws so that physics becomes *simpler* and more *unified* (2001, p. xi). Physicist Paul Davies (1992, pp. 21, 211) and mathematician Ian Stewart (2007) explain how *symmetry* is an expression of the *simplicity* and *unity* of the universe which scientists find particularly beautiful. The title of Stewart's book sets his assertion about the beauty of symmetry center stage: *Why Beauty is Truth: A History of Symmetry*.

This is only a small sampling of the available data, but it follows the general trend of the comments found in the work of physicists. More direct quotes can be found in my previous work (2021; 2026). The quotations selected here are representative of the handful of qualities which constantly recur: *simplicity*, *harmony*, *order*, and *fittingness*. Even when those exact words are not used, they refer to the same kinds of qualities.

Either the physicists are imagining things, or they are talking about a real aspect of their work and of the world. Either beauty is real and has these qualities, or it is only in the minds of the physicists. What becomes necessary to examine here, then, is the philosophy of beauty. The physicists are not philosophers, and a fuller account of the nature of beauty must be found in the domain of philosophy.

3. The nature of beauty

The primary challenge that faces the aesthetics of science is the simple fact that scientists do not always agree on what they find beautiful or why they find it beautiful (cf. de Regt, 2002). As the passages cited above demonstrate, physicists use a variety of language, even if there are observable patterns. So, basing a philosophy of aesthetics on the statements of scientists may not be the best approach. An already established philosophy should be able to do justice to what physicists say. Kovach presents such a philosophy (1976). While Kovach does not discuss *scientific* aesthetics, his philosophy forms a foundation that can sustain what scientists have said about beauty in science.

Two key features of Kovach are his realist approach and his definition of beauty. Kovach argues that beauty is a feature of reality itself, and he defines beauty as “*order, that is, integral unity, or integral unity with or without proportional parts*” (Ibid., p. 215). As such, Kovach is an aesthetic realist according to current terminology (Bender, 2009, pp. 96-97), which differs from the terminology Kovach uses (1976, pp. 51, 156). According to both sets of word usage, Kovach is a realist since he argues that beauty is a real feature of reality, not simply that statements about beauty have truth value regardless of whether or not beauty is actually a part of things (Bender, 2009, pp. 96-97). According to current usage, an objectivist would hold that true statements can be made about beauty or that characteristics can be called beautiful even if beauty is not actually outside of the human person and in the exterior world and the objects being identified as beautiful (Ibid.).

Kovach, in his realist perspective, identifies beauty as order and integral unity (1976, p. 215). This definition is derived from a survey of philosophers of aesthetics who discuss the various reasons why people identify things as beautiful. He synthesizes those various characteristics into a succinct definition that does justice to the various reasons people find things as beautiful, just as I am trying here to synthesize the things physicists have identified as beautiful.

Another key aspect of Kovach's aesthetics is that there is a metaphysical basis for his definition. *Order* is not just another characteristic like the coordination of colors or balance of sensory input; *order* has to do with how something exists. In other words, it has to do with the being of the thing in question. Remove all order and unity from an

object, and it ceases to be a thing at all. The order determines the relation of the parts to the whole and the whole to the parts. Far from being something that results from a property or a collection of properties (supervenience), what is at issue here is the manner of existence of a thing according to the kind of thing that it is.

That fact that the nature of a thing is what determines *order* for it highlights the role of the intellect in this aesthetics. Beauty is not merely or even primarily known through the senses; the work of the intellect is necessary (Ibid., pp. 55-64). The importance of the role of the intellect is also attested to in neuroaesthetic research. Leder, Belke, Oeberst and Augustin, as a result of fMRI scans, have developed a 5-stage model of aesthetic appreciation when it comes to modern art that highlights the role that the intellect plays in recognizing, analyzing and identifying modern art (2004). Kovach operates generally within the framework of Thomas Aquinas who also identified the importance of the intellect in recognizing the natures of things and, therefore, their beauty as well (Summa Theologiae, I, q. 5, a. 4, ad 1). Things are beautiful insofar as they are intelligible, and things are intelligible insofar as they exist to the fullness of their nature. If, regarding order and unity, Roger Scruton asks “unity and order according to what” (2011, p. 162), the answer would be: according to the kind of thing that it is.

This role of the intellect in the recognition and experience of beauty is the reason I am calling this a *critical* realist perspective. Beauty is mediated to us through the intellect and the human ways of knowing, like science, and we recognize and analyze aesthetic delight by reflecting on such encounters. The union of a human’s experience and the real world is the cause of our appreciation of beauty. Thus the necessity that we have the right disposition, education, and attention to see beauty, otherwise we will not be receptive to the order and unity that is truly present in things.

Among the first of those who would deny aesthetic realism is Baruch de Spinoza who claims that the minds and tastes of men vary considerably, and people make judgements about beauty according to those various dispositions (1998, Appendix). What one person thinks is orderly another finds confused, and what one finds delightful, another finds odious, he argues (Ibid.). In other words, beauty is not an objective reality, but only an expression of what an individual finds pleasing and harmonious and there is no criterion of beauty outside of the individual observer. In making such an argument, Kovach would classify Spinoza as an aesthetic subjectivist (1976, p. 82). Spinoza, of course, is not the only aesthetic subjectivist (e.g. Stolnitz, 1960, p. 392), and in each case the primary argument for aesthetic subjectivism is the simple fact that people disagree about what is beautiful.

As the reader can observe, much of the discussion of the philosophy of aesthetics takes place within the context of art, but even when it comes to the beauty identified by

physicists, there is not complete agreement about which theories are beautiful and why (cf. de Regt, 2002); however, there does seem to be general agreement about some theories such as Maxwell's equations (Engler, 2002; Stewart, 2007, p. 180; Lederman and Hill, 2008, p. 68) and Einstein's theory of relativity (Schrödinger, 1996, p. 25; Engler, 2002; Stewart, 2007, pp. vii - viii). Chandrasekhar himself says that beauty is subject to the temperaments of the individuals (1987, p. 153), similar to Spinoza (1976, p. 82), and yet at the same time he approves of Heisenberg's definition of beauty as a harmonious order of parts (1987, p. 52; cf. Heisenberg, 1970).

Disagreement over what is beautiful need not disprove aesthetic realism, though, especially as it is defined and defended by Kovach who discusses 36 reasons why there might be disagreement among people when it comes to differences of opinion about what is beautiful (1976, pp. 101-136). As for a few examples, the disagreement is sometimes only apparent because the people are not operating from a common understanding of the term *beautiful*; some people may simply mean that they find something pleasing while others may have a more formal and objective definition in mind (Ibid., pp. 105-107). Another reason, he argues, why people may disagree is that one observer may be overfamiliar with a beautiful object and over time have been dulled to the beauty which strikes someone who experiences it for the first time or who sees it from a new perspective (Ibid., pp. 107-108). In some cases, it takes time and education to be able to see the beauty in something, as is definitely the case in physics; someone without significant training in physics simply will not be able to see the beauty in the theories, and that would lead to disagreements about what is beautiful (Ibid., p. 111). Two more examples: the conditions of a person's senses as well as a person's emotional or physical state may get in the way of someone's ability to perceive a particular beauty (Ibid., pp. 114-134). In summary, there are many reasons why people may disagree about *what* is beautiful.

However, when we look at *why* people say that something is beautiful, if they have the ability to articulate it, there is a striking pattern. Take the quotes from the physicists in section 2. The ideas of order, harmony, proportion, integrity, and unity. Essentially, when people find something beautiful, the *reasons* they find it beautiful are in alignment with one another; i.e., there is agreement about why the things that are beautiful are beautiful. Even when Spinoza argues for the subjectivity of beauty, he says that it is because people differ in what they find delightful and orderly (1998, Appendix). Even in his evaluation, it is implied that *order* is what people find beautiful. Kovach would argue that people disagree, then, because of their different capacities, whatever the reasons, for recognizing order and delighting in it.

Since the standard for beauty in the realist perspective has to do with *why* things are beautiful instead of agreement on *what* things are beautiful, disagreements over which

theories are beautiful or whether or not the beauty of physics lies in the equations, the theories, or some other aspect of science do not disprove the objective nature of beauty. To view it from the other side, consider cases where people praise the beauty of something *because* of its disorder, dissonance, and lack of unity. Even in cases where the disorderly and grotesque (e.g. Eco, 2007; Fine, 2023) are praised as beautiful, what is praised is not necessarily the disorder and grotesque in itself, but because those traits are somehow given meaning or are well-ordered to the work as a whole, the nature of art itself, the historical context of the art, the current trends in art, or the state of society and culture of its time. A painting that depicts something ugly is still a painting; if it lacked all order, it would not be a painting (or anything!) at all.

4. Beauty in physics

The same can be said for the universe itself. The discoveries of physics have revealed a real and fundamental order about the universe. Beauty has an objective reality, but it is known by humans through the methods and mathematical language of physics. It adds another layer of complexity which takes into account *how* humans know things and know beauty. The physics we have is the product of many methods, developments, and paradigm shifts over the years. Beauty is known through the union of the human mind with the aspects of the physical universe described by physics, a human endeavor shaped by centuries of human development and discovery. It is through these modes that we discover and come to appreciate order and integral unity in the quantifiable characteristics of the physical universe. Whatever is described as beautiful by physicists, whether they agree in particulars or not, can be accounted for by this critical realist perspective on beauty.

When physicists discuss the beauty of physics, it is always some sort of order that they praise. For the most part, their comments imply that physics in fact reveals something about the universe itself. Some physicists are explicit in claiming that the beauty science reveals is the beauty not just of equations or products of the human mind but the universe itself (Davies, 1992, p. 152; cf. Penrose, 1999, p. 430). This is best accounted for by a critical realist perspective on beauty. We are dealing here not even with particular characteristics or properties, but the nature of the being of the universe; the symmetries and intelligibility of the fundamental existence of the universe itself come to the surface through physics. Any other philosophy of aesthetics would undermine what physicists say; the goal of philosophy here is to explain what they say, not explain it away. Comments like those of Davies and Penrose require more than mere aesthetic objectivism in order to be true.

So, the definition of the beauty of physics I propose here, as I have elsewhere (D'Antuono, 2026) is this: *the order and unity of the physical universe as observed and understood by human minds*. This definition is based on a rigorous metaphysical and aesthetic philosophy, and it does justice to what the physicists have said about the beauty of physics.

There are some physicists who claim that their science does not necessarily give information about the universe itself; theory is only a way of organizing experimental results (e.g. Duhem, 1991, p. 54). It is beyond the scope of this paper to investigate the philosophy of physics as well, but it can be noted that the philosophy of science and the philosophy of aesthetics are necessarily intertwined when it comes to these things that physicists say. Duhem's perspective, however, does not undermine the realist *aesthetic* philosophy proposed here. The definition of the beauty of physics as the order and unity of the universe as understood by human minds explains the beauty argued for by both Penrose *and* Duhem.

This definition also does justice to the claim made by some physicists about the relationship between the beauty of a theory and its truth. A true theory is one that describes the intelligibility of the universe, and the universe's intelligibility is encountered as beauty *and* truth in the mind of the physicist. Sometimes, it takes time for physicists to appreciate the beauty of a theory, but this process is united with the times it takes to see the truth of a theory, as McAllister has outlined (1996, pp. 33, 65, 78). As the mind meets with oneness of reality as it truly is, the intellect recognizes and delights in its intelligibility.

In summary, the fact that people disagree about beauty does not disprove the realist theory of beauty, and that is part of what makes Kovach's definition of beauty useful in making sense of the beauty of physics where there is some disagreement. Also, his definition fits well with the aspects of theories identified as beautiful: order, harmony, simplicity, fittingness, etc. Over the years, as paradigms and tastes have shifted and as some theories have come to be appreciated over time, account can be taken by considering the *critical* aspect of critical realism which considers the way in which science is known through human modes of knowing, describing, and discovering.

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