Glücklicher Zufall

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In a famous remark from the *Critique of Practical Reason*, Kant mentions two things that fill the mind with “ever new and increasing awe and wonder”: “the starry heavens above me and the moral law within me” (5:161).[1] That remark is quoted toward the end of the fascinating history of wonder and curiosity which Raine, together with her coauthor Katharine Park, narrate in their 1998 book *Wonders and the Order of Nature*. Their point is to underscore a shift in the object of the emotion of wonder that came about with the Enlightenment. The proper object of wonder is no longer the anomalous, the surprising, the unexpected—the “wonder” of the *Wunderkammer*—but rather its opposite: the immutable regularity of the universal laws of nature, associated, for Kant, with the absolute authority of the moral law.

Is the experience of wonder, for Kant, definitively dissociated from that of surprise, of our response to the unexpected? I would like to complement Raine’s invocation of Kant by suggesting that Kant does allow for wonder as a reaction to the unexpected, although in a way compatible with the idea that it responds to the lawfulness of nature rather than to the apparently anomalous. The wonder I have in mind is described in the *Critique of Judgment*, where Kant has us reflect on the relation between nature’s empirical laws—the ones we discover through observation and experiment—and our own cognitive capacities. What turns out to be unexpected, in this reflection, is that nature’s empirical laws are such as to allow us to come to know them. There is nothing surprising about our capacity to know the a priori synthetic laws Kant identifies in the *Critique of Pure Reason*—for example, that substance is permanent or that every event has a cause—since these laws, like those of arithmetic and geometry, originate in our own cognitive faculties. But, Kant reminds us, these transcendental laws do not imply that “nature is a system comprehensible by the human cognitive capacity through empirical laws”: they leave open the possibility that the diversity of natural forms and corresponding empirical laws could be “infinitely great,” presenting us with “a crude chaotic aggregate without the slightest trace of a system” (20:209). That nature is, instead, comprehensible to us and indeed allows of being systematized by us in a thoroughgoing way, is entirely contingent—so much so that when we discover systematic unity among empirical laws of nature, it is like a “happy accident {glücklicher Zufall} favouring our intention” (5:184). The discovery that two or more apparently heterogeneous laws can be unified under a single principle yields “a very remarkable pleasure, often even a wonder {*Bewunderung*} which does not cease even when we are already sufficiently familiar with its object” (5:187). This is indeed close to the idea of wonder at the regularity of nature, but it includes an element of surprise. What we wonder at is not that nature is intrinsically regular but that it is regular *in a way that we can comprehend*—something that, given the independence of empirical nature from human cognitive faculties, we have no right to expect.

The wonder Kant describes here is linked with a different kind of wonder or admiration, that associated with pleasure in the beautiful. Like the first, it involves surprise. There are no rules for determining whether or not something is beautiful and thus no way that we could predict from the description of a beautiful object that we will find it beautiful (5:284–286). Like nature’s comprehensibility to us, the beauty of objects we encounter can be regarded as a gift, a way in which nature favors us (5:380). Kant holds that the capacity to experience beauty is a condition of knowledge, so the fact that we are able in principle to feel pleasure in the beautiful is no more contingent than our capacity in principle to bring objects under concepts and to organize those concepts under higher concepts. What *is* contingent is the fact that objects exist that awaken this capacity. We could perfectly well conceive of a world without a single beautiful object, just as we can conceive of a world in which our capacities to conceptualize and systematize nature are constantly frustrated.

Is Kant—the prototypical philosopher of the Enlightenment—willing to settle for this radical contingency at the heart of his philosophical system? On the one hand, he does, in typical Kantian fashion, discipline it by making it the object of an a priori principle: the

1 References to Kant cite volume and page number of Immanuel Kant, *Gesammelte Schriften*, 29 vols., vol. 1–22 ed. Preussische Akademie der Wissenschaften, vol. 23 ed. Deutsche Akademie der Wissenschaften zu Berlin, vol. 24–29 ed. Akademie der Wissenschaften zu Göttingen (Berlin: 1900–).

principle of nature's purposiveness for our cognitive faculties. We have to presuppose a mutual fit between nature and our cognitive faculties as a condition of being able to bring the natural world under empirical concepts, and so of cognizing it empirically. On the other hand, unlike the synthetic a priori principles of the *Critique of Pure Reason*, the principle of nature's purposiveness is not one which we know to obtain. We have to proceed in our cognitive activity on the assumption that nature is going to favor our attempts to understand it, but we have no objective reasons for taking this assumption to be true or even probable. The fact that we cannot seek empirical understanding of nature without assuming it to be empirically comprehensible by us does not take away from the contingency of that comprehensibility. This contingency might be seen as a source of extreme anxiety. What if nature's comprehensibility fails from one moment to the next, leaving us cognitively adrift in a sea of alien phenomena? But Kant emphasizes instead the positive aspect of the contingency, as a source of pleasurable wonder: both at nature's unexpectedly satisfying our desire to understand it and at the unanticipated beauty that we encounter both in the products of human art and in nature itself.

"But Most by Numbers Judge …"[1]

Catherine Goldstein

The epitome of mathematical surprise is perhaps John McKay's observation in 1978 that $196883 + 1 = 196884$. Note that $196735 + 1 = 196736$ would not have done the trick. To become a surprise, the six-digit number on the right-hand side of the equation had to be associated with a well-known complex function, that on the left-hand side with an important finite group. Groups are perhaps the simplest mathematical structures used to encapsulate symmetries, from those of geometrical figures to those of roots of equations to those of movements of particles in physics. The classification of finite groups occupied dozens of mathematicians and thousands of pages in the twentieth century and involved constructions that amazed even the specialists of the field; John Conway, for instance, significantly described one of them in these terms: "In 1964, Zvonimir Janko gave us the first of a list of surprises, by announcing the discovery of a new simple group of order 175560, which at that time seemed quite a large number."[2]

The "large number" 175560 here is the order, that is the number of elements, in the group; we knew of groups of any order (for instance, the group of symmetries of the vertices of a regular polygon with any number of sides), but this new group did not belong to any well-known families and was simple, that is, indecomposable into other smaller groups. Since 1964, a handful of other new simple groups have been brought to light and their classification completed. The largest one has $2^{46} \cdot 3^{20} \cdot 5^{9} \cdot 7^{6} \cdot 11^{2} \cdot 13^{3} \cdot 17 \cdot 19 \cdot 23 \cdot 29 \cdot 31 \cdot 41 \cdot 47 \cdot 59 \cdot 71$ elements (a 54-digit number) and is known by the nickname "The Monster." To help understand such large structures, mathematicians represented them in various ways: in particular The Monster can be represented as the set of symmetries of a 196883-dimensional space. And here is our 196883.

As for the 196884, it appears totally independently, as one of the first coefficients of the Fourier development of the so-called *j*-function, a function introduced by Felix Klein in the nineteenth century

1 Alexander Pope, *An Essay on Criticism* (London: 1711), 21.

2 John Conway, "Monsters and Moonshine," *Mathematical Intelligencer* 2 (1980): 165–171, on 165.