Regrounding the New Physics in a New Philosophy: An Overview[1]

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ABSTRACT

This article attempts to distil as simply and concisely as possible the author's previous work on the need to transform the philosophical foundation of modern physics (Rosen 1994, 2008, 2015, and others). Here we basically see that while subject-object interaction lies at the heart of quantum mechanics, the default setting that grounds mainstream physics has been the non-interactive philosophy of René Descartes. After indicating the obstacle this has created for further progress in physics, the author proposes that the problem can be addressed by shifting physics' philosophical underpinning from objectivism to phenomenology. Rosen shows that this can be accomplished by employing qualitative mathematics in a phenomenological way.

Having heard a lecture by his younger colleague Wolfgang Pauli, the renowned physicist Niels Bohr is said to have commented: "We are all agreed that your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct. My own feeling is that it is not crazy enough." Many contemporary physicists acknowledge that the phenomena of their field are so odd, the problems so befuddling to our current ways of thinking, that only a completely "crazy" theoretical approach to them has any possibility of success. But resolving the problems of modern physics may require something "crazier" still—not just an entirely new theory, but a whole new philosophical base, a new way of intuiting the world.

The general features of quantum mechanics are widely known. At the heart of the matter is Heisenberg's famous uncertainty principle. If you throw a ball into the air, in principle you are able to pinpoint both its position in space from moment to moment and the velocity with which it is traveling. But, in probing the subatomic world, the focus of physical reality softens and blurs and you are no longer able to be entirely certain about the locations and velocities of the tiny bits of matter found there. Why does reality lose its focus in the microworld? It is because, at this level of nature, the very act of observing a particle significantly affects the particle observed. So the fundamental uncertainty of quantum physics—an indeterminacy that no refinement of measuring instruments can eliminate—brings to light the intimate interaction of observer and observed, subject and object, mind and matter.

No doubt the radical interaction of subject and object in the microworld flies in the face of mainstream objectivist science, which has been deeply committed to keeping subject and object apart. Has this led physicists to call for a fundamental

[1] Portions of this article were adapted from an earlier paper (Rosen 2014).

change in science's posture? By and large it has not. Physics still operates on a set of unspoken assumptions, an underlying philosophical base that is incompatible with its own findings: at bottom it still adheres to the 350-year-old dualistic philosophy of René Descartes. Descartes drove a wedge between mind and matter that paved the way for science to ignore mind and put all its emphasis on being "objective." In a philosophical mood, contemporary physicists might acknowledge the reality of the mind and the importance of consciousness, but when hunkering down for serious work in the laboratory, they are dedicated to determining what is "out there," to laying out the "facts" of the material world.

Through much of the 20th century, physicists (using probability theory to approximate the behavior of subatomic particles) had been able to work around the conflict between their philosophical default setting and their actual findings. But, in the last quarter of that century the situation began to change. As physics probed more and more deeply into the microworld, exploring smaller and smaller scales of magnitude in search of a theory that would unify all the forces of nature, it came to a point where its methods for skirting the subjectivity at its core outlived their usefulness and progress ground to a halt. In 2006, physicist Lee Smolin noted accordingly that "for more than two centuries…our understanding of the laws of nature expanded rapidly…. [yet] today, despite our best efforts, what we know for certain about these laws is no more than what we knew back in the 1970s" (viii). Nothing basic has changed since Smolin wrote those words. Why have meaningful advances in theoretical physics been thwarted over the last 40 years? I suggest it is because physics can no longer effectively deny the profound relationship between subject and object, psyche and matter—a relationship requiring a whole new philosophical base. What I am proposing is that physics can address its fundamental problem by shifting from a philosophical foundation that is at odds with its own basic phenomena to one that is consonant with them, namely, *phenomenological* philosophy.

Phenomenology comes out of a tradition in European thought that dates back to the nineteenth century. In my own work, I have emphasized the contributions of philosophers Martin Heidegger and Maurice Merleau-Ponty, especially the latter. Merleau-Ponty (1962, 1968) writes about the embodied flowing together of subject and object, which takes place when our perceptions of the world aren't ruled by the dualistic objectifications of classical thinking that drive subject and object apart. He writes about the need to *accept* chaos and paradox (rather than running away from them as conventional physics often tries to do), and about space and time as concretely grounded, lived dimensions (what he calls the *lifeworld*; 1964, xvi), not the divisive abstractions of space and time found in mainstream physics. All this offers a new beginning for a science that badly needs one, a starting point more in keeping with the phenomena of science themselves. In this newly grounded physics, psyche or embodied subjectivity would be included both in theory and in practice. Such a phenomenological physics would not just deal with physical processes occurring in the objective world "out there" but would be thoroughly *psycho*physical. That is the focus of my 2008 book, *The Self-Evolving Cosmos: A Phenomenological Approach to Nature's Unity-in-Diversity*.

In *Cosmos*, I build a bridge between modern physics and phenomenological philosophy. Physics is traditionally a "hard" science, one demanding strict objectivity and quantitative precision. Phenomenology, for its part, generally has been "softly" philosophical: largely intuitive and sometimes vaguely allusive. In my book, I attempt to bridge the gap between "hard" and "soft" by introducing certain enigmatic figures from qualitative mathematics.

Since the early 1970s, I have been working with some odd geometric structures that seem to flout Descartes's neat divisions. The simplest of these is the Moebius strip. You can best appreciate the properties of the Moebius by comparing it with its more conventional counterpart, a cylindrical ring (fig. 1).

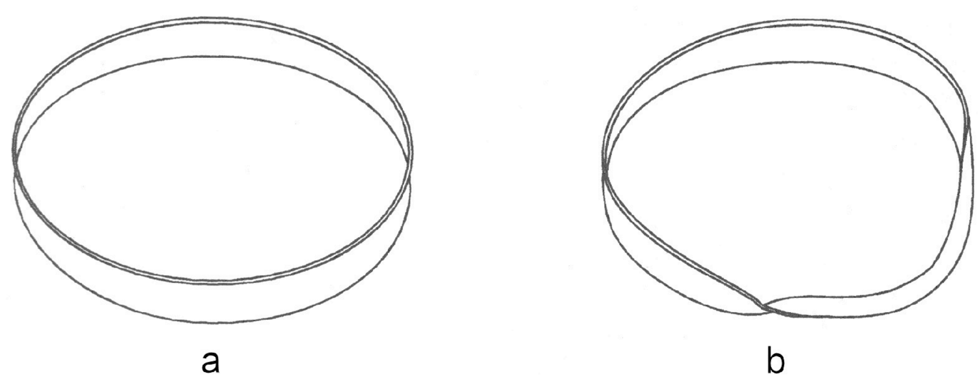

Figure 1. Cylindrical ring (a) and Moebius strip (b)

If you take a strip of paper and join the ends, you form a simple cylindrical ring (fig. 1a). But suppose, before taping the ends together, you give one end a half-twist through an angle of 180°. You have then produced a Moebius ring (fig. 1b).

The Moebius strip possesses three surprising properties. First of all, it is *one-sided*. In the less surprising cylindrical case, if you start out on a particular side of the ring, you can keep going around it without ever coming into contact with the other side. This shows that the cylinder does have two distinct sides, as you would expect. But it is different with the Moebius. Even though, at any local cross-section of the strip, you can put your thumb on one side and your forefinger on the other, when the full length of the strip is taken into account, opposing sides dissolve into each other; they twist together to form a paradoxical unity. It is easy to confirm this. Starting on one side of the Moebius, you can draw a continuous line along the whole length of the strip. What you find when you return to where you began is that you have covered *both* sides of the strip—something that does not happen on the ordinary cylinder.

The second notable property of the Moebius is the effect it has on left-right orientation:

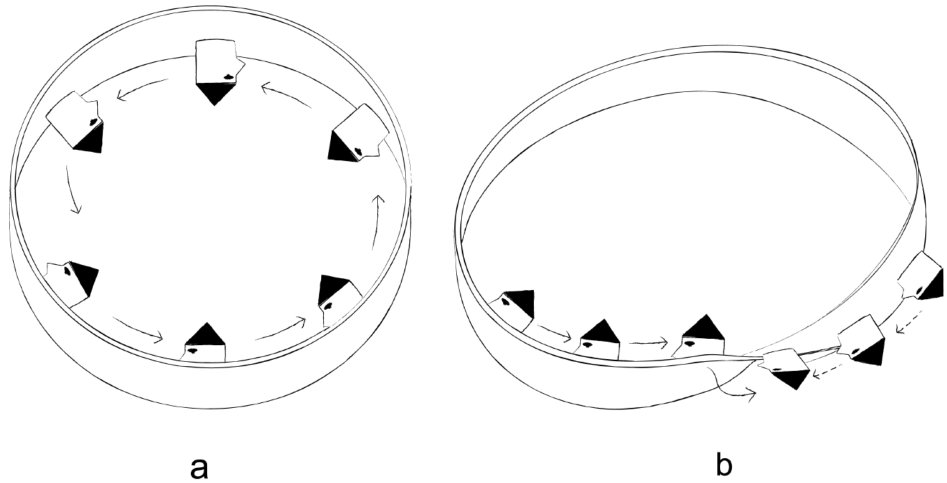

Figure 2. Revolution of asymmetric figure on cylindrical ring (a) and Moebius strip (b)

In figure 2a, a left-facing profile is rotating around the cylindrical ring. In the course of its movement, it turns upside down but never stops facing left (by tilting your head to adopt the profile's perspective as it is inverted, you can see how it continues to face left). Figure 2b tells another story. Moving through the twist in the Moebius, the left-facing profile is turned around to become a right-facing profile. (Reversal of orientation is crucial to the action of subatomic particles, as noted below.)

There is one more relevant property of the Moebius. In twisting from one side of the strip to another, you twist into an *added dimension*. Let me demonstrate this by drawing another contrast with the cylindrical ring.

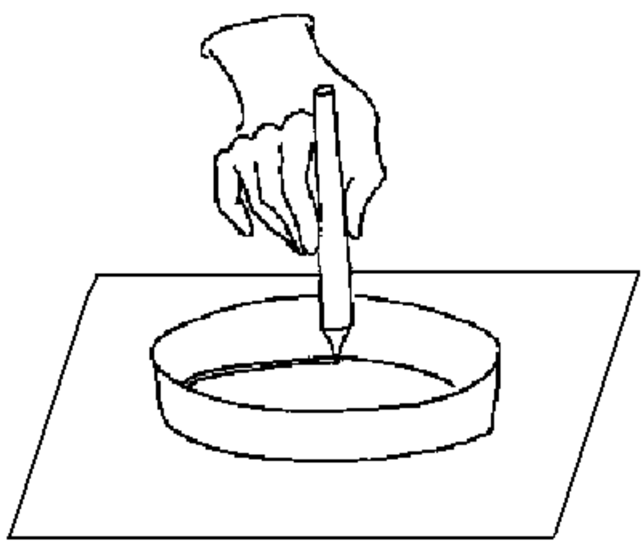

Figure 3. Tracing a path on a two-dimensional surface via the cylindrical ring

In figure 3, an orbit is traced on a two-dimensional surface by penciling around the bottom edge of the cylindrical ring. Proceeding in this way, you can make a complete record of rotation around the ring without ever leaving the plane. The same cannot be done with the Moebius. Placing the Moebius strip on a flat sheet of paper, you can indeed begin penciling around the Moebius' bottom edge at the place where it meets the surface, but you will quickly lose contact with that surface, since traveling along an edge of the Moebius means being lifted out of the two-dimensional plane into the third dimension.

To sum up: the Moebius structure is one-sided; it changes orientation, turning left into right and right into left; and it engages an extra dimension.

Now, the Moebius strip has a higher-dimensional counterpart that will help us make the connection with modern physics. If you were to take two Moebius strips and glue them together along their edges, what you would produce is a structure called a *Klein bottle* (named after Felix Klein, the nineteenth century German mathematician who first worked with it).

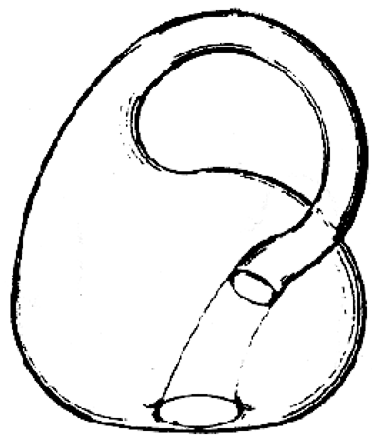

Figure 4. The Klein bottle (from Gardner 1979, 151)

The Klein bottle (fig. 4) is a paradoxical container that curves back into itself, penetrates itself in such a way that its inside and outside flow together as a single side. Like the Moebius strip, the Klein bottle is a one-sided structure; it embodies a union of opposing sides. Also like the Moebius, the Klein bottle transforms spatial orientation: moving along its surface, left becomes right and right becomes left. Finally, a higher dimension must be involved in forming the Klein bottle—not the third dimension as in the Moebius case, but a *fourth* dimension.

Why a fourth dimension? It is because, according to mathematicians, you can't really make a proper model of the Klein bottle with just three dimensions. The bottle does penetrate itself and, in three dimensions, you have to break it open to allow that to happen. This makes it less than perfect from a mathematical point of view. But mathematicians tell us that, if we had a *fourth* dimension at our disposal, using the extra space, the extra degree of freedom (dimensions can be associated with degrees of freedom), we could then complete the formation of the Klein bottle *without* tearing a hole in it (just as we were able to complete the construction of a Moebius strip in *three*-dimensional space without cutting a hole in it). Of course, this fourth dimension is quite mysterious. Unlike the dimensions of width, height, and depth, we have no access to it; it is invisible to us.

I have shown in my earlier writing (Rosen 1997, 2004, 2006) that the unseen fourth dimension in which the paradoxical Klein bottle expresses itself is not just an extension of the objective, physical dimensions that are familiar to us—the classical spaces in which subject and object, observer and observed, are kept separate from each other. Instead of just being a physical dimension, the Kleinian fourth dimension is *psycho*physical—a phenomenological dimension in which psyche and matter are thoroughly woven together. So, from a four-dimensional perspective, the Klein bottle does not merely unite the inside and outside of an object appearing out in space before a detached observer; rather, it unites the observer and observed, the subject and object themselves. That is why the Klein bottle has been so helpful to me in my effort to model some of the paradoxes of modern physics, the most important of which is the interpenetration of subject and object noted above. The bottom line is this: If the microphysical world involves an intimate fusing of observer and observed, then the geometry of that world can be seen as following the phenomenological design of the Klein bottle.

Let me take this a little further. In *The Self-Evolving Cosmos*, I demonstrated that what lies at the heart of quantum mechanics and is closely involved with its uncertainty relation is a dynamically spinning counterpart of the Klein bottle. While its presence at the core of microphysics is implied, the appearance of the Klein bottle is well disguised in conventional accounts. There does seem to be little doubt among physicists that a curious kind of submicroscopic spinning plays a central role in quantum mechanics. In attempting to describe this micro-action, certain exotic numbers had to be used. I am going to link one of these numbers to the Klein bottle. But before getting into that, I would like to provide some background on the relevance of numbers to the general problem at hand.

Psychologist C. G. Jung wrote to physicist Wolfgang Pauli about the unique importance of numbers when it comes to unifying psychology and physics. Numbers "*are as much inside as outside*" (Jung quoted in Meier 2001, 127). By this Jung meant that numbers mysteriously correspond to both the inner world of the mind and the outer world of measured objects and events. Jung believed then, that "the sought after borderland between physics and psychology lies in the secret of the number" (Jung quoted in Meier 2001, 127). "The mysterious nature of numbers," Jung said, "is the most obvious thing for forming a foundation for both physics and psychology" (Jung quoted in Meier 2001, 128).

Now, the behavior of bodies moving through space can be described by using numbers. You can write a mathematical description of an object moving in a straight line, for example, and another description giving a precise account of something moving in a circle. But in the *microscopic* world, things don't behave the way we're used to, as I have already noted. Take a phenomenon like spin. When I set an ordinary top in motion by giving it a twist, it spins in a smoothly continuous way that can be described mathematically (even though the top may start wobbling after awhile). But the spinning of subatomic particles is much stranger than that. Here you have discontinuity, with particles taking quantum leaps from one state to another without seeming to pass through the space in between. We cannot use an ordinary mathematical description for this, one based on smooth continuity. To describe microphysical spin, physicists have indeed had to resort to some strange kinds of numbers, numbers that depart from our common sense view of the way numbers should behave. A basic example of this is the "imaginary" number *i*, a number that, when multiplied by itself, surprisingly gives you a negative value (when you multiply any normal number by itself—2 x 2, 4 x 4, -5 x -5, etc.—the value that results is always positive). Without attempting to explain imaginary numbers in technical detail, let's just say that the imaginary number *i* takes us into a new dimension that allows physics to deal with what ordinary numbers cannot handle: the strangely discontinuous spinning of sub-atomic particles.

But where does the Klein bottle enter the picture? After the imaginary number *i* was used to describe microscopic spin, mathematician Charles Musès (1976, 1977) showed that, to properly describe the spinning of a subatomic particle, you actually have to go beyond *i* and employ a higher-dimensional version of it that he called *epsilon* ($\varepsilon^2 = +1$, but $\varepsilon \neq \pm 1$). To clarify the meaning of this "hypernumber," Musès (1977, 77) translated its action in geometric terms: epsilon represents a spinning into a fourth dimension and back into the third in which left is transformed into right and right into left. Does that sound familiar? In *The Self-Evolving Cosmos*, I related the spinning of epsilon to the Klein bottle—which, in turning itself inside-out, does change right into left and vice versa, and requires a fourth dimension to do so. To repeat what I said above: the necessary "fourth" dimension is not just an objective physical dimension but a dimension joining psyche and matter in an intimate way.

In this brief overview, I have tried to show the need for modern physics to be replanted in more fertile philosophical soil. With the Klein bottle, we see the pivotal role played by qualitative mathematics in this endeavor. The oddly configured geometric structure—interpreted phenomenologically as involving a psychophysical dimension, not a merely physical one—serves as a bridge between a philosophy that by itself is too "soft" and a physics that is too "hard."

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