BRIDGING THE "TWO CULTURES": MERLEAU-PONTY AND THE CRISIS IN MODERN PHYSICS

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ABSTRACT: This paper brings to light the significance of Merleau-Ponty's thinking for contemporary physics. The point of departure is his 1956–57 Collège de France lectures on Nature, coupled with his reflections on the crisis in modern physics appearing in *The Visible and the Invisible*. Developments in theoretical physics after his death are then explored and a deepening of the crisis is disclosed. The upshot is that physics' intractable problems of uncertainty and subject-object interaction can only be addressed by shifting its philosophical base from objectivism to phenomenology, as Merleau-Ponty suggested. Merleau-Ponty's allusion to "topological space" in *The Visible and the Invisible* provides a clue for bridging the gap between "hard science" and "soft philosophy." This lead is pursued in the present paper by employing the paradoxical topology of the Klein bottle. The hope is that, by "softening" physics and "hardening" phenomenology, the "two cultures" (cf. C. P. Snow) can be wed and a new kind of science be born.

KEYWORDS: Merleau-Ponty; topology; quantum mechanics

Although Merleau-Ponty did not write extensively about the discipline of physics over the course of his career, he made it clear that the subject held much significance for him. "Why not admit," he said to Bergson in a mild rebuke of Bergson's occasionally anti-scientific stance, "that physics, as objective as it is, can be highly meaningful for philosophy?" (1956–60/2003, 110). Merleau-Ponty was also convinced of the converse: that physics can benefit from philosophy, and in particular, from the phenomenological approach. This is because contemporary physics, in unquestioningly adhering to the classical ontology, is hard put to deal with the nonlinearities and paradoxes of the phenomena it encounters. In Merleau-Ponty's words, "The physicist frames with an objectivist ontology a physics that is no longer objectivist" (1968, 25). Merleau-Ponty well understood how the phenomena of modern physics uniquely defy the dualisms, objectifications, and idealizations of Cartesian thought, and how this necessitates a reorientation of physics' philosophical foundations. He knew, for example, that, to deal meaningfully with the microphysical inseparability of observer and observed, the observer or subject must be recognized as being *situated* in the world, not seen as a *deus ex machina* that flies above it. But Merleau-Ponty never crystallized in detail his vision of a phenomenological physics. A gap was thus left between the "soft" intimations of phenomenology and the "hard" facts of physics. Might it be possible to "soften" physics and "harden" phenomenology in a manner that would bridge the gap between these seemingly irreconcilable endeavors, these "two cultures"? The present paper is devoted to exploring such a possibility.

To my knowledge, Merleau-Ponty's most explicit treatment of modern physics appears in *La Nature* (1956–60/2003), the course notes from his Collège de France lectures on the concept of Nature. The material in question is found in Part 2 of the First Course (1956–57), titled "Modern Science and Nature."[1] After introducing the subject by bringing out the contribution modern science can make to the ontological clarification of nature, Merleau-Ponty proceeds to focus on quantum mechanics. Using Laplacean ontology as his foil, he summarizes interpretively such quantum mechanical themes as complementarity, nonclassical logic, and the inherently probabilistic nature of microphysics. Then he broadens his scope to explore the philosophical significance of quantum mechanics. In raising the question of what would constitute a philosophy adequate to the phenomena of the microworld, Merleau-Ponty rejects both nominalism and idealism. "If a philosophy can correspond to quantum mechanics, it will be both a more realistic philosophy, of which the truth will not be defined in transcendental terms, and more subjectivist. The situated and incarnated aspect of the physicist must succeed the universal 'I think' of transcendental philosophy" (97).

The incarnated subject is of course a *perceiving* subject. "The problem posed by physics," notes Merleau-Ponty, "approaches the problem posed by perception" (97). The upshot is that physics and philosophy alike must learn to start their work not from the lofty abstractions of Cartesianism, but from the lived experiences of subjects who share a common world. Perception has primacy in such a lifeworld. But isn't ordinary perception repelled by the ambiguities of modern physics? Merleau-Ponty notes that despite this widespread belief, in actuality ordinary perception is itself filled with quantum-like ambiguities—provided that it is not idealized in the Cartesian way (99). Though the conventional idea of "common sense" may eschew such apparent anomalies, to the *common sense* or shared sensibility of the intersubjective world, they

[1] A word of caution: In the translator's introduction to this work, Robert Vallier acknowledges that the text does not derive from the pen of Merleau-Ponty himself but from his spoken lectures, which were distilled by a diligent student in the form of typewritten notes. Nevertheless, the editors obviously found this material credible enough and valuable enough to publish it.

are neither unfamiliar, nor are they denied. Merleau-Ponty concludes that "physics destroys certain prejudices of philosophical and non-philosophical thought….The internal critique of physics leads us to become aware of the perceived world" (100).

In subsequent lectures of the First Course, Merleau-Ponty takes up the questions of space and time, and Whitehead's approach to these issues. For present purposes, I will limit myself to considering only the portion of this material with the greatest relevance for physics. Here Merleau-Ponty turns to the theory of relativity and Einstein's notion of the relativity of simultaneity. He agrees with Einstein that there is no absolute simultaneity in the classical sense of all events being timed by a single clock ticking objectively across the universe. But Merleau-Ponty takes exception to the Einsteinian implication that each local observer possesses his or her own unique time concretely disjoined from all others, coordinated with them only through the mathematical abstractions of the space-time continuum. Merleau-Ponty says:

> My duration is not a purely interior one. Certainly universal time is not the same as mine (there is not objective simultaneity), but it cannot be absolutely other, either. Something responds to my duration….The proper given of philosophy is not interior time, but the time in which we are placed, in which we live, not the signification time and space of science, but actual time and space….The Absolute [time and space] that the philosopher returns to is that of the incarnated and situated subject…. If the physicist [hopes] to retrieve a world behind equations, it is because there is a participation in this intersubjectivity. This philosophical simultaneity emerges from our belonging to the world as the world from which we arise. (111–12)

La Nature is not the only forum in which Merleau-Ponty reflects on contemporary physics. In a later discussion appearing in *The Visible and the Invisible*, he says that, while the phenomena of modern physics cry out for a new, nonclassical, non-objectifying ontology, they are "retranslated [by physicists] into the language of the traditional ontology" (1968, 16). Merleau-Ponty devotes much attention here to questioning the objectifying tendencies in both modern physics and psychology, tendencies that presuppose the subject-object split:

> The cleavage between the 'subjective' and the 'objective' according to which physics defines its domain…and correlatively psychology also establishes its domain, does not prevent [the subjective and objective] from being conceived according to the same fundamental structure; on the contrary it requires that: they are finally two orders of objects, to be known in their intrinsic properties by a pure thought which determines what they are in themselves. But…a moment comes when the very development of knowledge calls into question the absolute spectator always presupposed. (1968, 19–20)

Over half a century has passed since Merleau-Ponty's death and—because physics has still not responded effectively to the critique of the "absolute spectator" implicit in its own phenomena, its crisis has continued. In fact, it has gotten worse. This is brought out by the physicist Lee Smolin in his controversial book, *The Trouble With Physics* (2006). In my own work (Rosen 2004, 2008a, 2008b), I have attempted to get to the nub of the predicament.

According to modern physics, nature is governed by four fundamental forces: electromagnetism, gravitation, and the strong and weak nuclear forces. These forces appear to operate in very different ways and theorists have long been concerned with the question of how they could be described in a unified manner. The unification project is wedded to cosmogony. We are told that, even though the forces of nature assume distinct forms in the present-day universe, around the time of the big bang they constituted a single, amalgamated force. Then, as the universe cooled and expanded, this primordial symmetry was spontaneously broken and the forces took on their present appearance of being irreconcilably different. The aim of theoretical physics is to recover the original symmetry through mathematical analysis. And the underlying problem is that the early universe existing before expansion and cooling was a microphysically compressed, hyper-energetic, roiling chaos that flies in the face of Cartesian order. With each mathematical step backward toward the big bang taken in the name of unification, the chaos that must be accommodated increases and the analysis becomes more strained. The physicists Steven Weinberg and Abdus Salam did appear to successfully unify the electromagnetic and weak nuclear forces in 1968. Electroweak unification was cast within the framework of quantum mechanics, where the uncertainty associated with microworld turbulence was well managed by the probabilistic equations. In attempting to accomplish a unification that included the strong nuclear force, physicists of the 1970s faced higher energies and greater levels of uncertainty. Nevertheless, the so-called grand unification of the three quantum mechanical forces could still be considered at least a partial success, enough so that attention could be turned to the ultimate goal of incorporating the gravitational force. And that is where progress ground to a halt. The equations that would unify all four forces of nature were now completely unable to contain the even more wildly fluctuating energies, as manifested by infinite probability values that turned up to render those equations useless. Consequently, there has not been much meaningful movement toward an effective theory of quantum gravity over the past 35 years. Musing ironically over this, Smolin (2006) observes 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).

What "best efforts" is Smolin referring to? Since the 1970s, the quest for a mathematical unification of nature has largely been dominated by an approach known as *string theory*. Quantum mechanical uncertainty is correlated with scale of magnitude: the smaller the scale, the greater the uncertainty. There is actually a specific threshold called the Planck length (10^{-35} meter) below which the chaos becomes totally unmanageable. What string theory does is avoid probing below this scale simply by assuming that the smallest constituents of nature are not indefinitely miniscule point-particles as previous theory had assumed, but string-like vibrating elements of finite extension conveniently scaled at the Planck length. It is because this stratagem has successfully managed to eliminate infinite terms from quantum gravitational equations that it has become the preferred approach. But the price paid for this positivistic ploy is now being acknowledged more openly (Smolin 2006, Woit 2006). In my own exploration of the matter (Rosen 2004, 2008a, 2008b), I have identified several problems with string theory.

First, while it is true that string theory serves the classical ontology by sidestepping sub-Planckian ambiguity, an *epistemic* ambiguity takes its place. String theory's general equations may be free of unmanageable infinities, but theorists must be able to solve these highly abstract equations in a manner that produces a specific description of the world as we know it. As things now stand, the equations yield a vast array of possible solutions with no guiding principle by means of which the field can be narrowed in unique correspondence with known physical reality. A second limitation of the theory is the evident impossibility of objectively testing it in a direct fashion since, according to physicist Brian Greene, the test would have to be conducted on a scale "some hundred million billion times smaller than anything we can directly probe experimentally [!]" (1999, 212). Finally, the theory seems to contradict itself in its assumption of fundamental particles with finite extension. "Strings are truly fundamental" says Greene, "they are 'atoms,' uncuttable constituents" of nature. So, "even though strings have spatial extent, the question of their composition is without any content" (141). But isn't this a contradiction? For—at least according to the classical concept of the continuum not explicitly challenged by string theory, to be spatially extended is to be *cuttable*, in fact, infinitely divisible. How then could a string be a fundamental particle, an atomic or indivisible ingredient of nature, when it is spatially extended? In sum, string theory is ambiguous, objectively untestable, and it contradicts itself when seen in classical terms. At bottom the message seems to be that—in seeking a "theory of everything" that would unify all of nature within the classical ontology—physics has reached the point where it is unable to deny the *repudiation* of classical ontology. I noted earlier Merleau-Ponty's observation in the 1950s that the "physicist frames with an objectivist ontology a physics that is no longer objectivist" (1968, 25). What we are witnessing since the confrontation with quantum gravity began in the 1970s is the physicist's utter inability to effectively employ objectivist ontology. Now s/he has no choice but to find a nonobjectivist approach capable of doing justice to the phenomena—to the inherently ambiguous *things themselves*.

The general effect of classical ontology on perception has indeed been profound, and it is no less evident among physicists. Little wonder then that the "sub-Planckian chaos" should look so alien to a Cartesian physics still attempting to idealize the world from afar. Of course the "chaos" might appear quite different to a physicist who is *situated* in that world. As Merleau-Ponty knew, the phenomena of modern physics do evidence such intensive participation in nature. This is specifically seen in the quantum mechanical uncertainty relation. The uncertainty that arises in measuring the positions and velocities of particles reflects the fact that, in the quantum world, the very act of observing significantly influences the states of the beings that are observed. And the closer we draw to the Planck length, the greater is this interaction between observer and observed. It is as if the quantum phenomena themselves were extending an invitation to the physicist to abandon his or her position of aloof "objectivity" and enter into the natural order of things. Though ignoring this invitation has not been a viable option for physics since the 1970s, ignored it has been, and the consequence has been stagnation.

Given the longstanding, deeply engrained habits of thought that have come to govern "common sense," it is not surprising that physics has thus far been unable to reground itself in a nonobjectivist ontology such as that offered by Merleau-Ponty and other phenomenological philosophers. But, granting the understandable intransigence of this "hard science," perhaps the problem also lies in the "softness" of phenomenology, the non-specificity of its concepts and structures. Two years before his death, Merleau-Ponty himself provided a clue for how the gap between "soft" and "hard" could be bridged:

> Take topological space as a model of being. The Euclidean space is the model for [idealized] perspectival being [and is consistent]...with the classical ontology....The topological space, on the contrary, [is] a milieu in which are circumscribed relations of proximity, of envelopment, etc. [and] is the image of a being that...is at the same time older than everything and 'of the first day' (Hegel)....[Topological space] is encountered not only at the level of the physical world, but again it is constitutive of life, and finally it founds the *wild* principle of

> Logos — — It is this wild or brute being that intervenes at all levels to overcome the problems of the classical ontology. (1968, 210–11)

Of course, *conventional* topology is just as much part of the objectivist enterprise as conventional physics. Here topology is defined abstractly as the branch of mathematics that concerns itself with the properties of geometric figures that stay the same when the figures are stretched or deformed. Merleau-Ponty was clearly not thinking of topology in these terms. For a better understanding of his thinking, it may help to consider the etymology of the word. Topology is the study of *topos*, "place." The concrete character of this term is evidenced by its relation to words like "posture": the root meaning of "posture" is "to place." Philosopher of science John Schumacher thus defines "posture" as "the way a thing makes a place in the world" (1989, 17–18)—i.e., the way it situates itself (the original name for topology was "analysis situs"). Accordingly, the philosopher Maxine Sheets-Johnstone is able to demonstrate that, whereas Euclidean geometry, for example, involves practices that are largely disembodied, "topology...is rooted in the body" (1990, 42). Then could topology not be useful in an ontological regrounding of physics that requires it to descend from its Cartesian heights and reenter the natural world in an embodied way? One curious topological structure proves especially promising in mediating between theoretical physics and phenomenological intuition: the *Klein bottle.*

An ordinary bottle conforms to conventional intuition regarding inside and outside. It is a container whose interior region is clearly set off from what lies outside of it. If we fill such a bottle with liquid, for instance, and seal its cap, the fluid will remain enclosed—unless the surface is broken, in which case it will pour out. Although conventional containers are thus either open or closed, let us try to imagine a vessel that is *both.* I am not merely referring to a container that is *partially* closed (such as a bottle without its cap), but to a vessel that is completely closed and completely open *at the same time.* The liquid contents of such a strange vessel would be well sealed within it, and yet, paradoxically, they would freely spill out! The Klein bottle (Fig. 1) is a container of this sort. Its paradoxical structure flagrantly defies the classical intuition of containment that compels us to think in either/or terms (closed or open, inside or outside, etc.).[2]

[2] Elsewhere I have shown how the standard analysis of the Klein bottle questionably sidesteps the challenge to classical thought, and how conventional mathematics itself must be challenged to bring to light the Klein bottle's full implications for phenomenological philosophy (Rosen 2004, 2006) and theoretical physics (Rosen 2004, 2008a, 2008b). Since I cannot go into these matters here, I will take the liberty of employing the Klein bottle in a nonstandard, nonobjectivist manner without attempting to justify this approach.

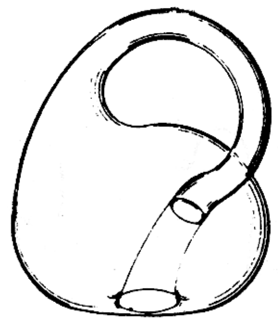

Figure 1. The Klein bottle

The topological property of the Klein bottle that is responsible for its peculiar nature is its *one-sidedness*. More commonplace topological figures such as the sphere and the doughnut-shaped torus are two-sided; their opposing sides can be identified in a straightforward, unambiguous fashion. Therefore, they meet the classical expectation of being closed structures, structures whose interior regions *remain* interior. In the contrasting case of the Klein bottle, inside and outside are freely reversible. Let me try to shed more light on just what this means.

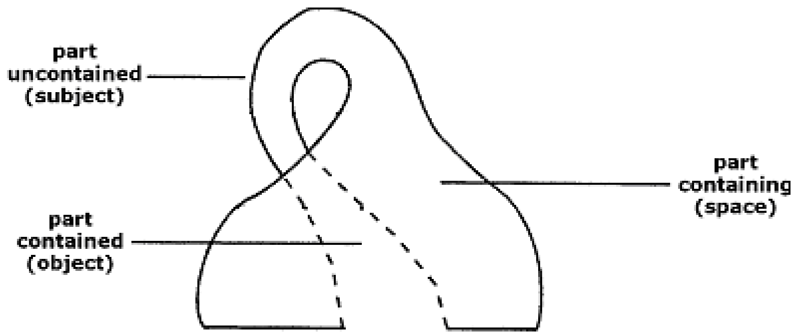

Figure 2. Parts of the Klein bottle (after Ryan 1993, 98)

Figure 2 is my adaptation of communication theorist Paul Ryan's (1993, 98) linear schemata for the Klein bottle. According to Ryan, the three basic features of the Klein bottle are "part contained," "part uncontained," and "part containing." Here we see how the part contained opens out (at the bottom of the figure) to form the perimeter of the container, and how this, in turn, passes over into the uncontained aspect (in the upper portion of Fig. 2). The three parts of this structure thus flow into one another in a continuous, self-containing movement that flies in the face of the classical trichotomy of contained, containing, and uncontained—symbolically, of object (that which is contained), space (the container), and subject (uncontained or transcendent consciousness). So Figure 2—in schematically depicting the process by which an object, in the act of containing itself, is fluidly transformed into subject—can be said to constitute a simple blueprint for phenomenological interrelatedness. What we have here is a graphic indication of how the mutually exclusive categories of classical thought are surpassed by a threefold relation of mutual inclusion.

One is reminded of the *depth dimension* described by Merleau-Ponty in "Eye and Mind" (1964). Using the painting of Cézanne as his primary example of depth, Merleau-Ponty intimates a visual space that is not abstracted from its content but constitutes an unbroken flow from container to content. In Cézannian space, "we must seek space and its content *as* together" (180). Moreover, the depth dimension engages embodied subjectivity: it "goes toward things from, as starting point, this body to which I myself am fastened" (173). Therefore, in realizing depth, we surpass the concept of space as but an inert container and come to understand it as an aspect of an indivisible cycle of action in which the "contained" and "uncontained"—object and subject—are integrally incorporated.

What the Klein bottle does for its part is help sharpen the intuition of depth by lending topological detail and precision to it. Had I the space, I would develop this more fully (see Rosen 2004, 2006, 2008a, 2008b). For now, let me just suggest that this "firming up" of phenomenological insight into the nature of dimensional structure brings phenomenology a step closer to being able to serve effectively in a regrounding of modern physics. However, to close the gap between the "hard" and the "soft," "hardening" phenomenological intuition is not enough. Physics must be "softened." Functioning as intermediary, the Klein bottle can facilitate this as well. Again I will limit myself to a summary account.

The core feature of quantum mechanics is a subatomic process known as the *quantum of action*. This term refers to an oddly nonlinear quantized spinning that occurs at the Planck length and is associated with the emission of radiant energy. Said spin is the source of the microphysical uncertainty (Hestenes 1983, 73), and its mathematical expression as Planck's constant is found everywhere in the equations of quantum mechanics, since the constant is necessary for managing the uncertainty. In two earlier works, I was able to demonstrate that the quantum of action is embodied by the Klein bottle, and that, in fact, the connection is already implicit in the standard formulation of subatomic spin, though the relationship is well disguised (Rosen 2008a, 2008b).

The link with the Klein bottle is traced back through the work of Wolfgang Pauli. When Pauli sought to model quantum mechanical spin, he employed the mathematics of complex numbers (involving the imaginary *i*), and, in particular, the "hypernumbers" previously developed by William Clifford. The mathematician Charles Musès (1977) related microphysical spin to a particular hypernumber he called "epsilon"[3], and I, for my part, have shown that the topo-phenomenological counterpart of epsilon is the Klein bottle.

But mainstream theoretical physics does not recognize the "soft" Kleinian core of subatomic spin. Instead, physics stays "hard," maintains its objectivity, by treating the quantum of action like a "black box." We need not be concerned about the chaos the box contains—the uncertainty, the subject-object interpenetration, the "wild being" (Merleau-Ponty 1968, 211)—as long as it *can* be contained. This is done by incorporating the underlying Kleinian spin into the theory as a constant value in accounts that maintain in probabilistic approximation the old aims of objectifying and controlling nature. In this way, the intrinsic dynamism of the world is cordoned off, functioning as an isolated negativity within an otherwise purely "positive" treatment of nature.

I noted earlier, however, that when it comes to the problem of unifying all four forces of nature through a theory of quantum gravity, physics does face the prospect of probing inside the Planck-scaled "box," and thus encountering the sub-Planckian pandemonium so dreaded by objectivist ontology. A *Pandora's* box would therefore be opened or—switching metaphors, the genie would be let out of the bottle.

What I am proposing is that the crisis can effectively be addressed by recognizing the "bottle" to be *Kleinian*. Though physics can no longer "stay hard," maintain its objectivist stance when confronted with quantum gravity (as the limitations of string theory attest), neither need it simply dissolve in chaos if it has the wherewithal to shift its philosophical ground to phenomenology. Understanding the sub-Planckian world as Kleinian rather than purely chaotic facilitates such a shift, thereby bringing about a fruitful "softening" of physics. By concretizing phenomenological relatedness through topological imagination and applying it to microphysics, uncertainty and subject-object interaction can come to be fully and constructively accepted. In fact, this approach can advance the work of quantum gravity in specific ways. In particular, I have shown that the Klein bottle generalizes to a family of four topological structures aligned with the four forces of nature (see Rosen 2008a, 2008b).

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[3] Epsilon is defined as $\varepsilon^2 = +1$, but $\varepsilon \neq \pm 1$.

Summing up, this paper has sought to carry forward Merleau-Ponty's insights into the crisis in modern physics. Following Merleau-Ponty, I have suggested that physics can address the dilemma it faces only by shifting its philosophical base from objectivism to phenomenology. To bridge the gap between "hard science" and "soft philosophy," I have taken Merleau-Ponty's cue about the promise of topology and expanded on it via the Klein bottle. The hope is that by "softening" physics and "hardening" phenomenology, the "two cultures" can be wed and a new kind of science be born.

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