

PAULI'S DREAM
JUNG, MODERN PHYSICS, AND ALCHEMY¹

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ABSTRACT

C. G. Jung devoted much of his life to exploring the dark borderland between psyche and matter. While engaged in that inquiry, he corresponded with physicist Wolfgang Pauli and was drawn to the phenomena of quantum mechanics. Just what is it about modern physics that invites intimate contact with the psyche? In examining this question, we see the broader need for setting physics and psychology on a new philosophical foundation consonant with the integrative worldview of alchemy studied by Jung. Against this philosophical backdrop, the relationship between modern physics and alchemy comes into sharper focus as we turn to the paradoxical mathematics of the Moebius strip and Klein bottle, seen as reminiscent of alchemy's Hermetic vessel. The weaving together of psychology, physics, and mathematics is foreshadowed in several of Pauli's dreams and the paper begins and ends by contemplating one of these.

At the end of a lecture in Vancouver, Jungian analyst Thomas Kirsch (2008) was asked what he thought was the single most exciting new horizon for 21st century Jung studies. His answer: the relationship of Jung's work to contemporary physics. Jung's own interest in this field was spurred by his collaboration with the Nobel Prize-winning physicist Wolfgang Pauli. The two men met in 1931 and their correspondence lasted for almost twenty-six years (from 1932 until close to the time of Pauli's death, in 1958). In the course of their encounters, Jung analyzed many of Pauli's dreams. I would like to begin this essay with a dream of Pauli's appearing in a letter he sent to Jung in October of 1946.

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My summary of the dream paraphrases the original account (Meier 2001, 30–32). Pauli describes his dream as follows:

A blond man serving as a kind of teacher or guide is standing next to me, and I am reading an ancient book about the Inquisition and its trials against the disciples of Copernicus (Galileo and Giordano Bruno). The blond man now exclaims: “The men whose wives have objectified rotation are being tried.” I am upset by these words and next find myself in a courtroom on trial with the others. My wife is not on the scene but I manage to have a note sent to her telling her the situation and asking her to come at once. Soon she turns up and says: “You forgot to say good night to me.” With this, the scene lightens and I am no longer in the courtroom among the accused but back where I was at the outset of the dream, the difference being that my wife is now present. Once again I am reading the old book, with the blond man at my side. Referring to the book, he comments that “the judges do not know what rotation or revolution is, and that is why they cannot understand the men...But you know what rotation is!” “Of course,” I reply, it is the “circulation of the blood and the circulation of light—all that is part of the basic rudiments.” (This seemed to be a reference to psychology, but the word is never mentioned.) The blond man responds to me by saying, “Now you understand the men whose wives have objectified their rotation for them.” At this point I kiss my wife, say good night to her, and express sadness at what these poor people who have been charged are going through. Overcome by emotion, I begin to weep. But the blond man says with a smile: “Now you’ve got the first key in your hand.”

Though I only learned about this dream a couple of years ago, it seems to have a remarkable relationship to work I have been doing for many years. But rather than commenting further on it here, I would like to let the dream incubate. I will return to it toward the end of this essay.

Jung, Pauli, and modern physics

Pauli and Jung influenced each other profoundly. Pauli's contact with Jung led him to seek a whole new way of doing physics. Under the influence of Jung, Pauli came to recognize the unconscious as the deep source of physicists' insights into the workings of nature. This led him to believe that dreams, active imagination, and intuition might effectively be used as *basic methods* in the work of physics, though he could not quite summon up the courage to bring this into his scientific work with his colleagues (see Miller 2009, 161–62). Jung, for his part, was emboldened by Pauli to pursue his own deep interest in physics. He was fascinated by the prospect that the revolutionary findings of physicists like Pauli might well hold the key to realizing his lifelong goal of bridging the gap between psyche and matter. “[M]icrophysics,” Jung exclaims, “has come up against the psyche in the most tangible and unexpected way” (1951, par. 268). Later in the same text he says: “Sooner or later nuclear physics and the psychology of the unconscious will draw closer together as both of them, independently of one another and from opposite directions, push forward into transcendental territory, the one with the concept of the atom, the other with that of the archetype” (1951, par. 412).

Just what is it about modern physics that so excited Jung's interest? Jung himself takes a step toward answering this question. He notes that *classical* science aimed at

eliminating the psyche as something merely “subjective.” It hoped to produce “a picture of the world that [is] entirely independent of the observer.” But “this hope,” says Jung, “has been fulfilled only in part, as the findings of modern physics show: the observer cannot be finally eliminated, which means that the psychic premises remain operative” (1945, par. 378). So while classical physics upheld the deep Cartesian division between psyche and matter, the phenomena of modern physics challenge Rene Descartes’ split.

The general features of quantum physics are well 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, psyche and matter.

No doubt then, the radical interaction of subject and object in the microworld flies in the face of objectivist science, which has been deeply committed to keeping subject and object apart. Has this led modern physicists to call for a fundamental change in science’s posture? By and large it has not (even Pauli was reluctant to openly champion this when interacting with his professional colleagues). Modern 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.

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—around two decades after the deaths of Pauli and Jung—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. At present, physics can no longer effectively deny the profound relationship between subject and object, psyche and matter—a relationship requiring a whole new philosophical base. In *The Self-Evolving Cosmos* (Rosen 2008), I go into all this in detail. What I propose there 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 and alchemy

Phenomenology comes out of the European tradition in philosophy that dates back to the 19th century. In my work, I draw mainly from 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 are not 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. So the new foundation for physics is distinguished by the fact that—unlike the objectivist approach to physics taken until now—the psyche, embodied subjectivity, would be *included in the practice of physics*, not just objectified or dropped. While participating at a conference five years ago, I spoke along these lines, suggesting that imaginal practices such as dream work and active imagination have to find their way into the doing of physics, since the unity physicists are seeking cannot be reached through detached observation and theoretical abstraction alone (Rosen 2009). It was only since that conference that I discovered to my excitement the extent to which Jung and Pauli were advocating the same kind of thing.

It is clear to me that there is an intimate relationship between phenomenological philosophy and a much older tradition, one dating back many centuries: the ancient discipline of *alchemy*. Though alchemy is commonly regarded as an absurd flirtation with transforming cheap metals into gold, Jung discovered that it actually involved a sustained and serious effort not merely at transforming matter, but the human psyche as well. It was alchemy that captured Jung's imagination and absorbed his attention for decades. Three whole volumes of his *Collected Works* (1944, 1956, 1967) are explicitly devoted to it and alchemical themes appear in many of his other works. And Jung believed that the phenomena of *modern physics* essentially lend themselves to an alchemical approach. He was convinced that the viability of future science depends on reviving this old paradigm

in a new and revitalized form. According to his personal secretary Aniela Jaffé, Jung called for “the construction of a new, unitary world-model [in which] spirit and matter are no longer [merely] opposites....This new world-model is a reconstruction of the old, intuitive vision of the alchemists” (1989, 72). Jung anticipated the demise of conventional science and reemergence of alchemy with the following words:

The moment when physics touches on the “untrodden, untreadable regions,” and when psychology has at the same time to admit that there are other forms of psychic life besides the acquisitions of personal consciousness—in other words, when psychology too touches on an impenetrable darkness—then ... the physical and psychic are once more blended in an indissoluble unity [as they were in old alchemy]. We have come very near to this turning-point today. (1944, par. 394)

Wolfgang Pauli also saw the relevance of alchemy to contemporary physics, as is clear from his correspondence with Jung, documented by C. A. Meier (2001). Jungian analyst Nathan Schwartz-Salant says it well in *The Mystery of Human Relationship*:

Alchemical thinking holds out a way of returning to wholeness without abandoning separation and distinctness of process. In a way, alchemy’s time has come. Perhaps we can now return to those mysterious realms or “third areas” that are neither physical nor psychic, domains whose existence must be recognized if we are to reconnect split orders of reality such as mind and body. I believe that such “third areas,” a major concern of alchemy but left behind by [classical] scientific thinking, will have to be reintroduced. (1998, p. 18)

Alchemy, modern physics, and topology

I would now like to look at the relationship between alchemy and modern physics in more specific terms. To set the stage for this, let me note my long-term fascination with qualitative mathematics.

Since the early 1970s (Rosen 1973), I have been working with some odd geometric structures that have always felt archetypal to me, structures that seem to embody the *coincidentia oppositorum*, the union of opposites that Jung wrote so much about (1944, 1952, 1956, 1966). The simplest of these figures is the well-known Moebius strip. You can best appreciate the properties of the Moebius by comparing it with its more conventional counterpart, a cylindrical ring (fig. 1).

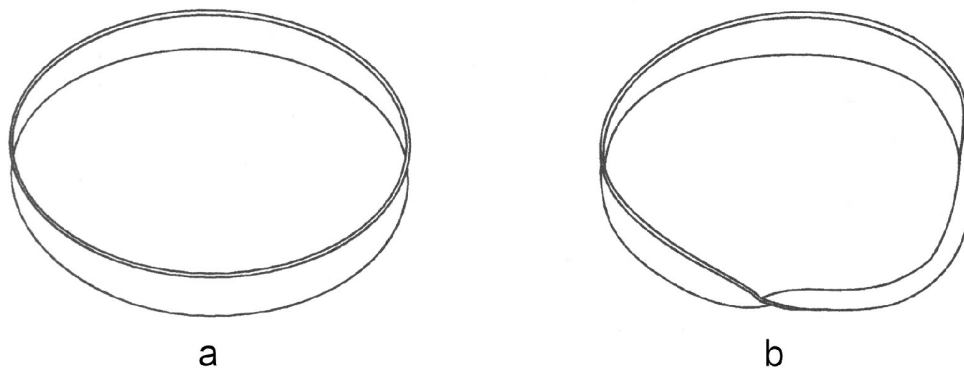


Figure 1. Cylindrical ring (a) and Moebius strip (b)

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:

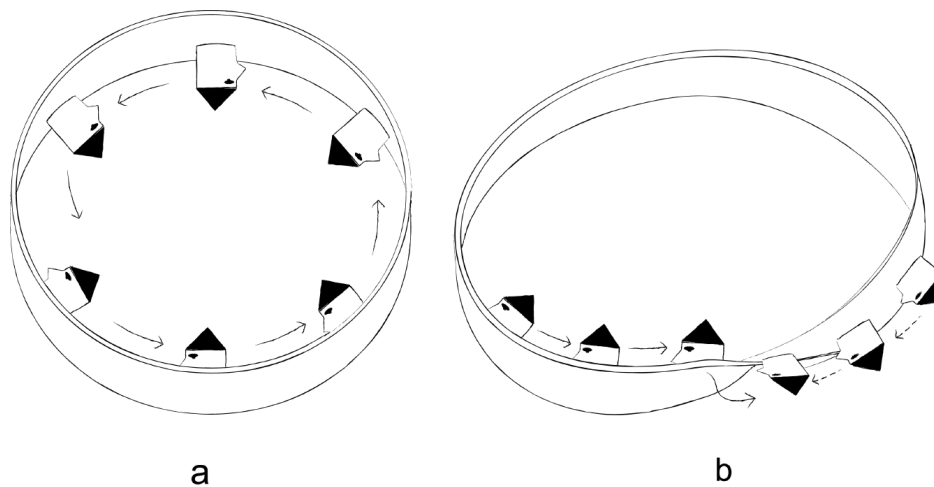


Figure 2. Revolution of asymmetric figure on cylindrical ring (a) and Moebius strip (b)

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 you will see 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.

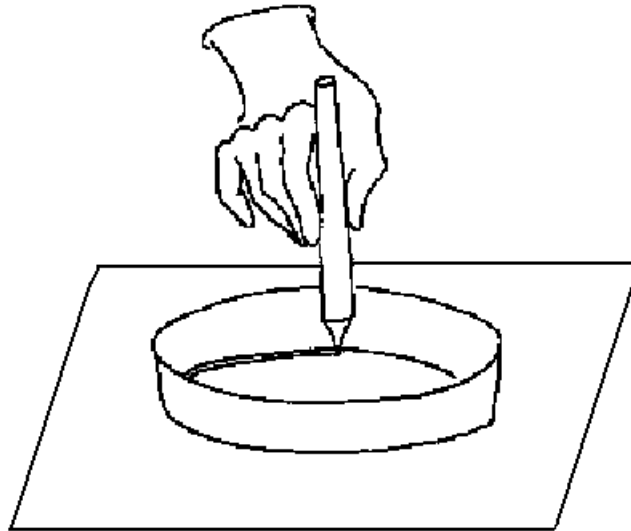


Figure 3. Tracing a path on a two-dimensional surface via the cylindrical ring

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 and alchemy. 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).

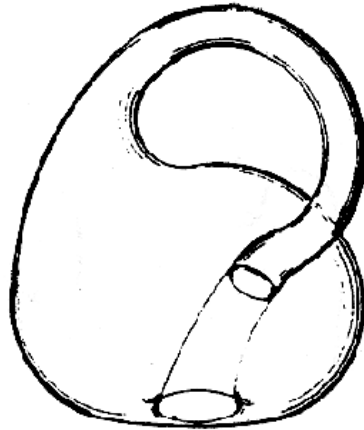


Figure 4. The Klein bottle (from Gardner 1979, 151)

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 embodying the union of opposites, the *coniunctio* that Jung explored in *Mysterium Coniunctionis* (1956) and elsewhere (e.g., 1944, 1952, 1966). Also like the Moebius strip, 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 cannot 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 this 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.

Elsewhere (Rosen 1997, 2004, 2006), I have suggested that the unseen fourth dimension in which the archetypal 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 *psychophysical* (Rosen 2008)—an *alchemical* 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 as Pauli and Jung well understood, then the geometry of that world can be seen as following the design of the four-dimensional Klein bottle.

But there is more to this. Around 20 years ago, in turning to the study of alchemy, I discovered that its work is carried out in a strangely configured apparatus known as the Hermetic vessel. At the time, I was struck by the vessel's interesting resemblance to the

Klein bottle, especially a version of the vessel associated with the shape of a pelican (fig. 5).

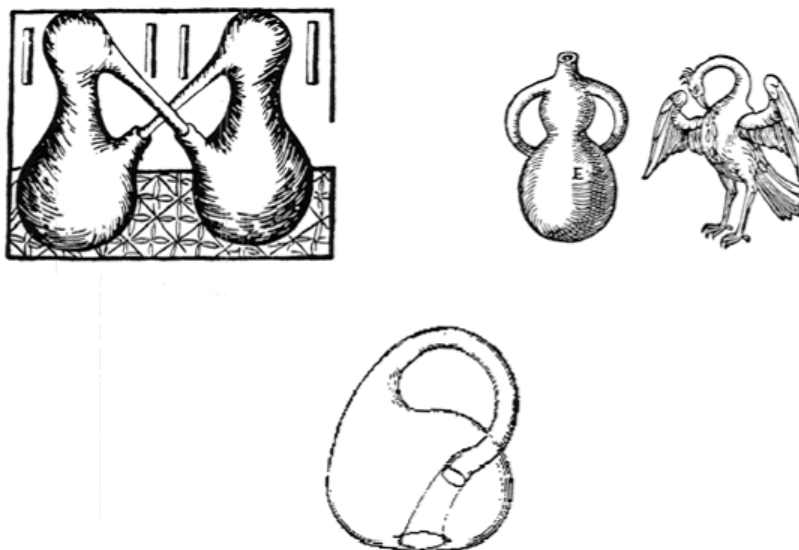


Figure 5. Upper left: Hermetic vessel called the “double pelican” (from *Das Buch Zu Distillieren*, Brunswick, 1519); upper right: Hermetic vessel compared to pelican (from J. B. Porta, *De Distillatione*, lib. ix, Rome, 1608); below: Klein bottle (from Gardner 1979, 151)

Intrigued by this correspondence, I studied Jung’s accounts of the properties of the *vas Hermeticum* derived from old alchemical texts and came to the conclusion that the Klein bottle can be reasonably regarded as a modern-day mathematical counterpart of alchemy’s ancient vessel (Rosen 1995). Both structures possess the feature of curving back into themselves, penetrating themselves so as to unite inner and outer, psyche and matter. In fact, both can be taken as mirroring the ancient emblem of alchemy, the self-swallowing snake or uroboros (fig. 6).



Figure 6. The uroboros (from an image appearing in the *Chrysopoeia of Cleopatra*, an ancient Egyptian alchemical text)

(Forms of this image actually appear on some depictions of the Hermetic vessel.) If the Klein bottle does effectively model the subject-object interaction of modern physics, then physics and alchemy become linked in recognizing the bottle's alchemical underpinning.

The Klein bottle can be seen to connect physics and alchemy in another way—one that will bring us back to where this essay began. I have shown elsewhere (Rosen 2008) that what lies at the heart of quantum mechanics and is intimately involved with its uncertainty relation is a dynamically spinning counterpart of the uroboric 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.

Jung wrote to 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 do not 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— 2×2 , 4×4 , -5×-5 , etc.—the value that results is always positive). Without attempting to explain imaginary numbers in technical detail, let us 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* ($\epsilon^2 = +1$, but $\epsilon \neq \pm 1$). 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 my own writing (Rosen 1994, 2008), I have 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. Let me repeat what I said above, when I first mentioned this Kleinian action pattern: the necessary “fourth” dimension is not just an objective physical dimension but, in effect, an *alchemical* one joining psyche and matter in an intimate way.

But who was the physicist who first modeled quantum mechanical spin by using the imaginary number i ? And who, in fact, was among the first to introduce spin to begin with, as a key characteristic in the behavior of electrons moving within the atom? It was none other than Wolfgang Pauli. Did Pauli go so far as to make the connection with the hypernumber epsilon and the Klein bottle? As far as I know, he did not. And even if he did, it is unlikely that he consciously recognized in the Klein bottle what he had long been searching for under the influence of Jung: an alchemical link between psyche and matter forged through the use of imaginal mathematics.

Pauli's dream of the "blond man" has been incubating since I introduced it at the outset and I would now like to go back and reconsider it:

A blond man serving as a kind of teacher or guide is standing next to me, and I am reading an ancient book about the Inquisition and its trials against the disciples of Copernicus (Galileo and Giordano Bruno). The blond man now exclaims: "The men whose wives have objectified rotation are being tried." I am upset by these words and next find myself in a courtroom on trial with the others. My wife is not on the scene but I manage to have a note sent to her telling her the situation and asking her to come at once. Soon she turns up and says: "You forgot to say good night to me."

With this, the scene lightens and I am no longer in the courtroom among the accused but back where I was at the outset of the dream, the difference being that my wife is now present. Once again I am reading the old book, with the blond man at my side. Referring to the book, he comments that "the judges do not know what rotation or revolution is, and that is why they cannot understand the men...But you know what rotation is!" "Of course," I reply, it is the "circulation of the blood and the circulation of light—all that is part of the basic rudiments." (This seemed to be a reference to psychology, but the word is never mentioned.) The blond man responds to me by saying, "Now you understand the men whose wives have objectified their rotation for them." At this point I kiss my wife, say good night to her, and express sadness at what these poor people who have been charged are going through. Overcome by emotion, I begin to weep. But the blond man says with a smile: "Now you've got the first key in your hand."

Now, I am not an analyst and I do not want to put myself in the position of offering a definitive “interpretation”; interpreting Pauli’s dreams was Jung’s job. But—as you might imagine—I do have some thoughts and feelings about this dream and its relation to my work.

When I first came across the dream and digested its implications for me, I felt plugged into Pauli’s unconscious. Pauli puts himself on trial for “objectifying rotation” in such a way that the *anima*, the feminine element, is denied. It is true that, in the dream, the “wives” are said to have objectified rotation for their men, but the men—Pauli and his colleagues—cannot properly explain rotation to the “judges” because the “accused” have left the feminine element behind them; their “wives” are nowhere to be found. In doing this, the men have projected rotation into the world as something purely physical or mathematical, an external abstraction devoid of the concrete inner life of the psyche.

When Pauli’s “wife” arrives on the scene, everything changes. Now he knows that the true nature of rotation must include the “circulation of the blood,” i.e., the soul, the psyche or *anima*. In speaking of “rotation” or “revolution,” Pauli can of course be said to be referring to *microphysical spin*, the phenomenon that he struggled to understand for so many decades, and that was so central to his whole life’s work. Though Pauli came to recognize in his work with Jung that the alchemical element of *anima* or psyche was missing from his mathematical formulations of the quantum world, as I said earlier, he could not quite bring himself to share this with his more conventional-minded scientific colleagues for fear of facing his own Inquisition. Therefore, in a compensatory way, the *anima* haunted his dreams. Still, in commenting on his dream of the “blond man” in his letter to Jung, Pauli’s awareness of the problem is evident: “From the higher point of

view of acquiring consciousness, the accusation relates to the fact that the men did not know where their wives (= anima) were, nor what *their* role was in the process of perception” (quoted in Meier 2001, 31).

Reflecting further on his dream, Pauli notes that his “blond teacher” speaks in a “neutral language,” one that goes beyond the separate languages of physics and psychology, and incorporates both. To Pauli this suggests alchemy’s “middle sphere” or “intermediary layer” (quoted in Meier 2001, 31–32), what Jung calls the “intermediate realm of subtle bodies” (1944, par. 394), and what Schwartz-Salant calls the “third area,” the mysterious region that is “neither physical nor psychic” (1998, 18).

Related to this is a second dream of Pauli’s. It is actually more like a consciously processed daydream or work of active imagination. Pauli calls his visionary experience of 1953 “The Piano Lesson.”

A mysterious woman is teaching Pauli to play the piano as he contemplates the challenge of finding a language, a way of communicating, that would integrate physics with psychology and biology. Piano playing, in fact, represents for Pauli the realm of feeling, femininity, and soul, which somehow must be reconciled with the rational abstractions of mathematical physics. Toward the end of the vision, Pauli is about to leave the room when he hears a voice saying: “Wait. Transformation of the centre of evolution.” He immediately associates this with turning lead into gold (i.e., with *alchemical* transformation), whereupon his piano teacher slips a ring off her finger and lets it float in the air. She tells him that it is the “ring *i*.” This is the imaginary number *i* that Pauli used in his description of microphysical spin. Pauli says in response: “The *i* makes the void and the unit into a couple.” The teacher agrees and notes that imaginary *i*

transmutes instinctive, intellectual, and spiritual spheres “into the unified or monadic whole that the numbers without the i cannot represent.” Pauli then chimes in: “The ring with the i is the unity beyond particle and wave, and at the same time the operation that generates either of these.” As I read these words (from Pauli 1953/2009), my own understanding of microspin comes to mind: the progression from the imaginary i to Musès’ hypernumber epsilon to a spinning Klein bottle, which, as Pauli says of i , “makes the void and the unit into a couple.” Why do Pauli’s paradoxical words apply to the Klein bottle? It is because, in penetrating itself, the Klein bottle creates a hole, a void, while yet retaining its unity or integrity—its wholeness. In the past, I have likened the spinning Klein bottle to a vortex swirling around its empty center (Rosen 2006)—and to a whirling spiral galaxy (fig. 7).



Figure 7. Barred Spiral Galaxy NGC 1672, from NASA/ESA Hubble Space Telescope (cover image of *The Self-Evolving Cosmos*, Rosen 2008)

Now, in both of Pauli’s dreams, he is intent on finding a whole new mode of scientific discourse, a means of communication that surpasses intellect alone so as to include the dimension of feeling. Remember that, in the initial dream, when Pauli weeps, his teacher tells him with a smile that he now has “the first key in [his] hand.” This

keying of emotion—triggered by the *piano* keys in Pauli’s 1953 vision—strikes a responsive chord in me and reminds me of a dream of my own, with which I will end.

I had the dream in February of 1992, just a few hours before I was to drive down to Philadelphia from New York to give a talk on a new intuitive approach to modern physics (Rosen 1992). In the dream, I was also giving a presentation to a group of people, reading my hand-written prose from long yellow sheets of paper. As I droned on and on in a fragmented, halting way, the audience was becoming restless and disaffected; I was losing them. And I was losing my own place in my manuscript as well. Finally, in frustration and some despair, I thought, “What’s the use?” I then broke away from my text and started speaking to the audience directly, my voiced filled with emotion. In fact, I begin to weep. With this, one man gets up in alarm, as if he wants to go for help. I respond by saying, “No, you don’t have to do that. I *can* communicate with you in this way. This is the way we *should* be communicating.”

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