

# **Einstein and Quantum Nonlocality: A Doorway to Emptiness and Compassion**

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A theoretical physicist is walking in the woods one day. The giant trees are swaying in the breeze and changing patterns of sunlight dance across the forest floor. The beauty and majesty of it all overcomes him. He thinks, “How amazing that all of this comes from the early big bang when the four forces of nature were unified. The universe cools, the four forces differentiate, galaxies form, planets evolve, and this extraordinarily beautiful woods develops.” In the midst of these pleasant reflections, he hears a great crashing in the brush behind him and turns to find a huge grizzly bear charging upon him. He runs in panic. His heart is pounding, the bear is gaining on him, and he can even smell its bad breath. As the bear closes in on him, he trips on a root of one of those majestic trees. Falling to the ground, he cries, “Oh God!”

Suddenly, out of a profound stillness a deep resonant voice booms from the sky and says, “So, when you’re in trouble you cry out to me and want help like the good Christians who pray fervently to me everyday. But when lecturing at the university, you deny my existence, telling people it’s all an expression of the four forces in nature.” The physicist, being well trained in the importance of logical consistency, replies, “Yes, I admit that would be inconsistent. But how about making the bear more like a good Christian?” God says, “Yes, I can do that.”

The grizzly bear stands upon his hind legs, bows deeply before the physicist, puts his forepaws together in front of his chest and says, “We give thanks for these gifts we are about to receive.” He then extends his claws, opens his huge maw, and devours the fallen man.

Our physicist wakes up screaming from this terrible nightmare. Even though still bathed in terror, the physicist says, “Oh, thankfully it’s only a dream.” However, **while in the dream**, it is all as real as any waking experience. Each object from tree to bear appears to exist independently or inherently, to exist from its own side. The mind, along with forming the varied objects and subjects in the dream, projects independent self-existence into them. The dreamer is fully convinced of the inherent or independent existence of the bear. Its evil-looking fangs and ex-

tended claws surely exist from their own side and are findable upon analysis—but who has time for analysis when you're running for your life? Thus, the dreaming mind projects inherent existence into its own creations and suffers because of it.

According to Middle Way Buddhists, just as in a dream, the waking mind projects independent existence into our sense of self and the objects surrounding it. This projection is then the false foundation for our attachments and the associated suffering. They are not saying that life is a dream, but that the same projective mechanism, the same unconscious investing of objects and subjects with inherent existence that gives dreams their vivid reality, is also operative in waking consciousness. Upon this false projection of independent existence we generate our cravings, aversions, and attachments—the roots of suffering.

According to the Middle Way, objects and subjects surely exist in the conventional sense. They certainly function and cause us help or harm. Independent existence, the very quality we think makes them real and functional, is precisely what emptiness denies. Stated positively, all objects and subjects only exist as a complex web of interrelationships, as complex expressions of dependent arising. Deeply understanding emptiness weakens the attachment to our ego and leads to the practice of universal compassion.

### **Emptiness and Quantum Nonlocality**

There is an extraordinarily precise resonance between Middle Way emptiness and quantum nonlocality, the most important finding at the conceptual foundation of modern physics.<sup>1</sup> Thus, if we can understand the deep connection between emptiness and modern physics then, since emptiness leads to compassion, we can see that physics indirectly points toward love. Since physics powerfully shapes our modern worldview and thereby influences our actions, gaining a greater appreciation for these connections encourages universal compassion. Moreover, a feeling connection towards the suffering of others naturally leads to a deeper appreciation for the interdependence mirrored in quantum mechanics and emptiness. In this way, love then leads to knowledge.

Physicists rarely discuss how physics shapes our worldview and influences our culture. A notable exception is the late David Bohm, internationally known for his important contributions to quantum mechanics. Bohm writes:

It is proposed that the widespread and pervasive distinctions between people (race, nation, family, profession, etc.), which are now preventing mankind from working together for the common good, and indeed, even for survival, have one of the key factors of their origin in a kind of thought that treats things as inherently divided, disconnected, and “broken up” into yet smaller constituent parts. Each part is considered to be essentially independent and self-existent.<sup>2</sup>

Quantum nonlocality—the inability to localize a particle in a finite region of space—differs radically from the assertion that “each part is essentially independent and self-existent.” The most penetrating understanding of quantum nonlocality comes from the celebrated Bell’s Inequalities,<sup>3</sup> which analyze correlated pairs of particles. “Correlation” is used in the sense that two gloves or two shoes comprising a pair are correlated. The analysis of Bell’s Inequality is independent of the current formulation of quantum mechanics and therefore any future theory must embody nonlocality. Thus, nonlocality is not an artifact of quantum mechanics but a fundamental property of nature.

The Bell Inequality analysis has its origin in the famous paper by Einstein, Podolsky, and Rosen<sup>4</sup> (EPR), which considered correlations between pairs of widely separated particles. Although Einstein pioneered quantum mechanics, he was never happy with it. From the 1920’s to 1935, when EPR was published, he engaged in a number of debates with Niels Bohr about the conceptual foundations of quantum mechanics.<sup>5</sup> Many physicists consider these Einstein-Bohr debates to be the most thrilling and important discussions in science.

We can go right to the heart of the controversy by examining Einstein’s most explicit formulation of his position.

If one asks what is the characteristic of the realm of physical ideas independently of the quantum-theory, then above all the following attracts our attention: the concepts of physics refer to a real external world, i.e., ideas are posited of things that claim a “real existence” independent of the perceiving subject (bodies, fields, etc.) . . . it is characteristic of these things that they are conceived of as being arranged in a space-time continuum. Further, it appears to be essential for this arrangement of things introduced in physics that, at a specific time, these things claim an existence independent of one another, in so far as these things “lie in different parts of space.” Without such an assumption of the mutually independent existence (the “being-thus”) of spatially distant things, an assumption which originates in everyday thought, physical thought in the sense familiar to us would not be possible. Nor does one see how physical laws could be formulated and tested without such a clean separation. Field theory [the theory of electromagnetic or gravitational fields, for example] has carried out this principle to the extreme, in that it localizes within infinitely small

(four-dimensional) space-elements the elementary things existing independently of one another that it takes as basic, as well as the elementary laws it postulates for them.

For the relative independence of spatially distant things (A and B), this idea is characteristic: an external influence on A has no immediate effect on B; this is known as the “principle of local action,” which is applied consistently only in field theory.<sup>6</sup>



**Figure 1: Niels Bohr and Albert Einstein**

By “local action,” Einstein means that the velocity of light is the maximum transmission speed for any information or physical effect. Since light speed is finite, there can be “no immediate effect” of a particle in region A on another particle in region B, or vice versa.

The EPR/Bell experiments use local action (today called “locality”) to isolate each particle in the pair. These experiments make nearly simultaneous measurements on widely separated correlated particle pairs. The time interval between the measurements is smaller than the light propagation time from one particle to the other. Thus, measurements on one particle cannot influence the other by any kind of signal or force field. The correlated particles are thus isolated.

Einstein’s reference to “mutually independent existence of spatially distant things” is pivotal. Objects separated in space and free from any interaction with other objects (because of locality) must exist independently or have well-defined, intrinsic properties. Relationships be-

tween objects are then built upon this fundamental independent existence; however, the relationships are less fundamental than the “mutually independent existence” of the related entities.

Einstein believes the mutually independent existence “originates in everyday thought,” since we believe that objects free of interaction with other objects have an independent existence. If this “mutually independent existence” were absent then “physical thought in the sense familiar to us would not be possible.” In addition, Einstein claims that things have a “‘real existence’ independent of the perceiving subject.” He thus assumes objects have two essential properties: mutually independent existence and independence of our knowing.

Einstein’s two assumptions are precisely a belief in independent or inherent existence—what we unconsciously project in dreaming or waking life and exactly what emptiness denies. For the Middle Way, it is critically important to define clearly the “object of negation.” Without such a precise definition, we are in danger of nihilism or eternalism. Einstein is doing us a great favor by carefully defining precisely what emptiness denies.

Deriving the Bell Inequalities only requires assuming locality (local action) and mutually independent existence. Physicists are fully confident that nature embodies locality. Therefore, the experimental violation of the Inequalities—which today students can demonstrate in an undergraduate lab—conclusively shows that the correlated particles do not have mutually independent existence. Instead, as quantum mechanics implies, nature is nonlocally interconnected. Therefore, despite Einstein’s objections, *what happens in region A is instantaneously influenced by what happens in region B, regardless of the distance between A and B.*

The Inequalities’ analysis, however, does not replace our erroneous view of objects as having independent existence with some new principle. Just as in traditional Middle Way arguments establishing emptiness, there is a massive negation of independent existence without invoking any principle beyond nonlocality.

The correlated particles are instantaneously interconnected in mysterious way. We are so used to conceiving of a world of isolated and independently existing objects that it is difficult to appreciate this rigorous experimental refutation of independent existence. The very nature of physical reality demands a major paradigm shift—one with enormous implications for fields well beyond the boundaries of science and philosophy.

In the David Bohm quote cited above, he suggests that a key factor giving rise to the pervasive strife between peoples and nations is “a kind of thought that treats things as inherently

divided, disconnected . . . [where] each part is considered to be essentially independent and self-existent.” We have just seen that quantum nonlocality teaches just the opposite. Let me elaborate by turning to the Middle Way.

In Middle Way Buddhism, emptiness characterizes all phenomena, from the nature of elementary particles to our deepest level of consciousness. The realization of emptiness—the complete lack of independent existence in all subjects and objects and their profound interdependence with each other—decreases egotism and increases a genuine concern for all life. If my deepest reality is one of mutual dependence upon other life forms and my environment, how can I be concerned with just me? How can I focus only on the needs of just one intersection among the innumerable dependency relations that define all people and things? Of course, we have no rational justification for our self-centeredness and self-cherishing. Nevertheless, these firmly ingrained tendencies are painfully difficult to uproot.

The greatest obstacle to appreciating emptiness is our inveterate belief in the independent existence of our own egos. Practicing compassion weakens this false belief that blocks the doorway to the wisdom of emptiness. Thus, a genuine concern for others deepens our assimilation of emptiness, our profound interconnectedness with all of life. Emptiness and compassion therefore have a synergistic relationship and that issues in a responsibility for the welfare of all sentient beings and the environment.

I have always wanted to understand more deeply the connection between emptiness and compassion. I actually wanted to derive compassion from emptiness, to see how it flows logically from interdependence, like a result in physics. Perhaps my years of doing theoretical physics predispose me to this approach. While emptiness certainly implies compassion, it was never satisfying to derive compassion from intellectual analysis.

Fortunately, life has shown me a little about approaching compassion through the heart, how to take in the pain of others and make a deep feeling connection to them. I then become more open to them and the reality of their suffering. Instead of approaching compassion through emptiness or nonlocality, I try to open to the suffering of others and thereby assimilate my profound interconnections with them. The ultimate goal is to expand this openness to include all suffering beings. Such openness to the suffering of others softens my habitual focus on my ego and its needs. The connection is through the heart not through the head. It leads to a feeling realization of emptiness. I then appreciate how connections to others establishes my identity and

how without these relationships there is no me at all. Here is a short personal experience from a couple of years ago to convey what I mean.

### **The Thief as Guru**

I am traveling for several weeks in Europe giving lectures and workshops. Despite the terrific extroversion of such activities, I am enjoying the periods of isolation and introversion that travel provides. I have finished reading the books I brought from home, so in a London airport I purchase *Ethics for the New Millennium* by the Dalai Lama. Although I have heard all of these ideas before, both through reading and oral instruction, the book's direct, clear, and simple message inspires me. With a minimum of technical language, the Dalai Lama shows how both our deepest happiness and genuine ethics follow from our effort to alleviate suffering. These well-known ideas have been electrifying me for the last couple of days.

In the Barcelona airport, after about an hour of reading, I stretch my legs with a walk among the fancy shops. On my return to the departing line, I sincerely vow to work more intensely on practicing compassion. I tell myself, "I can surely do much better."

Suddenly, out of the corner of my eye, I see a fearsome fist fight about 20 meters from my departure line. A policeman and another man are furiously pummeling each other. The policeman is on the floor and getting the worst of it. I instantly decide that this is harming the other man even more than the policeman. I sprint to the fight, grab the man by the shoulders, and pull hard, but I cannot separate them. In desperation, I come up behind the man, wrap my right arm over his right shoulder, grasp his left arm, and give a mighty heave. As the two men separate, the man pinned against my chest gives a powerful two-legged thrust to the policeman's chest knocking off his badge and throwing him flat on his back. The man and I land in a heap with me on my back and him on top of me.

I hug him tightly to my chest, while we struggle awkwardly to a sitting position. He is breathing like a racehorse. His heart is pounding. I feel his beard stubble against my left jaw. Astonishingly, the policeman jumps up and runs to the far end of the terminal and telephones for help. I am very unhappy being left clutching the fighter, but soon other people come to restrain him. I say to him with surprising tenderness, "Just let it go. It is not worth it." These seem like strangely ineffective words, especially since he is unlikely to understand English. I notice that he is about thirty years old, the same age as my oldest son.

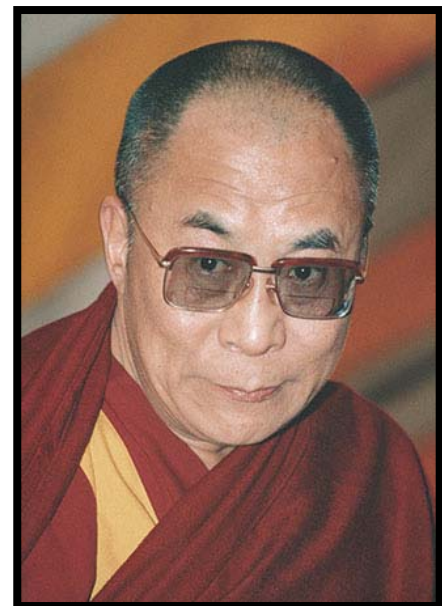
In a few minutes, more police arrive and handcuff the man. I get up from the floor and return to the departure line. My tailbone is sore from landing on it. Somebody hands me the Dalai Lama book that had fallen to the floor early in the struggle. As I walk back to the line I think, “The cop didn’t even say ‘*Gracias.*’”

Standing in line, a deep sadness overwhelms me. I have to fight the desire to sob uncontrollably. Embarrassed to cry in the departure line, I ask myself, “What is this powerful sadness?” Somebody ahead of me in the line tells me that the policeman caught the man picking somebody’s pocket.

That overwhelming sadness has long mystified me. At first, I thought my sadness was due to the policeman not recognizing or appreciating my effort. “I risked physical harm to minimize the pounding that policeman was taking. I want at least a ‘Thank you.’” Even more, it embarrasses me to confess my desire to be lionized as a hero. Realizing that my motivation was not entirely pure grieves me, especially when in the book that was just inspiring me the Dalai Lama writes, “When we give with the underlying motive of inflating the image others have of us—to gain renown and have them think of us as virtuous or holy—we defile the act. In that case, what we are practicing is not generosity but self-aggrandizement.”<sup>7</sup>

My motivation was not entirely pure, but there surely is more to it. When I clutched that man in my arms, besides feeling his heart beating wildly, his gasping breath, and even the scratch of his whiskers, I also felt his suffering. A genuine tenderness welled up in me towards him. More than physical intimacy, I directly contacted the broken life that led to the event, a brokenness that was likely to continue well after the prison term that was sure to follow. It is one thing to reflect quietly on suffering while reading a book and another to feel it squirming against your body. I did not have to think about nonlocality in quantum mechanics to make a connection with this man. I only had to be open to his suffering. The Dalai Lama writes,

When we enhance our sensitivity toward others’ suffering through deliberately opening ourselves up to it, it is believed that we can gradually extend our compassion to the point where the individ-



**Figure 2: The Dalai Lama**



ual feels so moved by even the subtlest suffering of others that they come to have an overwhelming sense of responsibility toward those others. This causes the one who is compassionate to dedicate themselves entirely to helping others overcome both their suffering and the causes of their suffering. In Tibetan, this ultimate level of attainment is called *nying je chenmo*, literally “great compassion.”<sup>8</sup>

I certainly have not attained anything like the advanced level of *nying je chenmo*, but I have seen how opening, even unwittingly, toward the suffering of others makes me appreciate the profound interconnectedness we all share. Such appreciation through the heart complements the intellectual understanding of quantum nonlocality and emptiness. That man, accused of being a pickpocket, could have been my son. As much as Einstein and Bohr educated my intellectual understanding, he educated my heart and helped me move toward a union of love and knowledge.

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<sup>1</sup> This paper is a much-condensed version of Chapter 4 in my *Tibetan Buddhism and Modern Physics* (Templeton Foundation Press, February 2008).

<sup>2</sup> David Bohm, *Wholeness and the Implicate Order* (London: Routledge & Kegan Paul, 1983), p xi.

<sup>3</sup> J. S. Bell, “On the Einstein Podolsky Rosen paradox,” *Physics*, 1:195, 1964; Alain Aspect, Jean Dalibard, and Gérard Roger, “Experimental Test of Bell’s Inequalities Using Time Varying Analyzers,” *Physical Review Letters*, 49:1804, 1982; W. Tittel, J. Brendel, H. Zbinden, and N. Gisin, “Violation of Bell inequalities by photons more than 10 km apart,” *Physical Review Letters*, 81:3563, 1998; M. A. Rowe, D. Kielpinski, V. Meyer, C. A. Sackett, W. M. Itano, C. Monroe, and D. J. Wineland, “Experimental violation of a Bell’s inequality with efficient detection,” *Nature*, 409:791, 2001.

<sup>4</sup> Albert Einstein, B. Podolsky, and N. Rosen, “Can Quantum-mechanical Descriptions of Physical Reality be Considered Complete?” *Physical Review*, 47:777, 1935.

<sup>5</sup> John A. Wheeler, Wojciech H. Zurek, *Quantum Theory and Measurement* (Princeton, NJ: Princeton University Press, 1983) give a detailed account of these debates along with reprints of all the key papers.

<sup>6</sup> Albert Einstein, “Einstein on Locality and Separability,” (1949) trans. Donald Howard, *Studies in History and Philosophy of Science*, 16, 3 (1985): 187-8.

<sup>7</sup> His Holiness the Dalai Lama, *Ethics for the New Millennium* (New York: Riverhead Books, 1999) p. 113.

<sup>8</sup> *Ibid.* p. 124.