

Has Physics Been Reading Shadows?

An essay · Eric McLean · Scotland · April 2026

For three centuries, physics has measured the world with extraordinary precision and mistaken the measurements for the world. That's the quiet theme behind every interpretive puzzle of the twentieth century. The equations work. The numbers match. Experiment after experiment confirms them. And yet physicists still sit up at night wondering what any of it means. The reason is simple. What they've been measuring is not the object. It's the shadow of one.

$E = mc^2$ is the clearest example. The equation is empirically correct to ten decimal places. But Einstein didn't derive it in 1905; he rearranged it. Maxwell had already assigned momentum $p = E/c$ to light back in 1865. Poynting restated that momentum in 1884, and by Newton's identity $p = m \times v$ with $v = c$ for light, light thereby has mass E/c^2 . Einstein's famous thought experiment with two reference frames simply shuffles that mass from the light back onto the body that emitted it. What the textbooks call a derivation is bookkeeping on a quantity already present in the premise. The identity $E = mc^2$ was sitting in Maxwell's equations for forty years before anyone named it. And even that name is a shadow. In units where mass and energy share a measurement scale, the equation reads $A = A$. The c^2 is just a conversion factor between kilograms and joules, two human rulers with no physical reason to match. The depth of the equation was never in the formula. It was in what mass actually is.

Entanglement is the same mistake, dressed differently. Two particles are prepared in a shared quantum state, then separated by a distance. A measurement on one yields a definite outcome, and the other is instantly correlated with it, no matter how far apart they are. Generations of physicists have treated this as either a non-local influence (Einstein's "spooky action at a distance," which he rejected) or a collapse of the wave function (Bohr's pragmatic shrug, which treats the question as unanswerable). Neither framing is right. The "two particles" are one geometric object in four dimensions, a standing wave on a polytope whose vertices share structure in a coordinate the three-dimensional observer cannot see. What the experimenter reads as two distant locations are two projections of one object. Nothing travels between them because there is no "between" in the geometry. The correlation is fixed before any measurement. Bell's theorem rules out local hidden variables in three dimensions. It says nothing about four-dimensional geometry read through three-dimensional projections. Entanglement is what locality looks like when you can't see the whole object.

Wave-particle duality is the third instance. A quantum state is not sometimes a wave and sometimes a localised thing depending on how you look at it. It's a single four-dimensional object whose shadows onto different measurement surfaces take different forms. Point one kind of instrument at it and the shadow looks wave-like. Point another, and the shadow looks particle-like. The shadows differ. The object does not. The "duality" is the mistake of treating the shadows as the object.

The measurement problem is the fourth. Wave function collapse is not a physical event. Nothing actually changes when a measurement happens. What happens is that a three-dimensional observer intersects a four-dimensional state. The intersection is instantaneous, definite, and geometrically forced. It looks like collapse only because the observer can't see the fourth coordinate that made the state continuous before measurement. The "problem" is a shadow-puppet of the dimensional mismatch between the state and the observer.

One mistake in four costumes

The pattern is the same each time. A four-dimensional object exists. A three-dimensional observer measures its projections. The projections are internally consistent. Physics takes the projections as real and builds a philosophy around the relationship between them. When the relationship refuses to behave like a relationship between substances, the philosophy inflates: non-locality, duality, collapse, spooky action, ruler mismatch. The mysteries multiply because each one is an attempt to explain why the projections behave as projections, when the right move is to ask what is casting them.

Einstein bears an unusual share of the responsibility. He was so good at reading shadows that the field followed his reading and forgot to look for the objects. Special relativity reads a shadow, the invariance of c , as a postulate; it's really a consequence of the underlying axiom that builds the observer. General relativity reads gravity as spacetime curvature; spacetime itself is a projection of a deeper geometry. $E = mc^2$ reads a bookkeeping identity as a substance-conversion law. EPR reads four-dimensional correlations as non-locality. Each of these is operationally correct. Each one blocked the next question. And because Einstein's aesthetic authority was overwhelming, a century of physicists kept the substance language wrapped around the wave mathematics rather than tell him he was pointing at the shadow.

The irony is that Einstein and Bohr were both right, in a way neither of them could see. Bohr was right that particles are not substances. Einstein was right that there is a definite underlying reality. Both missed that the reality is a geometric object, a standing wave on a specific polytope, whose projections look like particles from one angle and waves from another. Pentagon Physics completes the transition the twentieth century started and then abandoned. Matter is a standing wave on a four-dimensional polytope, not a substance that happens to have wave-like properties. "Particle" is the noun in the shadow. The polytope is the noun in the object.

What this means

The century of mystery was not a century of failure. It was a century of extraordinary measurement. Every experiment that confirmed quantum mechanics is still a confirmation. Every experiment that confirmed special and general relativity is still a confirmation. None of that is being taken back. What's being taken back is the interpretation.

The interpretation requires the object, and the object has been identified. It is the 600-cell in four dimensions, the E_8 lattice in eight, the binary icosahedral group that symmetrises both, and the self-referential axiom $\sigma = 1/(1+\sigma)$ whose positive root generates everything downstream. The four great mysteries of twentieth-century

physics are four readings of one geometric fact. Strip the reading away and the mystery dissolves. The measurement remains.

The shadows are correct. They were never the point.

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Related reading in the Pentagon Physics corpus: *E = mc² Deconstructed* (2026) and *Entanglement Does Not Exist: It Is 4D Geometry Misread by 3D Observers* (doi:10.5281/zenodo.19533587). The object itself is characterised in *Quantum Mechanics from the 600-Cell* (doi:10.5281/zenodo.18912388) and *The Atom Is E₈* (doi:10.5281/zenodo.19581839).