VOL. 62/NO. 9 • APRIL 2014

Virginia Lawyer

The Official Publication of the Virginia State Bar

The Laws of Physics – and – the Physics of Laws

By D. Arthur Kelsey

— INSIDE —

LHL

Why I Need Lawyers Helping Lawyers

By the Honorable William C. Mims

— *and* —

Governors Recognized for Historic Contributions

By Clarence M. Dunnaville Jr.

The Oldest Lawyer in Town

By Tim Davis

Lawyers Without Rights

By Brett Alexander Zwerdling

The Laws of Physics and the Physics of Laws

by D. Arthur Kelsey[1]

An Underlying Order

From ancient conjurers to modern scientists, those claiming to understand the nature of matter and energy often refer to their conclusions as "laws." Why would they do that? Newton's Law of Gravity, for example, could just as easily be called the gravity principle or Newton's axiom. Even so, scientists instinctively use the argot of lawyers and judges. I think they do so because law represents order, and order law.

Physicist Stephen Hawking reminds us that "ever since the dawn of civilization, people have not been content to see events as unconnected and inexplicable. They have craved an understanding of the underlying *order* in the world."[2] It is for this reason we lawyers can say that "the Sparks of all [the] Sciences in the world are raked up in the ashes of the Law."[3] For similar reasons, I wonder whether raking through the ashes of science (as well as some of its white hot coals) might reveal symmetries that reinforce our understanding of law. The parallels between science and law reveal the interwoven nature of the created order. Although neither, standing alone, claims to have produced a unified explanation of everything, viewed together they provide allegorical parallels between what we think we know about nature (science) and what we think we know about man (law).

The early common-law jurists thought this way. Even before the admixture of Reformation and Enlightenment influences, the common-law tradition we inherited assumed the laws of science naturally led to an understanding of the laws of men.[4] In Judge Henry Bracton's thirteenth-century treatise, the first true attempt to synthesize English common law, he defined jurisprudence as simply "the science of the just and unjust."[5]

Explaining the point further, Sir William Blackstone argued in his famous *Commentaries* that the elemental laws of physics provide the starting point in our effort to understand the laws of men:

> Law, in its most general and comprehensive sense, signifies a rule of action, and is applied indiscriminately to all kinds of action, whether animate or inanimate, rational or irrational. Thus we say, the *laws* of motion, of gravitation, of optics, or mechanics, as well as the *laws* of nature and of nations. And it is that rule of action which is prescribed by some superior, and which the inferior is bound to obey.[6]

Finding the same sense of order underlying the laws of men, Blackstone recognized free will as one of the intrinsic design features of the "noblest of all sublunary beings."[7]

> This, then, is the general signification of law; a rule of action dictated by some superior being, and, in those creatures that have neither the power to think, nor to will, such laws must be invariably obeyed . . . . But laws, in their more confined sense, and in which it is our present business to consider them, de-

> note the rules, not of action in general, but of *human* action or conduct; that is, the precepts by which man, the noblest of all sublunary beings, a creature endowed with both reason and freewill, is commanded to make use of those faculties in the general regulation of his behaviour.[8]

This jurisprudential view was a common theme among the great jurists of the past. They believed the laws of physics and the laws of men, taken together, represent a universal order, a kind of architectural design crafted with purpose and care. The two disciplines differed only in their coercive efficacy: Pebbles and stars are bound to obey the laws of physics, yet men are free to disobey the laws of men. Except for the normative nature of the laws of men, the two systems of law share many elegant parallels. Although this thesis was advocated with confidence in the eighteenth century, it still holds up pretty well today.

The First and Second Laws of Motion—Inertial Forces and Stare Decisis

Working from conclusions first reached by Galileo, Isaac Newton developed the Laws of Motion in his 1687 *Mathematical Principles of Natural Philosophy*, a work considered by Hawking as "surely the most influential book ever written in physics."[9] Newton's First Law holds: "Every body perseveres in its state of being at rest or of moving uniformly . . . except insofar as it is compelled to change its state by forces impressed."[10] Under his Second Law, "[a] change in motion is proportional to the motive force impressed … whether the force is impressed all at once or successively by degrees."[11]

It follows that, absent such a force, an object at rest will remain at rest. And if it is in motion, it will remain in motion. This idea Newton called the *vis inertiae*, the inherent nature of an object not to change its state of motion or rest.[12] Inertia is directly proportional to an object's mass: the greater the mass, the more its inertia; the smaller the mass, the less its inertia. Challenging the contrary orthodoxy first taught by Aristotle,[13] Newton's First and Second Laws laid the foundation for modern physics and helped explain the physical nature of our expanding universe. Rather than everything inevitably coming to rest, inertia maintains the status quo and resists changes to it.

The ancient Anglo-American tradition of stare decisis parallels the physics of inertia. Once a legal premise has been set in motion by a high court, protected by the force and stature of precedent, its momentum propels it effortlessly into future generations. Only a later court of equal or greater dignity with the initiating court can significantly alter the trajectory of the precedent into future generations. A resisting court's ability to do so is directly proportional to the mass of the moving precedent. Its mass is measured by the strength of judicial consensus on the truth of the precedent and the longevity of its journey over time.[14]

When precedents carry great intellectual mass (like Blackstone's interpretation of common law in his *Commentaries*[15] or John Marshall's assertion of judicial review in *Marbury v. Madison*[16]) they simply move from age to age along their original trajectories. Precedents of featherweight mass, on the other hand, usually come to an inglorious end without any appreciable possibility of moving forward into future generations.[17]

More often than not, however, the resistant forces we typically observe are sufficient only to change the relative vector of a disputable precedent, resigning it to a less ambitious course than originally charted by those who set it in motion. Yet, in all cases, the governing premise remains the same: The law of judicial inertia, stare decisis, presupposes that judicial precedents continue their intended course. Those seeking to change the course of a precedent or even possibly to end its journey altogether can succeed only by amassing sufficiently weighty reasons for doing so. In a common-law legal system, precedents do not — and should not — come to rest on their own accord.[18]

The ancient Anglo-American tradition of stare decisis parallels the physics of inertia.

Newton's Third Law: Opposing Forces and the Adversary System

Described as the fundamental principle of symmetry, Newton's Third Law of Motion provides that all forces come in opposing pairs. For each force we should expect to see an equal and oppo-

site counter-force.[19] "If anyone presses a stone with a finger," Newton observed, "the finger is also pressed by the stone."[20]

Newton's Third Law means that all forces in the universe can be best described as interactions between two different objects. Each force has two end points — two objects of force. Each is equal in magnitude but opposite in direction. The end points mirror each other. Force itself, as an intelligible scientific concept, does not exist outside of this point-counterpoint model. Thus, to physicists and schoolchildren alike, force is simply a tug of war. Each side pulls on the rope while the rope pulls on each side.

The adversarial system of justice presupposes that truth can be found in the competing contest between opposing forces.

The architects of the common-law system intuitively understood this principle. Unlike the inquisitorial system employed by continental courts applying civil law, the common-law courts of England and America created an adversarial system of justice. It presupposes that truth can best be found in the competing contest between opposing forces. For each matter in dispute, the assertion of X is expected to be accompanied by a counter assertion of not-X.

A less violent adaptation of the trial-by-combat adjudication of the Middle Ages,[21] most modern litigation is a forensic contest between two opponents. Each seeks to pull the tug-of-war rope of persuasion toward his side. Presiding over the contest is a neutral referee, a judge or jury. In every case, the initial assumption is the same: Both sides apply persuasive force in opposite directions to unbalance the other. Depending on the governing burden of proof (which determines which side is initially disfavored by the rules of the game), either side of the tug-of-war rope pulls until one wins or the game is called off. Despite the combative nature of the contest, the adversarial method of litigation resonates with good sense, in part at least, because of its symmetrical relationship with Newton's Third Law of Motion and the intrinsic sense of order in both.

The Wave-Particle Paradox and Law-Equity Justice

Much of the trouble in modern physics stems from an ancient question: Is light an indivisible particle or a wave?[22] In Albert Einstein's famous $E=mc^2$ equation, he described the energy-to-mass ratio as a function of the speed of light.[23] The history of nuclear fission, from the Manhattan Project to the modern worldwide use of atomic power plants, owes its existence to this simple equation. It thus should come as some surprise to learn that modern scientists still do not know what light actually is.

The debate over the nature of light began centuries ago with the teachings of Pythagoras, and continued with Aristotle, Newton, and Einstein.[24] Some considered light to be a stream of particles that traveled in straight lines, bouncing off mirrors like a ball off a wall. Others rejected this approach and treated light purely as an energy wave. Today's physicists offer little to resolve the conflicting theories of the nature of light. Using terms like "wave energy duality," they appear to accept the inexplicable paradox — unknown in classical physics — that light is sometimes a wave, sometimes a particle, and perhaps both at the same time.[25] In his legendary lectures, Physicist Richard Feynman described it as a "phenomenon which is impossible, *absolutely* impossible, to explain in any classical way, and which has in it the heart of quantum mechanics."[26]

A similar definitional paradox is deeply embedded in our understanding of justice. In every case there are two ways to perform the calculation of justice. On some occasions we choose the particle theory of *law*. On others, we choose the wave theory of *equity*. Sometimes we marble them together, allowing both to contribute to the decision. Even when we do so, however, we still get the unnerving sense that we are dealing with conceptually dissimilar concepts.

The law-equity duality has a long history. Many early common-law jurists looked to discrete, concrete rules of law and tended to apply them deductively.[27] Shortly after the birth of what we now call the common law, a competing vision of justice appeared. In medieval England, the King was the sovereign Liege Lord of the kingdom, divinely appointed protector of all dependent subjects, and thus the very fount of justice.[28] Whatever the common law may or may not be, the King believed his subjective sense of justice

superseded the uniform rules of common law.[29] This regal spirit of justice became known as equity.[30]

In the early 1200s, litigants began petitioning the King to intervene in disputes in which they thought the common law might violate the royal sense of justice.[31] When this docket of unhappy litigants became burdensome, the King delegated the task to his Chancellor, a close advisor and member of the King's Council.[32] Over time, chancellors began to look at justice inductively and made decisions on a case-by-case basis. Eschewing the common law as unduly inflexible, chancellors applied general maxims of equity, which they discovered in the writings of the great philosophers and theologians.[33] From the Chancellor's perspective, he "did not issue generally applicable 'legal' rulings. Quite the contrary. It was the very universality of the common-law precedents and their unbending quality that he might find, from time to time, unjust when applied to a specific set of circumstances."[34] As Thomas Aquinas starkly put it, "In these and like cases it is bad to follow the law, and it is good to set aside the letter of the law and to follow the dictates of justice and the common good."[35]

Needless to say, the development of an equity court did not please many common-law judges or lawyers. In his famous 17th-century protest, John Selden voiced the popular remonstrance against using equity as a substitute for law:

> Equity is a Roguish thing: for Law we have a measure, know what to trust to; Equity is according to the Conscience of him that is Chancellor, and as that is larger or narrower, so is Equity. 'Tis all one as if they should make the Standard for the measure, we call a Foot, a Chancellor's Foot; what an uncertain Measure would this be? One Chancellor has a long Foot, another a short Foot, a Third an indifferent Foot: 'Tis the same thing in the Chancellor's Conscience.[36]

Sir Edward Coke, Chief Justice of the King's Bench, shared Selden's discontent. He used the law court's power of habeas corpus to release litigants from the Chancery Court's contempt orders forbidding them from enforcing a common-law judgment that the Chancellor condemned as inequitable.[37]

On the eve of the American Revolution, Sir Robert Chambers (Blackstone's successor as the Oxford Vinerian Chair of English Law) framed the law-equity dispute not as an accident of judicial politics but as a deep jurisprudential paradox. "It has appeared to some a question difficult of decision," Chambers explained, "what is the use of a court of equity if our laws are right, and what is the use of laws if they are wrong."[38] Chambers answered the question by challenging its assumptions: "This question supposes in human institutions a degree of excellence which they never have attained. No human law was ever perfect, it has always equity for its object, but it sometimes misses of its end."[39] "Yet law is not unnecessary," he continued, "[t]he subject has, in the law, a rule of action always safe, and commonly right; and where it happens to be wrong a remedy is provided."[40]

At its founding, America inherited this parallax view of justice.[41] Although most American courts have merged the administration of law and equity (eventually abolishing the distinction between the judge and chancellor), the substantive distinction remains between the two disparate visions of justice. As Professor Pomeroy has explained, "While the external distinctions of form between suits in equity and actions at law have been abrogated, the essential distinctions which inhere in the very nature of equitable and legal primary or remedial rights still exist as clearly defined as before the system was adopted . . . ."[42]

Dozens of examples of the duality of law and equity can be given.[43] My only point is that it exists today and has existed for a very long time. The heart of the judicial system is justice. Yet, like modern physicists attempting to describe the properties of light,[44] we too must equivocate on the actual properties of justice. Is it governed by principles of law, maxims of equity, or both?

Our answer is unsettling but honest: Sometimes it is law, sometimes equity, sometimes both, but never neither. We find ourselves flanked by two competing strong towers of justice: the generally applicable law with its virtue of objective uniformity, and the specifically applicable equity with its virtues of particularity and tailored mercy. Neither paradigm, by itself, fully describes what we mean by justice. Perhaps we will never come up with a rhetoric that convincingly forces these competing virtues into a single formulation. Perhaps it is vain to think we could.

Heisenberg's Uncertainty Principle and the Jurisprudence of Doubt

In the mid-1920s, a young German physicist named Werner Heisenberg wanted to precisely describe tiny subatomic particles.[45] The conventional wisdom taught that such particles should have a physical position and measurable momentum at any given moment in time. Rejecting this view, Heisenberg postulated a system in which position and momentum were interdependent, not unlike Einstein's space-time theory.[46] Heisenberg believed "an observer cannot infer a single unique event that would have led to the measured outcome."[47] "There would always be, as Heisenberg put it, an 'inexactness' (*Ungenauigkeit*) in the conclusions."[48]

Later physicists realized Heisenberg's insight led to a simple, but startling, conclusion: Inherent in every measurement is a band of inescapable uncertainty. Heisenberg's thesis implied *the very act of measuring somehow changes the thing measured*. These concepts rocked the scientific community because of the implication that absolute certitude, when it comes to subatomic quantifications, is impossible. Heisenberg's discovery effectively unseated the scientist from his position as an objective and neutral observer and made him part of the thing being observed.

The epistemology of science continues, even today, to convulse over the implications of Heisenberg's uncertainty principle. Even so, Heisenberg's computations and experimental data have held up to rigorous scrutiny. The uncertainty principle, Hawking claims, "has been an outstandingly successful theory and underlies nearly all of modern science and technology."[49] In no small part, science has moved from the certitude that things can be measured precisely to a realization that the best knowledge we can hope to obtain lies in "probability cloud[s]."[50]

Long before the theory of quantum mechanics, the common-law tradition intuited a similar uncertainty principle. Dealing in mere probabilities, a concept previously foreign to classical physics, has always been a traditional feature of the law.

The institutional humility derived from inevitable uncertainty explains why the adversarial system does not begin with strict neutrality and then configure the trial as an even-handed experiment to ascertain truly objective realities. To be sure, just the opposite is true. Every trial begins with a wholly unproven assumption, a heuristic bias in the traditional sense of the term. We do not merely hypothesize its truth — we outright presume it. Every trial, to put it plainly, begins with a thumb on the scales of justice.

In a criminal case, for example, the accused is presumed to be innocent before a single fact is offered to support such a presumption. In a civil case, with few exceptions, the civil defendant is presumed to be not liable. The presumption could be that he did not act negligently, that he did not breach the contract, or that he did not act with malice.

Why would the law inject such bias into the adversarial system? Why would it not be far more sensible to begin a trial with utter objectivity, presuming neither side to be blameless and allowing the evidence, like the needle of a compass, to point to the objective truth? The reason is that lawyers and jurists alike have known for centuries that *irrefutable* truth is almost always, if not invariably, garbled by the exercise of discovering it. The very act of advocating tends to exaggerate the strengths of an assertion and to minimize its weaknesses. We use cross-examination to trim down overstatements and to fill in understatements of witnesses. We consult a library of evidentiary rules to filter out unreliable information. We rely upon a host of evidentiary presumptions — of varying degrees of persuasive weight — to temporarily predispose the case to the most risk-averse outcome.[51] We then deploy a multitude of burdens of proof (reasonable suspicion, probable cause, preponderance of the evidence, clear and convincing proof, beyond a reasonable doubt) to calibrate the tolerable limits of uncertainty for specific decision-making topics. Despite our best efforts, however, many cases end up presenting competing views of hyperbolized truth. Judges and juries grope for the median view, the probabilistic truth, which they estimate to be somewhere between the poles of embellishment.

This reality is not as unsettling as it seems. It simply acknowledges that our understanding of juristic truth — the *sui generis* kind of truth produced in courtrooms — is invariably affected by the truth-telling process of the adversary system. We do not — because we believe we cannot — demand or expect pure objectivity in an adversarial system. To the contrary, we accept as a given a certain "margin of misstatement" (as Justice Cardozo once put it[52]) inherent in the very nature

of our language, in the fog of memory, and in the rationalizations of disputants. It is for this very reason we engineer myriad default settings into the litigation process to act as temporary proxies for the truth. These truth presets, if we can call them that, ameliorate the capriciousness of Heisenberg's observation that the act of measuring something necessarily changes it.

Holmes's "Echo of the Infinite"

The laws of physics represent a search for order amid the tumult of matter and energy, from the most imperceptible subatomic speck to our grandest imagination of the ever-expanding universe. Most modern physicists (even those expressing their faith in "chaos theory"[53]) search for an underlying, universal order, rightly discounting as unhelpful the hypothesis that all things are merely a random physical and metaphysical game of chance. As Einstein famously said, "God does not play dice" with the universe.[54]

So, too, in the laws of men, we look for order amid the tumult of human conflict. Our laws, like our physics, rest upon presuppositions reinforcing that sense of order. We presuppose that traditional laws should have a measurable stare decisis force similar to the law of inertia. We rely on an adversarial system that pairs opposing litigable points of view similar to the pairing of all natural forces in Newtonian physics. We accept the apparent *ad hoc* duality in our definition of justice — generalized law and particularized equity — in the same way physicists accept particle-wave duality in their understanding of light. We accept our inability to reconstruct absolute truth through the judicial process, just as Heisenberg acknowledged his inability to overcome the principle of uncertainty in quantum mechanics.

Why should such things attract our interest? For me, the curious answer to this incurious question lies in the closing lines of Oliver Wendell Holmes's most celebrated essay:

> The remoter and more general aspects of the law are those which give it universal interest. It is through them that you not only become a great master in your calling, but connect your subject with the universe and catch an echo of the infinite, a glimpse of its unfathomable process, a hint of the universal law.[55]

D. Arthur Kelsey serves as a judge on the Virginia Court of Appeals. He previously served as a trial judge in the Fifth Judicial Circuit of Virginia and, before that, as a litigation partner with Hunton & Williams.

Endnotes:

1 The views advanced in this Essay represent commentary "concerning the law, the legal system, [and] the administration of justice" as authorized by Virginia Canon of Judicial Conduct 4(B) (permitting judges to "speak, write, lecture, teach" and otherwise participate in extrajudicial efforts to improve the legal system). These views, therefore, should not be mistaken for the official views of the Virginia Court of Appeals or my opinion as an appellate judge in the context of any specific case. I also appreciate the assistance of my law clerk, Shawn D. Lillemo, Esq., in the research for and editing of this essay. This essay is an abridged version of an article originally published in the Regent University Law Review. *The Laws of Physics and the Physics of Laws*, 25 REGENT U. L. REV. 89 (2012).

2 STEPHEN HAWKING, A BRIEF HISTORY OF TIME 13–14 (10th anniversary ed. 1998) (emphasis added).

3 HEN. FINCH, LAW, OR A DISCOURSE THEREOF 6 (photo. reprint 1992) (1678).

4 *See* 1 WILLIAM BLACKSTONE, COMMENTARIES *38–39.

5 2 BRACTON ON THE LAWS AND CUSTOMS OF ENGLAND 25 (Samuel E. Thorne trans., Harvard Univ. Press 1968) (c. 1250).

6 1 BLACKSTONE, *supra* note 4, at *38 (emphasis added) ("Thus, when the Supreme Being formed the universe, and created matter out of nothing, he impressed certain principles upon that matter, from which it can never depart, and without which it would cease to be. When he put that matter into motion, he established certain laws of motion, to which all movable bodies must conform.").

7 *Id.* at *39.

8 *Id.* Justice James Wilson — a signer of the Declaration of Independence, one of the principal framers of the Constitution, and an inaugural member of the Supreme Court of the United States — agreed: "Order, proportion, and fitness pervade the universe. Around us, we see; within us, we feel; above us, we admire a rule, from which a deviation cannot, or should not, or will not be made." James Wilson, *Of the General Principles of Law and Obligation*, *in* 1 THE WORKS OF JAMES WILSON 97, 97 (Robert Green McCloskey ed., Harvard Univ. Press 1967) (1804). "The great and incomprehensible Author, and Preserver, and Ruler of all things—he himself works not without an eternal decree," Wilson concluded. *Id.* "Such—and so universal is law." *Id.*

9 HAWKING, *supra* note 2, at 196.

10 ISAAC NEWTON, THE PRINCIPIA: MATHEMATICAL PRINCIPLES OF NATURAL PHILOSOPHY 416 (I. Bernard Cohen & Anne Whitman trans., Univ. of Cal. Press 1999) (1687) [hereinafter PRINCIPIA].

11 *Id.*

12 I. Bernard Cohen, *A Guide to Newton's Principia* in PRINCIPIA, *supra* note 10, at 3, 96. In other words, a "body exerts this force only during a change of its state, caused by another force impressed upon it." PRINCIPIA, *supra* note 10, at 404.

13 ARISTOTLE, THE PHYSICS, *reprinted in* 4 ARISTOTLE IN TWENTY-THREE VOLUMES bk. IV, at 303 (G.P. Goold ed., Philip H. Wicksteed & Francis M. Cornford trans., 1980) ("[A]ll the elemental substances have a natural tendency to move towards their own special places, or to rest in them when there . . . .").

14 In this context, the mass is in the enduring legal principle embedded in the precedent — not simply the judicial opinion expounding upon it. As Professor Bryson explains, common-law jurists "thought that the cases were not themselves the common law of England, but are only evidence of the common law." 1 RATIO DECIDENDI: GUIDING PRINCIPLES OF JUDICIAL DECISIONS 287 (W. Hamilton Bryson & Serge Dauchy eds., 2006). The common law, Lord Mansfield once remarked, "would be a strange science if it rested solely upon cases. . . . Precedent indeed may serve to fix principles, which for certainty's sake are not suffered to be shaken, whatever might be the weight of the principle, independent of precedent." *Jones v. Randall*, (1774) 98 Eng. Rep. 706 (K.B.) 707; Lofft 384, 385. Articulating a point largely lost in modern conversations about stare decisis, Lord Mansfield's view represented the original understanding of the concept: "[P]recedent, though it be evidence of law, is not law in itself; much less the whole of the law." *Id.*

15 1 BLACKSTONE, *supra* note 4, at *64.

16 *Marbury v. Madison*, 5 U.S. (1 Cranch) 137, 178 (1803).

17 It is also true, however, that even the slightest of influences can have enormous unforeseen legal consequences. What has become known as the "butterfly effect" in physics, EDWARD N. LORENZ, THE ESSENCE OF CHAOS app. 1, at 181–82 (1993), offers a compelling analogical explanation for how the most minute judicial precedent in one continent of law can create a legal tornado in another.

18 For those, like me, who like to see things from an allegorical perspective, think of stare decisis as the trajectory of a rocket. The greatest force must be applied at the earliest stage, lifting the rocket off the launch pad and pushing it beyond the Earth's gravitational pull. After lift-off, the rocket follows its flight path powered only by its momentum. Absent the application of a resistant force (such as a thruster burn, an asteroid, or a solar flare), the rocket will indefinitely continue on its intended trajectory. If that image is unhelpful, consider the physical flow of a river. Snow and rain flow down the mountains to the sea. The water carves gorges through rock, moves around boulders in the rapids, gets forced through man-made dams, and ultimately fans out into deltas and bays. Resistant forces may change the course of the river, but they rarely stop it altogether. Whether allegorized as a rocket trajectory or a winding river, stare decisis abides by Newton's principle of inertia. The basic formula of stare decisis describes the inertial history of common-law reasoning and quantifies the resisting force necessary to alter or end the originally intended trajectory of a legal principle.

19 PRINCIPIA, *supra* note 10, at 417.

20 *Id.*

21 *See* 2 BLACKSTONE, *supra* note 4, at *346–48.

22 Albert Einstein once wrote to a friend: "All these fifty years of conscious brooding have brought me no nearer to the answer to the question 'What are light quanta?' Nowadays every Tom, Dick, and Harry thinks he knows it, but he is mistaken." Martin J. Klein, *Einstein and the Development of Quantum Physics, in* EINSTEIN: A CENTENARY VOLUME 133, 138 (A.P. French ed., 1979). Physicist Richard Feynman described the state of confusion over the "wave-particle duality" of light with an oft-repeated quote: "[L]ight was waves on Mondays, Wednesdays, and Fridays; it was particles on Tuesdays, Thursdays, and Saturdays, and on Sundays, we think about it!" RICHARD P. FEYNMAN, QED: THE STRANGE THEORY OF LIGHT AND MATTER 23 n.3 (expanded ed. 2006) [hereinafter QED].

23 The formulation $E=mc^2$ is really a reformulation of Einstein's original equation $m=L/c^2$. *See* A. Einstein, *Does the Inertia of a Body Depend upon Its Energy-Content?*, *in* THE PRINCIPLE OF RELATIVITY 69, 70–71 (H.A. Lorentz et al. eds., W. Perrett & G.B. Jeffery trans., Methuen & Co. 1923).

24 The debate over the nature of light began in the fifth century B.C. Attributed by some to the teachings of Pythagoras, *see* E. NUGENT, OPTICS: LIGHT AND SIGHT THEORETICALLY AND PRACTICALLY TREATED, WITH THEIR APPLICATION TO FINE ART AND INDUSTRIAL PURSUITS 3 (London, Strahan & Co. new ed. 1870), "Greek atomists believed that seeing and hearing (and smelling) involved the traveling of atoms (at finite speed) from the perceived object to the perceiving organ and that the form of the atoms conveyed information," Olivier Darrigol, *The Analogy Between Light and Sound in the History of Optics from the Ancient Greeks to Isaac Newton. Part 1*, 52 CENTAURUS 117, 123 (2010). Aristotle disagreed with the particle theory, claiming light was more like a wave. ARISTOTLE, ON THE SOUL, *reprinted in* 8 ARISTOTLE IN TWENTY-THREE VOLUMES bk. II, at 107 (G.P. Goold ed., W.S. Hett trans., 1975) ("[I]t is the essence of colour to produce movement in the actually transparent; and the actuality of the transparent is light. The evidence for this is clear. . . ."). The wave theory seemed incomplete, however, to Newton, who noted light's ability to cast shadows suggested a stream of particles. ISAAC NEWTON, OPTICS (1704), *reprinted in* 34 GREAT BOOKS OF THE WESTERN WORLD 377, 529 (Robert Maynard Hutchins ed., 1952) ("Are not the rays of light very *small bodies* emitted from shining substances?" (emphasis added)). Most classical physicists of the nineteenth century who worked with electromagnetism seemed content to describe light as a wave. *See, e.g.*, J. Clerk Maxwell, *A Dynamical Theory of the Electromagnetic Field*, 155 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON 459, 499 (1865) ("[L]ight is an electromagnetic disturbance propagated through the field according to electromagnetic laws."). Thomas Young, an English scientist, popularized the wave theory with a simple, yet profound, experiment. He shined a beam of light onto a projection screen through a barrier with two closely spaced slits. AMIR D. ACZEL, ENTANGLEMENT: THE GREATEST MYSTERY IN PHYSICS 18 (2002). If light were made of particles, he reasoned, two closely spaced bright images would appear on the projection screen. But what he saw was not what he expected. Instead, *many* parallel lines in a classic wave interference pattern appeared on the screen. The only plausible explanation for these refracted images, Young concluded, was that light consisted of streams of wave energy, not particles. *See id.* at 18–19. Einstein, as he did with so many other topics, reconsidered the debate from an entirely different perspective. He pointed out that the photoelectric effect (certain metals releasing electrons when light shines on them) occurred in specific quantities. As Einstein viewed it, light must consist of streams of energized particles, Klein, *supra* note 22, at 134, indivisible packets of energy later called photons. Gilbert N. Lewis coined the term "photon" in 1926. *See* Gilbert N. Lewis, Letter to the Editor, *The Conservation of Photons*, 118 NATURE 874, 874 (1926) ("I therefore take the liberty of proposing for this hypothetical new atom, which is not light but plays an essential part in every process of radiation, the name photon."). Nevertheless, no part of Einstein's explanation refuted the earlier findings that light also acted like a wave insofar as it exhibited a wavelength and was capable of reflecting, refracting, and polarizing, which are typical functions of a wave.

25 Light and electrons "behave somewhat like waves, and somewhat like particles." QED, *supra* note 22, at 85. "In order to save ourselves from inventing new words such as 'wavicles,' we have chosen to call these objects 'particles'. . . ." *Id.*

26 3 FEYNMAN ET AL., THE FEYNMAN LECTURES ON PHYSICS § 1-1 (definitive ed. 2006).

27 *See* Roscoe Pound, *The End of Law As Developed in Juristic Thought*, 30 HARV. L. REV. 201, 201 (1917).
28 *See* 1 DAN B. DOBBS, LAW OF REMEDIES § 2.2, at 68 (2d ed. 1993) [hereinafter DOBBS 1993].
29 *See id.*
30 *Id.* § 2.1(3), at 63.
31 *Id.* § 2.2, at 67–68.
32 *Id.* § 2.2, at 69.
33 Until the appointment of Sir Thomas More in 1529, all earlier Chancellors were prelates, educated to be ecclesiastical scholars and appointed to be the King's personal confessors, 1 DOBBS 1993, *supra* note 28, § 2.2, at 66–67, and often relied on the teachings of Thomas Aquinas and Aristotle. *See* D. Arthur Kelsey, *Law and Equity in Virginia*, VBA NEWS J., Dec. 2002, at 6, 6 (citing Eric G. Zahnd, *The Application of Universal Laws to Particular Cases: A Defense of Equity in Aristotelianism and Anglo-American Law*, 59 LAW & CONTEMP. PROBS. 263, 265–73 (1996); Roger A. Shiner, *Aristotle's Theory of Equity*, 27 LOY. L.A. L. REV. 1245 (1994); 1 DOBBS 1993, *supra* note 28, § 2.3(1), at 74).
34 Kelsey, *Law and Equity in Virginia, supra* note 33, at 6.
35 3 ST. THOMAS AQUINAS, SUMMA THEOLOGICA, pt. II-II, q. 120, art. 2, at 1689 (Fathers of the English Dominican Province trans., Christian Classics 1981) (1274).
36 THE TABLE-TALK OF JOHN SELDEN 49 (S.W. Singer ed., London, John Russell Smith 2d ed. 1856); *see also Grupo Mexicano de Desarrollo v. Alliance Bond Fund, Inc.*, 527 U.S. 308, 332–33 (1999) (quoting 1 JOSEPH STORY, COMMENTARIES ON EQUITY JURISPRUDENCE § 19, at 21 (photo. reprint 1972) (1836)).
37 *See* CATHERINE DRINKER BOWEN, THE LION AND THE THRONE: THE LIFE AND TIMES OF SIR EDWARD COKE 478–88 (1957).
38 1 ROBERT CHAMBERS, A COURSE OF LECTURES ON THE ENGLISH LAW DELIVERED AT THE UNIVERSITY OF OXFORD 1767–1773, at 221 (Thomas M. Curley ed., 1986).
39 *Id.*
40 *Id.*
41 *See* 2 JOSEPH STORY, COMMENTARIES ON EQUITY JURISPRUDENCE § 1517, at 732–33 (photo. reprint 1972) (1836).
42 1 JOHN NORTON POMEROY, A TREATISE ON EQUITY JURISPRUDENCE § 354, at 795–96 (5th ed. 1941).
43 Even to this day, some of our most sacred rights, such as the right to a trial by jury in civil cases, specifically depend on which side of the law-equity boundary a given case falls. *See* U.S. CONST. amend VII; *Curtis v. Loether*, 415 U.S. 189, 193 (1974) (holding that the jury trial right of the Seventh Amendment applies to legal cases "in contradistinction to equity" (quoting *Parsons v. Bedford*, 28 U.S. (3 Pet.) 433, 446 (1830))). A "jury trial was given in actions at common law and not in suits in equity, and a jury trial may still be granted or not, according to whether the case is classified as one in equity or at law." DAN B. DOBBS, LAW OF REMEDIES § 2.1, at 28 (1973). The substantive distinction between law and equity remains important in determining available remedies. *See id.* § 2.6, at 67 ("[Q]uite apart from the fact of merger, there may be good reasons to deny equity remedies in 'law' type claims — not because they are claims at law, but because they do not warrant the exercise of the special power."). The distinction also affects the scope of injunctive relief, *see* KENT SINCLAIR, GUIDE TO VIRGINIA LAW/EQUITY REFORM AND OTHER LANDMARK CHANGES § 1.07, at 45 (2006), and provides a safe haven to worthy litigants from the strictures of the law, 3 POMEROY, *supra* note 42, § 804, at 189 ("Equitable estoppel" is a device whereby a party is "absolutely precluded, both at law and in equity, from asserting rights which might perhaps have otherwise existed."). Equity formulations often take on the role of exceptions. A rule of law, like the statute of limitations, usually states a categorical principle: A claimant cannot file a complaint more than a certain number of years after his cause of action arises. Equity sets this generally applicable rule aside if the complainant shows he was somehow tricked into waiting too late — a specific mercy-laden caveat called equitable estoppel. *See Schroeder v. Young*, 161 U.S. 334, 344 (1896) ("Under such circumstances the courts have held with great unanimity that the purchaser is estopped to insist upon the statutory period. . . .").
44 Along these same lines, consider the even more disquieting paradigm contest taking place in the deepest cavern of modern physics. Few scientists have engaged at this level, and those who have engaged returned with stories bordering on the unintelligible. *See generally* 1 JOSEPH POLCHINSKI, STRING THEORY (2005); KATRIN BECKER ET AL., STRING THEORY AND M-THEORY: A MODERN INTRODUCTION (2007). On one side of the cavern are the accepted principles of general relativity, Einstein's elegant explanation of the geometric properties of space-time. General relativity explains the essential gravitational structure of the universe at large. On the other side of the cavern is quantum mechanics, which explains the permissible range of properties of mass and energy at the level of subatomic matter. To date, many physicists have tried, although none have succeeded, to reconcile these paradigms. The math, the theory, and the experimental data frustrate all attempts to construct a unified "theory of everything" that would explain equally well the very large and very small — leaving not a few theorists content with the paradoxical hypothesis that gravity is at once a curvature in the fabric of space-time and a wavelike graviton particle. *See generally* BECKER ET AL., *supra*, at xi.
45 DAVID LINDLEY, UNCERTAINTY: EINSTEIN, HEISENBERG, BOHR, AND THE STRUGGLE FOR THE SOUL OF SCIENCE 84–86 (2007).
46 *Id.* at 131.
47 *Id.* at 146.
48 *Id.* at 147.
49 *See* HAWKING, *supra* note 2, at 58.
50 1 FEYNMAN ET AL., *supra* note 26, § 6-5.
51 Professor Wigmore said the "most important consideration in the creation of presumptions is probability." 2 KENNETH S. BROUN, MCCORMICK ON EVIDENCE § 343, at 500 (6th ed. 2006) [hereinafter MCCORMICK]. The probability biases range from mere permissible inferences to legally conclusive presumptions. *Id.* § 342, at 496. Wigmore devoted at least fifty-five sections of his original treatise to various evidentiary burdens and presumptions allocated by the common law to certain basic facts. 4 JOHN HENRY WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW §§ 2485–2540 (1905). Among the "hundreds of recognized presumptions" are the presumptions of regularity, such as that letters were delivered, that a person missing for seven years is deceased, and that offspring are the legitimate children of the husband. MCCORMICK, *supra*, § 343, at 501–06. The idea of presuming truth in the absence of proof, however, did not originate with the common law. As James Franklin, a professor of mathematics, notes in *The Science of Conjecture*, the Babylonian Talmud contained "a good deal of reasoning from presumption (*hazakah*)" as did Roman law at the time of Justinian and many other ancient legal codes. JAMES FRANKLIN, THE SCIENCE OF CONJECTURE: EVIDENCE AND PROBABILITY BEFORE PASCAL 6, 9–10 (2001).
52 Benjamin Cardozo, *Law and Literature*, 52 HARV. L. REV. 471, 474 (1939).
53 Sensitive dependence on initial conditions results in amplified divergence in outcomes, but, surprisingly, often in observable fractal patterns exhibiting such phenomena as Lorenz attractors. *See generally* JULIEN CLINTON SPROTT, ELEGANT CHAOS: ALGEBRAICALLY SIMPLE CHAOTIC FLOWS 11, 61 (2010). Because chaos still deals with deterministic systems, some consider the label "chaos" to be a bit of a misnomer. *See* STEPHEN H. KELLERT, IN THE WAKE OF CHAOS: UNPREDICTABLE ORDER IN DYNAMICAL SYSTEMS, at ix (1993) ("Chaos theory is not as interesting as it sounds. How could it be?").
54 HAWKING, *supra* note 2, at 58.
55 O.W. Holmes, *The Path of the Law*, 10 HARV. L. REV. 457, 478 (1897).