

THE LAWS OF SCIENCE, CONSTITUTIONAL LAW, AND THE RULE OF LAW

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This article¹ seeks to answer a basic question: Do the Declaration of Independence and the Constitution require lawmakers and judges to adhere to the fundamental laws of science? I think, as you will see, that Thomas Jefferson, John Adams, Benjamin Franklin, and James Madison would unhesitatingly say yes. Can our society and system of government and the rule of law be stable, successful, and just without adherence to the fundamental principles of nature revealed by science? I suggest that our history has shown it cannot be and that this question is as relevant today as when the Constitution was drafted in 1787. This article examines whether governmental decisions that ignore the laws of science and scientific fact are unconstitutional.

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¹ This article is a revised version of the biennial H. Albert Young Constitutional Law Lecture given by Prof. Hodas on October 28, 2015. It has been an exceptional honor and privilege to have been the 2013 – 2105 H. Albert Young Fellow in Constitutional Law. The Fellowship has enabled me to think deeply about some issues that had been rattling around in my head for years. I am extremely grateful to the Young Family for its support and vision and I want to take this opportunity to remember Stuart Young, who died not long after I was named the Young Fellow and is sorely missed. He was an outstanding lawyer, a man with a great passion for justice and his community, and was central to the creation of this Fellowship to honor H. Albert Young, who, as I recently learned from H. Alan Young, was considered a man of courage by none other than Thurgood Marshall, Supreme Court Justice and the lead attorney in *Brown v. Board of Education*.

Before I begin, I want to thank my father, Daniel Hodas, a remarkable American history historian, for his invaluable help on this project. The Young Fellowship afforded me a treasured opportunity to work with my father at a high professional level, and to benefit from his extraordinary understanding of American history. I also want to thank my wife, Judy Oken Hodas, for asking me the question that this project tries to answer and for her invaluable feedback and insightful questions all along the way. Any mistaken thinking in this article is due to my failure to heed their wise counsel.

Finally, I thank Jay Pasachoff, Field Memorial Professor of Astronomy at Williams College and his seminar, Rare Books of Astronomy, for the opportunity to test out my ideas, in my talk as H. Albert Young Fellow on *Isaac Newton and America's Founding Documents*. The excellent questions posed by seminar participants that pushed me to think more deeply. I also thank Prof. Pasachoff for the remarkable and rare opportunity to use original versions of Newton's *Principia* and Benjamin Franklin's *Collected Letters on Electricity*, and to read original copies of the Declaration of Independence and the Constitution of the United States during my talk.

Much has been written about science and the law²—about the role of courts as gatekeepers for the admission of scientific evidence at trial,³ about patent law,⁴ about the regulation of scientific research,⁵ about social science in constitutional litigation,⁶ about scientific uncertainty and the use of statistics and probability and when assessing legal causation,⁷ about the role of expert testimony in courts,⁸ religion, racial and gender inequality, abortion, and sexual orientation, about using scientific analogies to analyze legal doctrine, and the Supreme Court’s constant difficulty in accommodating science in its constitutional doctrines,⁹ and about the science of law.¹⁰ Scholars have used physics and the laws of science as metaphors¹¹ to explain and develop constitutional doctrine,¹² but the deeper issue of the founders’ original intent, their understanding of the role of the fundamental laws of science when they drafted the Constitution, and in interpreting the Constitution has not been examined.¹³ The core constitutional question is whether the due process clauses prohibit, as arbitrary and irrational, constitutional doctrines, court decisions, and statutes inconsistent with the laws of science. A timely answer is needed because the Constitution must be capable of resolving important issues on the horizon: climate change mitigation and adaptation, the intelligent electric grid, computer big-data and deep learning, robotics, genetic manipulation, neuroscience, and the general increase in complexity of human systems and the tighter links between these systems.

² See, e.g., Oliver Wendell Holmes, *Law in Science and Science in Law*, 12 HARV. L.R. 443 (1899).

³ See, e.g., Edward K. Cheng and Albert H. Yoon, *Does Frye of Daubert Matter? A Study of Scientific Admissibility Standards*, 91 VA. L.R. 471 (2005).

⁴ See, e.g., Ralph D. Clifford and Richard J. Peltz-Steele, *The Constitutionality of Design Patents*, 14 CHI-KENT J. INTELL. PROP. 553 (2015).

⁵ See, e.g., WENDY WAGNER & RENA STEINZOR, *RESCUING SCIENCE FROM POLITICS: REGULATION AND THE DISTORTION OF SCIENTIFIC RESEARCH* (2006).

⁶ See, e.g., Henry P. Monaghan, *Constitutional Fact Review*, 85 COLUM. L.R. 229 (1985).

⁷ See e.g., Stephanie Tai, *Uncertainty About Uncertainty: The Impact of Judicial Decisions on Assessing Scientific Uncertainty*, 11 U. PA. J. CONST. L. 671 (2009).

⁸ See e.g., Harold L. Korn, *Law, Fact, and Science in the Courts*, 66 COLUM. L.R. 1080 (1966).

⁹ See, e.g., DAVID L. FAIGMAN, *LABORATORY OF JUSTICE: THE SUPREME COURT’S 200 YEAR STRUGGLE TO INTEGRATE SCIENCE AND THE LAW* (2004).

¹⁰ See e.g., Roscoe Pound, *Law and the Science of Law in Recent Theories*, 43 YALE L.J. 525 (1934).

¹¹ See, e.g., Wai Chee Dimock, *Rules of Law, Laws of Science* 13 YALE J. L. & HUMAN. 203 (2001).

¹² See, e.g., Laurence H. Tribe, *The Curvature of Constitutional Space: What Lawyers Can Learn From Modern Physics*, 103 HARV. L.R. 1 (1989).

¹³ It is well recognized that the Founders were “men of the Enlightenment and were deeply influenced by the science of their times,” and “contemporary constitutional law scholars accept that science is a component of modern constitutional law,” and academics, such as David Faigman, have strongly criticized most judges’ and constitutional law scholars’ indifference to “the factual propositions and hypotheses that inform constitutional law.” FAIGMAN, *LABORATORY OF JUSTICE*, *supra* note 9, at xi. However, Faigman focuses on the social sciences and law, not the physical sciences or the fundamental laws of science.

My thesis is that the Constitution, a product of an age dedicated to reason and science as the engines for improving the human condition, is built on those two fundamental values: science and reason. We may have lost sight of the Constitution's fundamental assumptions about science and the law; they must be relearned in light of modern society and technology. They teach that the Constitution, and ultimately the rule of law, requires that all laws be rationally related to a legitimate government purpose and that at its core, rationality requires adherence to the fundamental laws of science.

Since the founding of our nation, the laws of science, such as physics, chemistry, biology, and geology have advanced beyond any possible imagining. The practical use of electricity, once a dream of Benjamin Franklin, now dominates our lives. The laws of science have radically changed the nature of our world, our economy, our society and our culture. The laws of science, and the technology engineered from them, dominate our lives, even though most of us have little knowledge of and care little about what these laws are or how they work. And while we depend on science and technology every day, we take them for granted.

Many lawyers and judges have scant training in science, and some openly admit, as we will see, they chose the profession to avoid scientific and mathematic challenges.¹⁴ In stark contrast, the founding fathers were both curious about and well-versed in the science and mathematics of their day.¹⁵ Their's was a pragmatic science based both on closely observed fact and the mathematically described laws of nature revealed by Isaac Newton in the late 17th century.¹⁶ They would have expected that the Constitution would be interpreted in conformance with evolving fundamental scientific principles.

They created our nation in the Age of Reason, or the Enlightenment, when science was "esteemed as the highest expression of human rationality."¹⁷ To the Founders, who were products of the Enlightenment, science and human reason were the epitome of human achievement and the essential vehicle for the improvement of society and human wellbeing.¹⁸ It is impossible to understand the Declaration of Independence and interpret the Constitution without appreciating the drafters' profound understanding that nature follows the laws of science. The founders' "original intent" was molded by their deep dedication to science and scientific reasoning, and by their rejection of superstition and fundamentalist thinking limited by the dead hand of the past.¹⁹ Yet, today, ironically, scientific illiteracy is rampant, and for many

¹⁴ David L. Faigman, *Judges as Amateur Scientists*, 86 B.U. L. REV. 1207, 1207 (2006) ("Judges, on the whole, have little training in, knowledge of, or inclination to learn science . . . Like all ignorance, scientific illiteracy casts knowledge into the shadows, where only forms can be made out and detail is impossible to discern.").

¹⁵ See generally I. BERNARD COHEN, *SCIENCE AND THE FOUNDING FATHERS: SCIENCE IN THE POLITICAL THOUGHT OF JEFFERSON, FRANKLIN, ADAMS, AND MADISON* (1995); FAIGMAN, *LABORATORY OF JUSTICE*, *supra* note 9, at xi.

¹⁶ COHEN, *supra* note 15, at 56-57.

¹⁷ *Id.* at 20.

¹⁸ *Id.* at 19-20.

¹⁹ See generally COHEN, *supra* note 15.

Americans, belief has replaced scientific reason and the recognition of what Alfred North Whitehead calls “irreducible and stubborn facts.”²⁰

The laws of science as understood when our nation was founded are deeply embedded in our constitutional and legal structure. New technology challenges existing legal doctrine – for instance, is a search warrant needed to detect from a public street infrared radiation- heat -emitted from a building? The Fourth Amendment, drafted in a different technological era, focused on common law notions of trespass by prohibiting unreasonable governmental searches and seizures of private property.²¹ Public information, such as that which the police could observe from outside the subject’s private property, is not protected by the Fourth Amendment.²² What if the observation is that of infrared radiation instead of radiated visible light? The only difference between the two is the frequency of the wave traveling to the viewer.²³ In neither case is the viewer going into the building or using radar to transmit radio waves or microwaves into the building to see inside the structure.²⁴ Rather, in the cases of visible light and heat, the police just detect what is coming out of the building into public space, without entry into private property.²⁵

Yet, the modern Supreme Court declared the remote observation of infrared radiation to be a search for purposes of the Constitution because, the Court explained, infrared detectors were then not in widespread use,²⁶ although now they can be bought in any home improvement store. On the other hand, when a specially trained police dog signals the presence of an illegal substance, there is no Fourth Amendment problem so long as the dog is not on the subject’s private property.²⁷ With a basic understanding of fundamental scientific principles, the Court would have at least considered that there is no the conceptual difference between a molecule that drifts into a dog’s superbly sensitive and trained nose and radiated heat that is detected by a sensitive thermometer. Without that basic scientific literacy, the Court

²⁰ ALFRED NORTH WHITEHEAD, *SCIENCE AND THE MODERN WORLD* 3 (1925) (adopting the phrase first used by William James).

²¹ *Florida v. Jardines*, 133 S.Ct. 1409, 1415 (2013) (“[O]ur law holds the property of every man so sacred, that no man can set his foot upon his neighbour's close without his leave.” As it is undisputed that the detectives had all four of their feet and all four of their companion's firmly planted on the constitutionally protected extension of Jardines' home, the only question is whether he had given his leave (even implicitly) for them to do so. He had not.”) (internal citation omitted).

²² *Id.* at 1409.

²³ See generally *Kyllo v. United States*, 533 U.S. 27 (2001); *Jardines*, 133 S.Ct. at 1409.

²⁴ *Jardines*, 133 S.Ct. at 1415, 1419-20.

²⁵ *Id.* at 1415, 1419-21; see also *Kyllo*, 533 U.S. at 35-36.

²⁶ *Kyllo*, 533 U.S. at 35.

²⁷ *Id.* at 46 (Stevens, J. dissenting); see also *United States v. Place*, 462 U.S. 696, 707 (1983). A dog sniff that “discloses only the presence or absence of narcotics” does “not constitute a ‘search’ within the meaning of the Fourth Amendment,” and it must follow that sense-enhancing equipment that identifies nothing but illegal activity is not a search either. *Id.*

ignored scientific reality when it declared that sensing heat that comes to you in a public space is a “search” of private property.²⁸

For many judges and lawyers, creating a legal doctrine without regard to scientific reality may not be troubling. But “scientifically illiterate judges . . . threat[en] . . . the judiciary’s . . . legitimacy.”²⁹ When they create precedent-based constitutional jurisprudence that is independent of scientific reality, they take us on a journey without a reality map. Today, satellite pictures of private property are available for free on Google Earth. Our digital data resides somewhere in the “cloud.” Facial recognition technology is being widely deployed. The government can take pictures of every vehicle’s license plate and detect transponder signals from virtually all newer cars. Smart meters can send detailed information on electricity use to electric utilities. And on another whole level, we can aggregate and analyze “big data” through computer “deep learning technology”³⁰ to discern information about specific individuals and groups;³¹ and the federal government collects and stores all of the daily data flow of the United States internet.³² Understanding the scientific reality of these technologies is essential for courts and society to develop new, coherent, reality-based privacy doctrines. New “deep learning” computer technology expands these capabilities exponentially.³³ Basing constitutional doctrine on whether a particular technology is available in the store today instead of on scientific reality is not the kind of reasoned, science-based lawmaking the Founders intended for our nation.

We justifiably expect our courts to rationally decide cases involving advanced technologies.³⁴ Worryingly, the open, unapologetic rejection of science in favor of belief is common in many areas of national concern and even in some opinions of Supreme Court justices that openly choose belief over the laws of science and belief over reasoning based on hard, stubborn facts.³⁵ For the founding fathers, scientific illiteracy and use of belief instead of scientific laws would be a return to medieval thinking and a profound threat to progress and republican democracy.³⁶ In that light, we need to

²⁸ *Kyllo*, 533 U.S. at 36-37.

²⁹ Faigman, *Judges as Amateur Scientists*, *supra* note 14, at 1207.

³⁰ *See, e.g.* Yann LeCun et al, *Deep Learning*, 521 *NATURE* 436-444 (2015).

³¹ For example, several years ago, Target, by analyzing customer purchasing patterns can detect that a woman is pregnant before she might even know. Data-mining technology is now much more sophisticated. *See* Kashmir Hill, *How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did*, *FORBES* (Feb. 16, 2012), <http://www.forbes.com/sites/kashmirhill/2012/02/16/how-target-figured-out-a-teen-girl-was-pregnant-before-her-father-did/>.

³² *See, e.g.*, *NSA Slides Explain the PRISM Data-Collection Program*, *POLITICS* (June 6, 2013), <http://www.washingtonpost.com/wp-srv/special/politics/prism-collection-documents>.

³³ *See, e.g.*, Cade Mtez, *Microsoft Neural Net Shows Deep Learning Can Get Way Deeper*, *WIRED* (Jan. 11, 2016), <http://www.wired.com/2016/01/microsoft-neural-net-shows-deep-learning-can-get-way-deeper/>.

³⁴ *See generally* *Ass’n for Molecular Biology v. Myriad Genetics, Inc.*, 133 S.Ct. 2107 (2013).

³⁵ *See generally id.* at 2120.

³⁶ *See* COHEN, *supra* note 15, at 235.

decide whether the Constitution is fundamentally arbitrary or is, at its core, based on reason and knowledge.

My interest in this topic was triggered almost a decade ago by Justice Scalia's remarks during an oral argument, remarks that revealed his fundamental misunderstanding of the relevant science and his view that scientific facts are not relevant to legal interpretation.³⁷ In that case, *Massachusetts v. EPA*, the relationship between law and science was central to whether the Clean Air Act empowered EPA to regulate greenhouse gas emissions from motor vehicles.³⁸ Lurking just below the surface was the unspoken question of whether the Constitution requires the law (including court decisions) to be consistent with the laws of science.

Here is the exchange during oral arguments between Justice Scalia and Massachusetts Attorney General Milkey:

JUSTICE SCALIA: Mr. Milkey [Massachusetts Attorney General] . . . To be sure, carbon dioxide is a pollutant, and it can be an air pollutant . . . But I always thought an air pollutant was something different from a stratospheric pollutant, and your claim here is not that the pollution of what we normally call "air" is endangering health . . . your assertion is that after the pollutant leaves the air and goes up into the stratosphere it is contributing to global warming.

MR. MILKEY: Respectfully, Your Honor, it is not the stratosphere. It's the troposphere.

JUSTICE SCALIA: Troposphere, whatever. I told you before I'm not a scientist.

(Laughter.)

JUSTICE SCALIA: That's why I don't want to have to deal with global warming, to tell you the truth.³⁹

It was disquieting that despite Milkey's correction and the undisputed science in the Court's record that carbon dioxide is primarily concentrated in the troposphere, although a small amount of carbon dioxide can drift up to the lower stratosphere,⁴⁰ Justice Scalia's dissenting opinion persisted with his

³⁷ Transcript of Oral Argument at 22-23, *Massachusetts v. EPA*, 549 U.S. 497 (2007) (No. 05-1120), http://www.supremecourt.gov/oral_arguments/argument_transcripts/05-1120.pdf.

³⁸ See generally *Massachusetts v. EPA*, 549 U.S. 497 (2007).

³⁹ Transcript of Oral Argument, *supra* note 37, at 23.

⁴⁰ As stated in a letter from Gary S. Guzy in the Office of General Counsel of the U.S. Environmental Protection Agency to the Honorable David M. McIntosh, the Chairman of the Subcommittee on National Economic Growth, Natural Resources and Regulatory Affairs:

First, your question appears to be premised on the proposition that the troposphere does not include the air at ground level, to which people ordinarily have access. It is our understanding, however, that the troposphere extends from the earth's

error (a dissenting opinion joined by three other Justices, including Chief Justice Roberts); this error was necessary for their conclusion that EPA did not have jurisdiction over greenhouse gases.⁴¹ According to the dissent:

... regulating the buildup of CO₂ and other greenhouse gases in the upper reaches of the atmosphere,⁴² which is alleged to be causing global climate change, is not akin to regulating the concentration of some substance that is *polluting the air*.⁴³

For those of you who are not atmospheric scientists, the atmosphere is composed of a lower level, called the troposphere, where people live and virtually all weather occurs.⁴⁴ The stratosphere is just above the troposphere, and between the two is a boundary area, the tropopause, which is the upper boundary of most weather.⁴⁵ Above the stratosphere are other layers, and beyond them is the vacuum of outer space.⁴⁶ Carbon dioxide and other greenhouse gases spread through the atmosphere near the earth's surface, the

surface up to a boundary layer some miles overhead that demarcates the lower reaches of the stratosphere (the "tropopause"). For example, a standard dictionary definition of the "troposphere" is: "[t]he lowest atmospheric region between the earth's surface and the tropopause." Webster's II New Riverside Dictionary. As you note, global warming is largely attributed to elevated levels of greenhouse gases in the troposphere.

Second, EPA currently regulates under Title I substances that are emitted and/or transported through parts of the troposphere above the height to which the public generally has access. For example, humans generally do not have access to the area immediately surrounding the top of tall smoke stacks. Nor do people generally have access to the altitudes through which air pollutants travel as they mix and move to areas downwind.

Joint Appendix-Letter from Gary Guzy to D. McIntosh at 71-72, *Massachusetts v. EPA*, 549 U.S. 497 (2007) (No. 05-1120), 2006 WL 2569818 (Aug. 30, 2006).

⁴¹ *Massachusetts*, 549 U.S. at 560.

⁴² See EPA, PUB. NO. EPA-456/K-07-001, THE PLAIN ENGLISH GUIDE TO THE CLEAN AIR ACT 1 (2007), <https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf>. This refers to a statement by the EPA, which Justice Scalia quoted on the same page: "CO₂, by contrast [to pollutants 'near the surface of the earth'], is fairly consistent throughout the world's atmosphere up to approximately the lower stratosphere." *Massachusetts*, 549 U.S. at 559 (quoting Control of Emissions From New Highway Vehicles and Engines, 68 Fed. Reg. 52922, 52927 (Sept. 8, 2003) (notice of denial of petition for rulemaking)). The statement by EPA is itself inaccurate since the EPA regulates a number of pollutants that exist at levels up to the lower stratosphere and even higher, such as SO₂ and stratospheric ozone depleting substances. See EPA, PUB. NO. EPA-456/K-07-001, THE PLAIN ENGLISH GUIDE TO THE CLEAN AIR ACT 18 (2007), <https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf>.

⁴³ *Massachusetts*, 549 U.S. at 559 (emphasis in original).

⁴⁴ National Oceanic & Atmospheric Administration (NOAA) National Weather Service, *Layers of the Atmosphere*, JETSTREAM, <http://www.srh.noaa.gov/jetstream/atmos/layers.htm> (last visited Sept. 24, 2015).

⁴⁵ *Id.*

⁴⁶ *Id.*

troposphere, where their concentrations are measured.⁴⁷ It is in the troposphere where carbon dioxide, and other greenhouse gases trap heat, thus warming the earth and changing global climate.⁴⁸ The four dissenting justices of the Supreme Court, including Chief Justice Roberts, rejected these scientific facts to reach their legal conclusion.⁴⁹

Science fared poorly in another issue in the case: whether the plaintiffs had standing to complain about the EPA's refusal to initiate rulemaking for rules that would regulate greenhouse gas emissions from motor vehicles under the Clean Air Act.⁵⁰ In his dissent, Chief Justice Roberts mischaracterized the facts and science of sea-level rise due to global warming to make it appear that the problem was not happening today, but was only a speculative future concern.⁵¹ Chief Justice Roberts rejected as conclusory the uncontested affidavits in the record that Massachusetts was already losing its own coastal land due to sea-level rise,⁵² and dismissed Massachusetts' concerns about the future as "pure conjecture," and based on too long a timeline.⁵³ Chief Justice Roberts ignored that the oceans have already expanded as they have warmed over the past century, and are steadily expanding as the oceans continue to warm.⁵⁴ As the oceans expand, sea level rises, consuming coastal land.⁵⁵ Fundamentally, he, and the three justices who joined his dissent, ignored the elementary science of thermal expansion⁵⁶: "water expands as it warms up . . . causing sea levels to rise."⁵⁷

⁴⁷ *Carbon Cycle Science*, NOAA EARTH SYS. RES. LABORATORY, <http://www.esrl.noaa.gov/research/themes/carbon/> (last visited October 11, 2015). NOAA's ClimateTracker Observing System collected more than 36,000 daily samples from 81 ground-based sites around the world. See Global Greenhouse Gas Reference Network, *CarbonTracker*, EARTH SYS. RES. LABORATORY, <http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/> (last visited October 11, 2015). NOAA also uses aircraft to collect air samples throughout the troposphere at altitudes up to 43,555 feet (the boundary with the stratosphere). See NOAA, Global Greenhouse Gas Reference Network, *Aircraft Program*, <http://www.esrl.noaa.gov/gmd/ccgg/aircraft/> (last visited October 11, 2015).

⁴⁸ NOAA, *Layers of the Atmosphere*, *supra* note 44.

⁴⁹ *Massachusetts v. EPA*, 549 U.S. 497, 559 (2007).

⁵⁰ *Id.* at 497.

⁵¹ *Id.* at 541-42.

⁵² Robin Kundis Craig, *Supreme Court News*, ADMIN. & REG. L. NEWS, Summer 2007, at 21-22 (Chief Justice Roberts dismissed the "uncontested testimony from an expert whose life's work is to measure loss of coastal land to the sea in that state.").

⁵³ *Massachusetts*, 549 U.S. at 541-42.

⁵⁴ *Id.* at 522-23.

⁵⁵ *Id.* at 522 ("These rising seas have already begun to swallow Massachusetts' coastal land . . . The severity of that injury will only increase over the course of the next century: If sea levels continue to rise as predicted, one Massachusetts official believes that a significant fraction of coastal property will be . . . lost . . .") (internal citations omitted).

⁵⁶ See generally University Corporation for Atmospheric Research, Center for Science Education, *Rising Sea Level*, <http://scied.ucar.edu/longcontent/rising-sea-level> (last visited Jan. 18, 2016).

⁵⁷ John Walsh et al., *Ch. 2: Our Changing Climate*, in CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 44-45 (Jerry M. Melillo et al. eds., U.S. Global Change Research Program 2014), <http://nca2014.globalchange.gov/eport/>

Are these examples of ideology or belief conflicting with hard, stubborn fact? Did the dissenters not listen to the explanation? Or not understand it? Or simply not care to become informed? Are these opinions examples of “scientific illiteracy cast[ing] knowledge into the shadows . . .”?⁵⁸

Six years later, in a 2012 commencement colloquy at Rensselaer Polytechnic Institute (RPI), Justice Scalia reaffirmed his error in *Massachusetts v. EPA* and insisted that his lack of scientific literacy was not relevant to his judicial role.⁵⁹ Shirley Jackson, a physicist and president of RPI, led the colloquy by asking Justice Scalia why he dissented in *Massachusetts v. EPA*.⁶⁰ Justice Scalia answered:

I don’t do science. I do law . . . The issue [in *Massachusetts v. EPA*] was simply whether carbon was an environmental pollutant or not . . . I did not think that it was ever regarded as that. It is not the atmospheric protection agency, it’s the environmental protection agency, and it has always been thought to have the authority only to control the environment and not outer space. That was the basis for my dissent. It was not a scientific basis but simply . . . a legal point⁶¹

RPI President Jackson then asked: “[W]hat would you say are the challenges for the court’s in dealing with complex scientific issues you know such as global warming?”

Scalia: We don’t deal with that stuff.

Jackson: But the cases come to you.

Scalia: Well but they’re not put in a scientific framework. They’re put in a legal framework . . . The areas where we have to figure out science—the major area is patent and copyright, intellectual property . . . And that does require judges to figure out a lot of technological and scientific matters that they have no natural background for and that’s hard; those cases are very hard⁶²

Just a year later, in 2013, Justice Scalia had the opportunity to “figure out” science in a patent case when the Supreme Court unanimously ruled that a gene, a naturally occurring DNA segment, was not patentable because it is “a

our-changingclimtae/introduction (“Since the late 1800s, tide gauges throughout the world have shown that global sea level has risen by about 8 inches . . . Since 1992, the rate of global sea level rise . . . has been roughly twice the rate observed over the last century . . . Ocean waters will . . . continue to warm and sea level will continue to rise for many centuries at rates equal to or higher than that of the current century.”).

⁵⁸ Faigman, *Judges as Amateur Scientists*, *supra* note 14, at 1207.

⁵⁹ Justice Antonin Scalia, *President’s Commencement Colloquy at Rensselaer Polytechnic Institute*, YouTube (May 25, 2012), <https://www.youtube.com/watch?v=Pr40kbqW03k>.

⁶⁰ *Id.*

⁶¹ *Id.*

⁶² *Id.*

product of nature.”⁶³ Justice Scalia agreed with the result but found it necessary to disassociate himself from one aspect of the opinion—the Court’s description of the science of molecular biology.⁶⁴ Concurring in part and concurring in the judgment, he wrote:

I join the judgment of the Court, and all of its opinion except [those parts] . . . of the opinion going into fine details of molecular biology. I am unable to affirm those details on my own knowledge or even my own belief . . . (emphasis added).⁶⁵

What did Justice Scalia mean when he dissociated himself from modern science because he could not affirm the details on the basis of his own belief? Is belief relevant? Is this a modern example of science’s long history of being filtered (or rejected) by the lens of dogmatic belief, be it political, religious, or ideological? Conceptually, how different is this from the religious condemnation of Cotton Mather in 1721 because he wanted to inoculate the people of Boston in response to a smallpox epidemic?⁶⁶ Or different from the politicized science in the Soviet Union, which prompted loyal scientists to proclaim that wheat could spontaneously morph into rye?⁶⁷ This belief became scientific dogma that controlled Soviet agriculture.⁶⁸ The result: mass starvation.⁶⁹

The Founders had a different vision. They wanted our new government to reflect Newton’s excellence. They gave us a heritage characterized by “[t]he open mind, the reliance on example and persuasion rather than on authority . . .”⁷⁰ and on the tradition of reasoned science begun with Isaac Newton’s 1687 revolutionary treatise, *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*), commonly referred to simply as *Principia*.⁷¹ The English political philosopher, John Locke, whose *Two Treatises on Government* set forth the political philosophy that most influenced the Founders, was a good friend of and deeply influenced by Isaac Newton.⁷² All of the Founders were products of the

⁶³ *Ass’n for Molecular Biology v. Myriad Genetics, Inc.* 133 S. Ct. 2107, 2111 (2013).

⁶⁴ *Id.* at 2120.

⁶⁵ *Id.* (Scalia, J., concurring in part, concurring in the judgment).

⁶⁶ See TONY WILLIAMS, *THE POX AND THE COVENANT: MATHER, FRANKLIN, AND THE EPIDEMIC THAT CHANGED AMERICA’S DESTINY* 89-96 (2010).

⁶⁷ TIMOTHY FERRIS, *THE SCIENCE OF LIBERTY* 209 (1st ed. 2010).

⁶⁸ *Id.*

⁶⁹ *Id.*

⁷⁰ J. ROBERT OPPENHEIMER, *THE OPEN MIND* 115 (1955).

⁷¹ FERRIS, *supra* note 67, at 58. Newton’s laws still hold true, except for when matter travels are velocities approaching the speed of light, when Einstein’s Laws of Special and General Relativity modify Newton’s laws. See James Schombert, *Relativity*, <http://abyss.Uoregon.edu/~js/ast122/lectures/lec20.html>.

⁷² FERRIS, *supra* note 67, at 61; COHEN, *supra* note 15, at 59-60 (“Locke was the first philosopher (in our modern sense of the word) to become a Newtonian”).

Newtonian scientific revolution.⁷³ Newton's impact was best captured by Alexander Pope, who wrote in 1727 on the death of Issac Newton:

Nature and Nature's laws lay hid in the night.
God said, Let Newton be, and all was light.⁷⁴

The founding fathers, whether university taught or self-educated, were courageously open-minded and fact-based, deeply influenced by the ideals, concepts, principles, and laws of science of Newton and others in physics, life sciences, and medicine.⁷⁵ The founders, especially Benjamin Franklin, John Adams, Thomas Jefferson and James Madison, were profoundly forward thinking people who strongly rejected superstition and the deadening doctrines from the past, "brand[ing] as cowardly the idea that the human mind is incapable of further advances."⁷⁶ As Thomas Jefferson wrote, superstition and the narrow religious and political thinking of the past was:

precisely the doctrine which present despots of the earth are inculcating, ... [the idea] "that it is not probable that any thing better will be discovered than was known to our fathers" . . . [Are we] to look backwards then and not forwards for the improvement of science, and find it amidst feudal barbarians and the fires of spiral-fields. But thank heaven that the American mind is already too much opened, to listen to these impostures⁷⁷

For Jefferson, it was his generation, so committed to science, reason, and liberty, that had "arrested [the] . . . despotism which had overwhelmed the world for thousands & thousands of years."⁷⁸ However, he worried that it would be "a monstrous phaenomenon" if future generations retreated from science and freedom, a retreat that he could not imagine possible "in this age and country."⁷⁹

Who were some of these courageous thought leaders? One of the leading minds was Benjamin Franklin, editor of the Declaration of Independence and a great self-taught scientist—the only American elected to both Royal Academy and French Academy of Science.⁸⁰ His theory of electricity still stands and underlies the modern equations for electricity and magnetism.⁸¹ John Adams (President, statesman, and editor of the Declaration of

⁷³ FERRIS, *supra* note 67 at 56-57.

⁷⁴ *Sir Isaac Newton*, WESTMINSTER ABBEY, <http://www.westminster-abbey.org/our-history/people/sir-isaac-newton> (last visited October 24, 2015).

⁷⁵ See generally COHEN, *supra* note 15, at 20.

⁷⁶ *Id.*; *Letter from Thomas Jefferson to William G. Munford*, FOUNDERS ONLINE (June 18, 1799), <http://founders.archives.gov/documents/Jefferson/01-31-02-0112>.

⁷⁷ *Letter from Thomas Jefferson to William G. Munford*, FOUNDERS ONLINE (June 18, 1799), <http://founders.archives.gov/documents/Jefferson/01-31-02-0112>.

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ COHEN, *supra* note 15, at 14.

⁸¹ *Id.* at 142.

Independence) studied Newtonian physics at Harvard and cited to Newton's laws of motion in an argument about the form of government and national legislation.⁸² His commitment to science is demonstrated by his central role in founding the American Academy of Arts and Sciences as rival to Franklin's American Philosophical Society⁸³ and at Adams' urging, the Massachusetts Constitution contained a provision obliging the state to provide public support for science.⁸⁴

Thomas Jefferson (President, scientist, statesman, president of the American Philosophical Society,⁸⁵ the scientist behind the Lewis and Clark expedition, and drafter of the Declaration of Independence) had a life-long passion for science.⁸⁶ He is probably the only U.S. president to have actually read Newton's *Principia* and apply it in practice.⁸⁷ For example, he used Newton's calculus and ideas to design an improved plow.⁸⁸ As a member of the first cabinet under President Washington, Jefferson used Newton's concept of mass and mathematics to propose a standard for United States weights and measures.⁸⁹ *Principia* was one of his favorite books and a portrait of Newton was most prominently placed in his Monticello gallery of the greatest minds in history.⁹⁰

James Madison (President and primary drafter of the Constitution) studied Newtonian physics at Princeton and later in life wrote on the relationship between the natural world and world of human affairs.⁹¹ Finally, George Washington (President, General, Surveyor, and Farmer) was technically skilled in mathematics and geometry and was an amateur agricultural scientist.⁹²

Newton's influence was wide-spread when our nation was formed and was so well known that Thomas Jefferson could refer to "rule of philosophy" concepts of cause and effect and quote from Newton's "Rules for Natural Philosophy" without even mentioning Newton and educated people would

⁸² COHEN, *supra* note 15, at 20.

⁸³ *Id.* at 196.

⁸⁴ TOM SCHACHMAN, GENTLEMEN SCIENTISTS AND REVOLUTIONARIES: THE FOUNDING FATHERS IN THE AGE OF ENLIGHTENMENT xi (2014). Chapter V section II of the Constitution of the Commonwealth of Massachusetts states: "Wisdom, and knowledge, as well as virtue, diffused generally among the body of the people, being necessary for the preservation of their rights and liberties; and as these depend on spreading the opportunities and advantages of education . . . it shall be the duty of legislatures and magistrates . . . to cherish the interests of literature and the sciences, and . . . [to promote] agriculture, arts, sciences, commerce, trades, manufactures, and a natural history of the country . . ." MASS. CONST. ch. V, sec. II.

⁸⁵ JONATHAN LYONS, THE SOCIETY FOR USEFUL KNOWLEDGE: HOW BENJAMIN FRANKLIN AND FRIENDS BROUGHT THE ENLIGHTENMENT TO AMERICA 6 (2013) (discussing how Jefferson is reputed to have greatly preferred his 18 years as president of the American Philosophical Society to being President of the United States).

⁸⁶ COHEN, *supra* note 15, at 62.

⁸⁷ *Id.* at 76.

⁸⁸ *Id.* at 101.

⁸⁹ *Id.* at 102.

⁹⁰ *Id.* at 20.

⁹¹ *Id.*

⁹² SCHACHMAN, *supra* note 84, at 7-8.

immediately recognize the reference.⁹³ For deists like Thomas Jefferson, Benjamin Franklin and others, Newtonian thought was a powerful counterbalance in the United States to the superstition and religious fundamentalism central to much religious practice in the colonies.⁹⁴ Enlightenment “reason” also counter-balanced the influential and radical mid-18th century French philosopher, Jean Rousseau, who argued that science corrupts and espoused fact-free thought, a view ultimately, and horribly, adopted by Robespierre.⁹⁵

The founding fathers’ contemporaries routinely used Newton’s laws as powerful metaphors in political thought and rhetoric. For instance, a close friend of Benjamin Franklin, James Wilson, in his *Lectures on Laws* (1790-91) explained that the failure of government to be effective was due to the inertia in public bodies in a direct analogy to Newton’s first law of motion, that a body at rest will stay at rest unless acted upon by a force.⁹⁶ Thomas Pownall, a friend of Franklin and a prominent colonial figure who had studied Newton’s science while a student at Cambridge, was a strong early advocate that England should give the colonies more political rights. In his two most important books, *Principles of Polity* (1752) and *Administration of the Colonies* (1764), he used Newton’s laws of physics and astronomy in his theory of government and of the organization of colonies, explaining that “North-America is become a primary planet in the system of the world,” a reference to Newton’s laws of planetary motion.⁹⁷

The Founders’ scientific outlook and devotion to reason are reflected in our founding documents. According to John Adams, Thomas Jefferson was selected to draft the Declaration of Independence because he “wrote 10 times better”⁹⁸ than Adams and because of the delegates high regard for his “reputation for literature, science, and a happy talent of composition.”⁹⁹ Benjamin Franklin and John Adams edited Jefferson’s draft and then sent it to the Delegates of the Continental Congress in Philadelphia for approval.¹⁰⁰ Despite 2 ½ days of intense review and edits, Jefferson’s introductory language remained:

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the **Laws of Nature** and of **Nature's God** entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

⁹³ COHEN, *supra* note 15, at 110.

⁹⁴ SCHAETMAN, *supra* note 84, at xii-xiii.

⁹⁵ FERRIS, *supra* note 67, at 120.

⁹⁶ COHEN, *supra* note 15, at 36-37.

⁹⁷ *Id.* at 39-41.

⁹⁸ *Id.* at 109.

⁹⁹ *Id.*

¹⁰⁰ *Id.* at 110.

We hold these **truths to be self-evident**, that all men are **created equal**, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness . . . (emphasis added).¹⁰¹

Many historians have characterized the Declaration of Independence as a philosophical “natural law” document because of its reference to the “Laws of Nature” and “Nature’s God.”¹⁰² This mistake is understandable since the concept of “natural law” was part of political thought and discourse in the 17th and 18th centuries.¹⁰³ It was central to John Locke’s political philosophy that people have a natural right to life, liberty and property, which they secure by contracting as a community to form a government.¹⁰⁴

Natural law was most powerfully advocated by political philosopher Hugo Grotius in the first half of the 17th century: that human conduct was subject to a universal and supreme moral law.¹⁰⁵ He applied his natural law theory to the problem of war, out of which emerged the concept of sovereign nations and international law, and the 1648 Peace of Westphalia, which ended the Thirty Years War that had engulfed nearly all of Europe.¹⁰⁶ As the central idea for ending one of the bloodiest wars in history, it is not surprising that “natural law” was “*the* dominant paradigm in ethics, politics and law” until the late 18th Century.¹⁰⁷

However, a natural law analysis is not particularly useful in understanding the Declaration of Independence, or anything else, because natural law has “almost unlimited possibilities of interpretation,” with no objective definition or even commonly understood usage.¹⁰⁸ In general, however, “[i]n Jefferson’s day, and for centuries earlier, ‘natural law’ meant a supreme moral law known through human reason.”¹⁰⁹ Natural law adherents use it to refer to a higher, more fundamental law than the laws of science or the laws of humankind.¹¹⁰

¹⁰¹ THE DECLARATION OF INDEPENDENCE paras. 1-2 (U.S. 1776).

¹⁰² COHEN, *supra* note 15, at 110-11.

¹⁰³ *Id.* at 111-112.

¹⁰⁴ Alex Tuckness, *Locke’s Political Philosophy*, STAN. ENCYCLOPEDIA OF PHIL., Winter 2012, at 1.

¹⁰⁵ Jon Miller, *Hugo Grotius*, STAN. ENCYCLOPEDIA OF PHIL., Spring 2014, at 12.

¹⁰⁶ MARK W. JANIS, AN INTRODUCTION TO INTERNATIONAL LAW 164 (4th ed. 1999).

¹⁰⁷ *Id.* (quoting H. GROTIUS, DE JURE BELLICI AC PACIS LIBRI TRES 20 (Kelsey trans. 1913) (“Throughout the Christian world I observed a lack of restraint in relation to war, such as even barbarous races should be ashamed of; I observed that men rush to arms for slight causes, or no cause at all, and that when arms have once been taken up there is no longer any respect for law, divine or human; it is as if, in accordance with a general decree, frenzy had openly been let loose for the committing of all crimes.”)).

¹⁰⁸ JANIS, *supra* note 106, at 162. One study has identified 120 different meanings of natural law. See Paul Foriers and Chaim Perelman, *Natural Law and Natural Rights*, in 3 DICTIONARY OF THE HISTORY OF IDEAS 13-27 (Philip P. Wiener, ed. 1973).

¹⁰⁹ COHEN, *supra* note 15, at 111.

¹¹⁰ Mark Murphy, *The Natural Law Tradition in Ethics*, STAN. ENCYCLOPEDIA OF PHIL., Winter 2011, § 4.5, <http://plato.stanford.edu/archives/win2011/entries/natural-law-ethics/> (“The paradigmatic natural law view holds that (1) the natural law is given by God; (2)

But, to the Founders, the term “Laws of Nature” referred to scientific laws not “natural law.”¹¹¹ The Declaration’s powerful introduction does not invoke natural law and does not refer to the then popular law of nations (now called international law), nor does it appeal to the Holy Bible or to the Christian God of revelation or salvation.¹¹² Instead, Jefferson, a deist, invokes the “Laws of Nature” and “Natures’ God,” ideas derived from the Newtonian thought that underlay the Age of Reason. Jefferson, a lawyer and careful wordsmith, knew the gaping difference between the “laws of nature” and “natural law.” When he used the phrase “laws of nature,” he was referring to science.¹¹³

The phrase “laws of nature,” was first used by the early 17th century French mathematician Rene Descartes, and was used by others, such as political philosopher, Thomas Hobbes, as a term referring to the “fundamental principles of science.”¹¹⁴ It became a nearly universally used term for science as a result of Newton’s *Principia* (1687), which established Newton’s “laws of motion” as the “laws of nature.”¹¹⁵ Although Newton used the term “laws of motion” in *Principia*, when he wrote his 1704 treatise, *Opticks*, he adopted the phrase “laws of nature.”¹¹⁶ In the 1727 preface by Roger Cotes to the second edition (1727) and subsequent editions of *Principia*, Cotes explained to the general public that in *Principia*, Newton described the “laws of nature” which were “the true principles of physics and the law of natural things.”¹¹⁷ Thus, by the mid-18th century, the phrase “laws of nature” was familiar to educated men in America, and connoted Newton’s science. For instance, in 1754 John Adams, a student at Harvard College, noted in his diary: “Sir Isaac Newton’s three laws of nature¹¹⁸ proved and illustrated.”¹¹⁹ Similarly, Jefferson’s education, his books read and owned, and his thinking all used the phrase the “laws of nature” in the sense that we use the phrase “laws of science” today.¹²⁰

The Declaration of Independence also announces “self-evident” truths.¹²¹ What did Jefferson mean when he wrote that the truths were “self-evident?”

it is naturally authoritative over all human beings; and (3) it is naturally knowable by all human beings.”).

¹¹¹ COHEN, *supra* note 15, at 110.

¹¹² *Id.*

¹¹³ *Id.* at 113.

¹¹⁴ *Id.* at 116-17.

¹¹⁵ *Id.* at 116.

¹¹⁶ *Id.* at 116-17. Since ancient times, understanding Motion was always considered fundamental, as Aristotle wrote: “to be ignorant of motion is to be ignorant of nature.” *Id.*

¹¹⁷ COHEN, *supra* note 15, at 115.

¹¹⁸ This refers to Newton’s three laws of motion: the law of inertia (a body at rest at rest or in motion will tend to stay at rest or in motion unless acted upon by a force); the law of forces (Force = Mass x Acceleration); and the law that for every action there is an equal and opposite reaction. *Newton’s Laws of Motion*, NAT’L AERONAUTICS & SPACE ADMIN., <https://www.grc.nasa.gov/www/k-12/airplane/newton.html> (last visited Jan. 18, 2016).

¹¹⁹ COHEN, *supra* note 15, at 120.

¹²⁰ *Id.*

¹²¹ THE DECLARATION OF INDEPENDENCE ¶ 2 (U.S. 1776).

The phrase “self-evident” comes from Greek geometry. The Founders all studied Euclid’s geometry, which uses “self-evident” as meaning an axiom or incontestable statement.¹²² This term, “self-evident,” was central to the 18th century definition of science contained in John Harris’ 1704 *Lexicon Technicum* that “Science is Knowledge founded upon, or acquired by clear, certain, and self-evident principles.”¹²³ Newton’s laws of motion are axioms: foundational, true understandings of nature.¹²⁴ For instance, inertia: a body at rest will stay at rest until acted upon by a force. In the Federalist Papers, Alexander Hamilton wrote of the “near-parallelism between the self-evident axioms characteristic of mathematics and their counterparts in political science.”¹²⁵ So, we must understand Jefferson’s “self-evident truths” as axioms of the Declaration of Independence.¹²⁶ The Declaration’s idea that all people have equal human rights is an axiomatic statement of the universal validity of scientific facts.¹²⁷ Thus far from being relative truths, the Declaration of Independence announces that scientific facts and laws are everyone’s truth, regardless of culture.

The very structure of the Constitution also reflects the influence of Newtonian ideas. In 1787, while in England representing the United States, John Adams published *A Defence of the Constitution of the United States*, in anticipation of the Constitutional Convention that abandoned the Articles of Confederation.¹²⁸ In this major work, Adams analyzed virtually every system of government then known in world history, seeking a scientific understanding of effective government constitutions and legal structures.¹²⁹ He summarized his goal as follows:

The United States of America have exhibited, perhaps, the first example of governments erected on the simple principles of nature and if men are now sufficiently enlightened to disabuse themselves of artifice, imposture, hypocrisy, and superstition, they will consider this event as an era in their history.¹³⁰

Adams wanted the world to know that the drafters of the Constitution did not have:

interviews with the gods, or were in any degree under the inspiration of heaven . . . it will for ever be acknowledged that these governments were contrived merely by the use of reason and the senses . . . As . . . Godfrey invented his quadrant, and

¹²² COHEN, *supra* note 15, at 122.

¹²³ *Id.* at 122-23.

¹²⁴ *Id.* at 123-24.

¹²⁵ *Id.* at 131.

¹²⁶ *Id.* at 133.

¹²⁷ *See id.* at 133.

¹²⁸ SCHATMAN, *supra* note 84, at 158.

¹²⁹ *Id.*

¹³⁰ JOHN ADAMS, A DEFENCE OF THE CONSTITUTIONS OF THE GOVERNMENT OF THE UNITED STATES OF AMERICA, at xvii (1787).

Rittenhouse his planetarium; as Boylston practised inoculation, and Franklin electricity . . . and Jefferson [refuted the European theory of American degeneracy] . . . — neither the people, nor their conventions, committees, or sub-committees, considered legislation in any other light than ordinary arts and sciences . . . Thirteen governments thus founded on the natural authority of the people alone, without a pretence of miracle or mystery . . .¹³¹

Adams viewed the designing of the Constitution as the scientific problem of how a nation should be governed.¹³² He carefully studied the history of earlier structures: monarchies, oligarchies, and even attempts at democratic government.¹³³ From this examination he developed a theory of democratic government that had a scientific core: the idea of balance of power.¹³⁴ Influenced by his college study of Newton's explanation of how gravity and the laws of motion dictate the movement of the planets, Adams argued for a government stabilized by a balance of power, a concept scientific in nature.¹³⁵ Adams did not use Newton's mathematics or laws in a precise way, but as metaphor: the federalist system reflects the orbit of small bodies about the federal government, whose gravitational force keeps the system in constant motion, yet stable in structure.¹³⁶ The Supremacy Clause, "This Constitution, and the Laws of the United States . . . shall be the Supreme Law of the Land . . ." ¹³⁷ reflects this concept.

Science also infused the details of Adams' analysis. For example, he argued that giving executive powers to the legislature "will corrupt the legislature as necessarily as rust corrupts iron, or as arsenic poisons the human body."¹³⁸ The Constitution reflects these concerns by erecting a structure that separates the power of the three great branches of government,¹³⁹ the Legislative (Congress), the Executive (the President) and the Judicial (the Courts), and is recognized and enforced as a foundational constitutional doctrine inherent in the structure of the Constitution.¹⁴⁰ And,

¹³¹ ADAMS, *supra* note 130, at xvii-xix.

¹³² SCHACTMAN, *supra* note 84, at 158.

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ *Id.*

¹³⁶ *Id.* Adams' "[d]efence consciously drew on what laymen believed that Newton had achieved, the promulgation of a set of 'laws' that perfectly explained and properly governed the physical behavior of the universe." *Id.* at 158-59.

¹³⁷ U.S. CONST. art. VI, § 2.

¹³⁸ SCHACTMAN, *supra* note 84, at 159.

¹³⁹ The political power principle of separation of powers did not come from Newton. COHEN, *supra* note 15, at 246. The idea of a three-branch government with separation of powers was first proposed by Montesquieu, a French Enlightenment political philosopher, in 1748. *Id.* at 246. However, Newtonian metaphors were used as political rhetoric in debates over ratifying the Constitution. *Id.*

¹⁴⁰ The Supreme Court has repeatedly "reaffirmed the importance in our constitutional scheme of the separation of governmental powers into the three coordinate branches." *Morrison v. Olson*, 487 U.S. 654, 693 (1988). This "system of separated powers and checks and balances established in the Constitution was regarded by the Framers as 'a self-executing

once the Constitution was drafted, both James Madison and Alexander Hamilton, who viewed science as the highest expression of human reason, employed a variety of scientific metaphors in their Federalist Papers essays advocating for ratification.¹⁴¹

Underlying the Constitution was the founders' deep commitment to science and reason, and to the rule of law based on science and reason. This commitment was not based on abstract philosophy, but on lessons learned from the use of reason and science that they had faced in their lives. Both Benjamin Franklin and Thomas Jefferson were acutely sensitive to how dangerous the refusal of politicians and religious leaders to accept scientific fact and the politically motivated espousal of false science could be.

Benjamin Franklin observed at least twice in his life that ignoring science or making science subject to religious or political dogma can have tragic consequences. As a teenager in Boston during its smallpox epidemic of 1721, he saw religious leaders and his own brother, James, a newspaper publisher, vigorously oppose efforts of Cotton Mather, a minister and witch-hunter turned scientist, and Dr. Zabdiel Boylston, a Boston surgeon, to promote the use of inoculation to prevent smallpox.¹⁴² The rhetoric was feverish and included death threats against any doctor who performed an inoculation; one issue of James Franklin's *Courant* denounced inoculation as:

an interference in the prerogatives of Jehovah, whose right it was to wound and heal, an attempt to thwart God, who sent the smallpox as a punishment for sins, and whose vengeance would thus be provoked all the more.¹⁴³

When the epidemic subsided, young Benjamin Franklin, who was James' apprentice, studied the results of this unintended citywide inoculation.¹⁴⁴ The data taught him the importance of scientific understanding, experimentation, and close, objective observation.¹⁴⁵ The results: inoculation enormously reduced the risk of death from smallpox and, if used throughout Boston, inoculation could have saved over 400 lives.¹⁴⁶ Seeing this, Franklin became a strong advocate for inoculation when he arrived in Philadelphia after escaping from his apprenticeship to his brother in Boston.¹⁴⁷

safeguard against the encroachment or aggrandizement of one branch at the expense of the other.' We have not hesitated to invalidate provisions of law which violate this principle." *Id.* (quoting *Buckley v. Valeo*, 424 U.S. 1, 122 (1976)).

¹⁴¹ COHEN, *supra* note 15, at 269-70.

¹⁴² WILLIAMS, *supra* note 66, at 102 ("As the printer and editor of the New England Courant, [James Franklin] let loose the dogs of war on . . . Boylston and Cotton Mather . . . special targets for heaps of abuse.").

¹⁴³ SCHACTMAN, *supra* note 84, at 26-27.

¹⁴⁴ *Id.* at 27.

¹⁴⁵ *Id.*

¹⁴⁶ *Id.* (referencing those who were inoculated died at a rate seven times less than the untreated).

¹⁴⁷ *Id.* at 102.

Franklin's second exposure to the dangers of belief trumping science involved one of his inventions, the lightning rod. Most of us know of Ben Franklin's kite experiments with lightning, but many of us do not appreciate that Franklin was a great scientist. His explanation of the nature of electricity was profound and fundamental, and is foundational to our understanding and use of electricity today. His brilliance was recognized in his day, and he was the only American elected to both the Royal Society and the French Academy of Science.¹⁴⁸ We laugh at his kite and key experiment, but it led to the lightning rod, which kept towns and cities from burning down from thunderstorms.¹⁴⁹ Thinking it so important to society, he refused to patent it and introduced it to England when he was living there.¹⁵⁰ But, because he was an American, some in England viewed his scientific insights as inherently inferior.¹⁵¹ As tensions in England with the American colonies mounted, a dispute arose in England as to whether lightning rods should have Franklin's design, a pointed end, or the blunt or round end that some Englishmen promoted.¹⁵² Franklin explained in considerable technical detail to the Royal Academy why a pointed end was scientifically important, if not essential, for effective protection from lightning.¹⁵³ Nevertheless, an insistent English dissenter urged blunt or round ends.¹⁵⁴ In early 1776, the Royal Society accepted Franklin's view over the dissent, and Franklin's science probably would have prevailed, had the recently arrived Declaration of Independence not transformed this technical dispute into a matter of major political consequence.¹⁵⁵ King George III wanted English round or blunt lightning rods to be placed on his palace, so he "asked" the president of Royal Society to retract its conclusion that Franklin's pointed ends were best.¹⁵⁶ The Society's President replied: "His majesty might change laws of the land but could not alter the laws of nature."¹⁵⁷ The King responded by erecting round-end lightning rods on his palace and replacing the Society's President with the leading round end dissenter; shortly thereafter, the Royal Society announced its support of round or blunt ended lightning rods.¹⁵⁸ Benjamin Franklin, ever the scientist and wit, observed at the time that it was only because the King "thought himself and family safe from the thunder of Heaven, that he dared to use his own thunder in destroying his innocent

¹⁴⁸ COHEN, *supra* note 15, at 14.

¹⁴⁹ *Id.* at 290

¹⁵⁰ SCHACTMAN, *supra* note 84, at 58.

¹⁵¹ COHEN, *supra* note 15, at 166.

¹⁵² *Id.*

¹⁵³ *Id.* at 169.

¹⁵⁴ *Id.* at 168.

¹⁵⁵ *Id.* at 169.

¹⁵⁶ *Id.*

¹⁵⁷ COHEN, *supra* note 15, at 169-70.

¹⁵⁸ *Id.* at 170.

subjects.”¹⁵⁹ Soon thereafter, Franklin hastily and secretly fled England to avoid arrest, or worse.¹⁶⁰

Thomas Jefferson also addressed false science in the only book he wrote, *Notes on the State of Virginia* (1785), a rousing defense of American virtue and vigor¹⁶¹ which detailed his refutation of the theory of degeneracy that was then broadly popular in Britain and France.¹⁶² According to that theory, all plants, animals, and humans in the New World (including Benjamin Franklin!) were inferior to those in Europe, and all plants, animals and people from Europe now in America would degenerate into inferior forms.¹⁶³ Degenerationists claimed that “America has not produced . . . one able mathematician, one man of genius in a single art or a single science.”¹⁶⁴ In *Notes on the State of Virginia*, Jefferson systematically described and analyzed an extensive array of carefully observed scientific facts, together with statistics on bones and other evidence he gathered himself and from sources such as American Philosophical Society and the American Society for Useful Knowledge.¹⁶⁵ Jefferson’s evidence overwhelming demonstrated that the theory of degeneracy was wrong in every regard, both factually and theoretically to Jefferson.¹⁶⁶ Europe and America are warmed by the same sun, have similar soil, and that all people and animals “derive their dimensions from the same nutritive juices.”¹⁶⁷

Yet, even this most scientific minded of our Founding Fathers, the man who spent more time at the American Philosophical Society studying newly found fossil bones than on his inauguration as George Washington’s Vice President,¹⁶⁸ that man let bias and personal interest override scientific reality on one crucial matter. Although Jefferson had roundly rejected the theory of degeneracy’s claim that Native Americans were racially inferior to Europeans, he also rejected, in stark contrast to Benjamin Franklin,¹⁶⁹ the essential, fundamental scientific truth that African-Americans are human beings.¹⁷⁰

¹⁵⁹ COHEN, *supra* note 15, at 171.

¹⁶⁰ *Id.*

¹⁶¹ JONATHAN LYONS, *THE SOCIETY FOR USEFUL KNOWLEDGE: HOW BENJAMIN FRANKLIN AND FRIENDS BROUGHT THE ENLIGHTENMENT TO AMERICA* 10 (2013) (“[T]he struggle to create American science and the struggle to create a free and independent America often went hand in hand.”)

¹⁶² SCHACTMAN, *supra* note 84, at 135.

¹⁶³ *Id.* at 136.

¹⁶⁴ *Id.* at 132.

¹⁶⁵ *Id.* at 134.

¹⁶⁶ *Id.* at 136.

¹⁶⁷ *Id.* at 137 (quoting THOMAS JEFFERSON, *NOTES ON THE STATE OF VIRGINIA* (1785)).

¹⁶⁸ COHEN, *supra* note 15, at 291.

¹⁶⁹ Franklin, as a scientist, thought that blacks were not “deficient in natural Understanding” and that their inferior position in society due to the oppressive conditions that defined their lives—the “galling chains, that bind his body, do also fetter his intellectual faculties, and impair the social affections of his heart.” *Id.* at 194-95. To Franklin, even free blacks suffered by being denied “the Advantage of Education.” *Id.* at 194-95. Franklin urged an end to slavery and a program to employ blacks and educate all black children. *Id.*

¹⁷⁰ *See id.* at 298.

Thomas Jefferson ignored this hard fact in his only book despite urgings from Philadelphian Charles Thompson of the American Society for Useful Knowledge that Jefferson was wrong and should delete this from his book, for it “would cause Jefferson no end of trouble.”¹⁷¹ Thus, Jefferson rejected the degeneracy theory in all respects but one—he determined that every person in America (including, explicitly, Native Americans) was fully human but for African-Americans.¹⁷² In *Notes on the State of Virginia*, Jefferson asserted “generalities about African-Americans which were [as unfounded as the theory of degeneracy he demolished¹⁷³ and merely] repeated the kinds of prejudices current among southern plantation owners.”¹⁷⁴ It was only much later that Jefferson acknowledged that his opinion that blacks “are inferior to the whites in the endowments both of body and mind” was just a non-scientific “suspicion.”¹⁷⁵ Yet, it is both ironic and baffling that Jefferson, a slave owner, also condemned all forms of slavery in *Notes on the State of Virginia*.¹⁷⁶ Late in Jefferson’s life he regretted his bias and scientific blindness¹⁷⁷ but did nothing to correct it, and in any event, by then it was far too late for his regret to affect the tragic course of American history.

Whether due to prejudice, economic self-interest, or political ambition, Jefferson, a national leader and leading scientific intellect, gave powerful supposedly “scientific” support to those persons who sought to justify the use of the Constitution to enshrine slavery as a legal institution in America. Jefferson’s prejudiced “science” that African Americans were inherently inferior human beings was foundational to the fatal flaws in the Constitution that allowed slavery to continue. A leader as important and respected as a scientist, Thomas Jefferson might have bent the arc of history if he had accepted African-Americans as fully human in his *Notes on the State of Virginia*. Instead, Jefferson’s ideological science, and his political efforts, led to the 1781 Constitution’s 3/5 person rule for allocating members of the House of Representatives and electoral votes, the structure of the Senate, and other provisions,¹⁷⁸ all of which gave the Southern states the political power to resist any federal attempt to regulate or end slavery.¹⁷⁹ Jefferson’s so-called “science” was ratified by the infamous *Dred Scott* case, which declared that no person of African-American descent, whether free or slave, could be a citizen of the United States.¹⁸⁰ It took a horribly bloody civil war to amend

¹⁷¹ SCHACTMAN, *supra* note 84, at 135.

¹⁷² COHEN, *supra* note 15, at 298.

¹⁷³ *Id.*

¹⁷⁴ *Id.* at 79.

¹⁷⁵ *Id.* at 299.

¹⁷⁶ *Id.* at 299.

¹⁷⁷ *Letter from Thomas Jefferson to Henri Gregoire*, FOUNDERS ONLINE (Feb. 25, 1809), <http://founders.archives.gov/documents/Jefferson/99-01-02-9893> (last update Sept. 29, 2015).

¹⁷⁸ See U.S. CONST. art. IV, § 2, cl. 3 (the return of fugitive slave provision); U.S. CONST. art. V (prohibiting, before 1808, any amendment of the Constitution with respect to the slave trade and per capita taxation of slaves).

¹⁷⁹ GARY WILLS, *NEGRO PRESIDENT: JEFFERSON AND THE SLAVE POWER* 5-6 (2003).

¹⁸⁰ See generally *Dred Scott v. Sandford*, 60 U.S. 393 (1857).

the constitutional definition of “person” to declare African-Americans as citizens and full human beings. But the Civil War did not end the effects of Jefferson’s abuse of science—his idea justified Jim Crow segregation,¹⁸¹ produced continuing constitutional struggle and the structural injustice that haunts our nation today. So, to the extent that the founders let prejudice and economic self-interest blind them to scientific reality, they (particularly Thomas Jefferson) violated their own commitment to scientific reason, and caused a tragedy.

Basic science is still being denied, ignored, or misused throughout our society for ideological, political, economic, or religious reasons, or perhaps due to scientific illiteracy. Mature science is today ignored in a political discourse that is “frequently disconnected from that knowledge,” and “resistance [to that knowledge] . . . is often intense.”¹⁸² Many current presidential candidates and their followers reject the fundamental laws of thermodynamics (that adding energy to a system will make the system warmer) in the area of global warming,¹⁸³ and some even question -once again- the efficacy of childhood vaccination.¹⁸⁴ Many people reject Darwin and evolution in the face of modern molecular biology, which explains in exquisite detail how genetic traits are expressed and passed from one generation to the next.¹⁸⁵ Some people reject geologic science that establishes that the world is billions of years old, not some 6,000 years old, as those people claim as religious truth.¹⁸⁶ So, we must consider, given what we have just learned about the founders’ deep commitment to science and reason, whether our constitution and the laws made under it can be legitimate, and legitimately interpreted, without regard to, or in conflict with, the laws of science.

Of course, the Constitution is silent with respect to how it should be interpreted. It only refers to science and technology two times: when it empowers Congress to “[t]o fix the Standard of weights and measures”¹⁸⁷ and to enact patent and copyright laws “[t]o promote the Progress of Science and the Useful Arts”¹⁸⁸ Neither of these specific clauses, although suggestive

¹⁸¹ See *A Brief History of Jim Crow*, CONSTIT. RIGHTS FOUND., <http://www.crf-usa.org/black-history-month/a-brief-history-of-jim-crow>.

¹⁸² J. Lubchenco & K. Grorud-Culvert, *Making Waves: The Science and Politics of Ocean Protection*, SCIENCEEXPRESS, Oct. 23, 2015, at 382-83.

¹⁸³ See Rebeca Kaplan & Ellen Uchimiya, *Where the 2016 Republican Candidates Stand on Climate Change*, CBS NEWS (Sept. 1, 2015) <http://www.cbsnews.com/news/where-the-2016-republican-candidates-stand-on-climate-change/>.

¹⁸⁴ See Michael E. Miller, *The GOP’s dangerous debate on vaccines and autism*, WASH. POST (Sept. 17, 2015), <https://www.washingtonpost.com/news/morning-mix/wp/2015/09/17/the-gops-dangerous-debate-on-vaccines-and-autism/>.

¹⁸⁵ G. Ledyard Stebbins & Francisco J. Ayala, *The Evolution of Darwinism*, SCIENTIFIC AMERICAN, July 1985, at 72, 81.

¹⁸⁶ Tia Ghose, *4 in 10 Americans Believe God Created Earth 10,000 Years Ago*, LIVESCIENCE (June 5, 2014), 11:46 AM, <http://www.livescience.com/46123-many-americans-creationists.html>.

¹⁸⁷ U.S. CONST. art. I, § 8, cl. 5.

¹⁸⁸ U.S. CONST. art. I, § 8, cl. 8.

of a deep commitment to science and technology, addresses the core question of whether law that overrides science can be constitutional.

There are many theories as to how the Constitution should be interpreted. This article does not attempt to add to or critique any of these theories. Rather, I have attempted to demonstrate that the Founders, as paradigmatic products of the Enlightenment and Age of Reason, so implicitly understood that Constitution would always operate within the laws of science that it never could have occurred to them to even mention it; fact-based reason was like the air they breathed. For instance, the First Amendment religion clauses implicitly require that governmental decisions be based on fact and reality, and not on faith, religion or free-floating belief, which by definition is independent of fact and science.¹⁸⁹

The constitutional principle requiring adherence to the fundamental laws of science is most powerfully captured in the due process clauses of the Fifth and Fourteenth Amendments, which represent a national commitment to reasoned, rational decision-making.¹⁹⁰ We know the constitutional doctrine under both the Due Process Clause and the Equal Protection Clause is that all laws must be rationally related to a legitimate government purpose.¹⁹¹ It has long been true that “if a statute purporting to have been enacted to protect the public health, the public morals or the public safety, has no real or substantial relation to those objects . . . it is the duty of the courts to so adjudge, and thereby give effect to the Constitution.”¹⁹² It is the Due Process Clause that empowers the Supreme Court to invalidate a statute that “is arbitrary, capricious, or unreasonable.”¹⁹³

This simple principle of due process is part of what it means to be governed by a rule of law, one of the fundamental principles inherent in what Lawrence Tribe calls *The Invisible Constitution*.¹⁹⁴ The rule of law is an ancient doctrine, which for the United States can be traced back at least to Magna Carta.¹⁹⁵ The rule of law requires that governmental decisions be based on facts and reality. The rule of law is why our rules of evidence prohibit unscientific evidence¹⁹⁶ and why trial verdicts may not be inconsistent with the laws of science.¹⁹⁷ The rule of law requires judges to take judicial notice of fundamental laws of science and undisputed scientific facts.¹⁹⁸ The Supreme Court long ago established that “Among the things of which judicial notice is taken are . . . things which must happen according to

¹⁸⁹ See, e.g., *Epperson v. Arkansas*, 393 U.S. 97, 107 (1968); *Edwards v. Aguillard*, 482 U.S. 578, 582-83, 592-93 (1987).

¹⁹⁰ U.S. CONST. amend. V; U.S. CONST. amend. XIV.

¹⁹¹ See *New State Ice Co. v. Liebmann*, 285 U.S. 262, 311 (1932).

¹⁹² *Mugler v. Kansas*, 123 U.S. 623, 661 (1887).

¹⁹³ *New State Ice Co.*, 285 U.S. at 285, 302 (Brandeis J., dissenting).

¹⁹⁴ LAWRENCE TRIBE, *THE INVISIBLE CONSTITUTION* 115 (2008).

¹⁹⁵ *Id.* at 13.

¹⁹⁶ See generally *Daubert v. Merrell Dow Pharm.*, 509 U.S. 579, 593-94 (1993).

¹⁹⁷ *Brown v. Piper*, 91 U.S. 37, 42 (1875).

¹⁹⁸ *Id.*

the laws of nature . . . ”¹⁹⁹ The rule of law is a fundamental element of “due process of law.”²⁰⁰

This principle was powerfully explained almost 140 years ago by the Supreme Court in the famous case of *Yick Wo v. Hopkins*:

When we consider the nature and the theory of our institutions of government, the principles upon which they are supposed to rest, and review the history of their development, we are constrained to conclude that they do not mean to leave room for the play and action of purely personal and arbitrary power . . . But the fundamental rights to life, liberty, and the pursuit of happiness . . . are secured by those maxims of constitutional law which . . . secur[e] . . . the blessings of civilization under the reign of just and equal laws, so that, in the famous language of the Massachusetts Bill of Rights, the government . . . “may be a government of laws, and not of men.”²⁰¹

So, my answer to this article’s question is that in our country it is unconstitutional for courts, legislatures and the executive branch to make law that is inconsistent with the fundamental laws of science or incompatible with scientific reality. The Founders intended this to be so and the rule of law and due process so require. Or to quote one our nation’s great philosophers, Homer Simpson, “we follow the laws of thermodynamics in this house.”²⁰²

¹⁹⁹ *Brown*, 91 U.S. at 42.

²⁰⁰ U.S. CONST. amend. V.

²⁰¹ *Yick Wo v. Hopkins*, 118 U.S. 356, 369-70 (1886).

²⁰² *The Simpsons: The PTA Disbands* (Fox Television Broadcast Apr. 16, 1995), <https://www.simpsonworld.com/video/294780995610>.