



When Ideology Eclipses Science

Upholding objectivity in a polarized polis.

Robert T. Pennock

What role should science and its special virtues play in the life of the state? Aristotle argued that any inquiry into ethics requires consideration of politics, which involves the well-ordering of communities. It is hard to be virtuous, so we need a supportive political structure to flourish. In *Politics*, he examined different political constitutions, asking which are best in the ideal and in real-world circumstances. Aristotle argued for a *polity*, a form of government that combines democracy with a stabilizing form of oligarchy, because he took simple democracies to be unstable, being susceptible to disruption by demagogues.

In times of uncertainty and fear, the bonds that hold democracies together are tested. We saw this disruption in the COVID-19 pandemic, when the world was confronted with a novel coronavirus of unknown effect. In such circumstances, objective science must step up to help hold the center of a democratic society without resorting to the oligarchy that was favored by Aristotle.

Reality must ground communal action, and science is the light that illuminates it. Science's evidence-based approach is our best method of determining truer understandings of the world. A couple of solar eclipse stories may help illustrate the importance of objective science for a well-ordered community.

A supportive political structure can aid human flourishing, especially during times of uncertainty, and objective science can help to hold the bonds of democracies together.

Moonshadow

I drove to Indiana for the April 8, 2024, solar eclipse. My phone's GPS helped me avoid the traffic of a million or so other hopeful viewers traveling to see the full eclipse. In Williamsburg, we would have nearly four minutes of totality. A partial eclipse is fascinating to watch through eclipse glasses as the Moon slowly covers our home star and one sees it in crescent. But even at 99 percent coverage, one does not observe the striking effect of a full eclipse. Only as the final 1 percent of sunlight diminishes, does the real show begin.

The quality of the light changes, darkening reds and making blues more luminous, like an otherworldly Instagram filter. In the last few seconds, the light dims quickly, leaving

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sunset colors around the horizon and a dramatic hole in the darkened sky. Watching this display, our small group cheered. We removed our glasses to directly view what are called *Baily's beads*, spots of sunlight shining

QUICK TAKE

The recent solar eclipse highlights the abilities of scientific research, which was used to plot the path of the totality years in advance; earlier eclipses provided evidence of relativity.

through the valleys on the Moon, and then the full, magnificent solar corona.

An airplane approached from the east. Perhaps its passengers could see the edge of the Moon's shadow on the ground. In the cockpit, Captain Benjamin Riley was pleased to have reached the line of totality at the right spacetime coordinates. He later recounted to a photographer that he had flown fast and "accepted all shortcuts" after departing LaGuardia Airport in New York to gain the 15 minutes he had earlier calculated would be needed to do so. Our eclipse-themed music stream was playing Cat Stevens's "Moonshadow" as the jet's flight path crossed the eclipsed Sun, like a dart hitting a bull's-eye. We burst into a second spontaneous cheer.

GRT and GPS

That moment, captured in the frame of a photo, deserves the caption: Brought to you by science (see figure on page 211). The image illustrates the power of objective scientific knowledge. Science predicts not just the time of eclipses, but their precise paths, correctly determined years in advance. Anyone inclined to deny science's ability to discover the facts of nature need only consider how such predictive power would otherwise be, as science fiction writer Arthur C. Clarke aptly put it, indistinguishable from magic.

Equally remarkable for this moment was one technical implementation of science: the Global Positioning System (GPS) technology used on my phone

Political polarization can skew the interpretation and implementation of scientific findings, but ensuring that scientific findings are objective can be unifying.



Ned Pennock Photography

American Eagle flight 4461, soaring at an elevation of 11,000 meters and at a speed of 665 kilometers per hour, was seen crossing the eclipse totality on April 8, 2024, from Williamsburg, Indiana. The photographer used a flight tracker, which relies on GPS, to identify the plane. The pilot had calculated that he needed to decrease his flight time by 15 minutes to reach the path of totality, which scientists had calculated years in advance, so this image really was brought to you by science.

to map my drive, used by the photographer with a flight tracker to identify the plane above, used by the pilot to fly said plane, and used by air traffic control to safely coordinate thousands of flights in the air at any given time. All these rely on scientific discoveries—physical laws that govern the movements of the Sun, Earth, Moon, and navigational satellites.

The path of totality can be predicted using Newtonian physics, but GPS requires Einsteinian physics. Clock adjustments based on both special and general relativity theory (GRT) compensate for relativistic effects caused by the speed of the orbiting network of satellites, or else their navigational

ability would fail. Given GPS's role in this intersection of paths, it is fitting to note that the crucial test that confirmed GRT was made possible by a total solar eclipse that occurred more than a century ago.

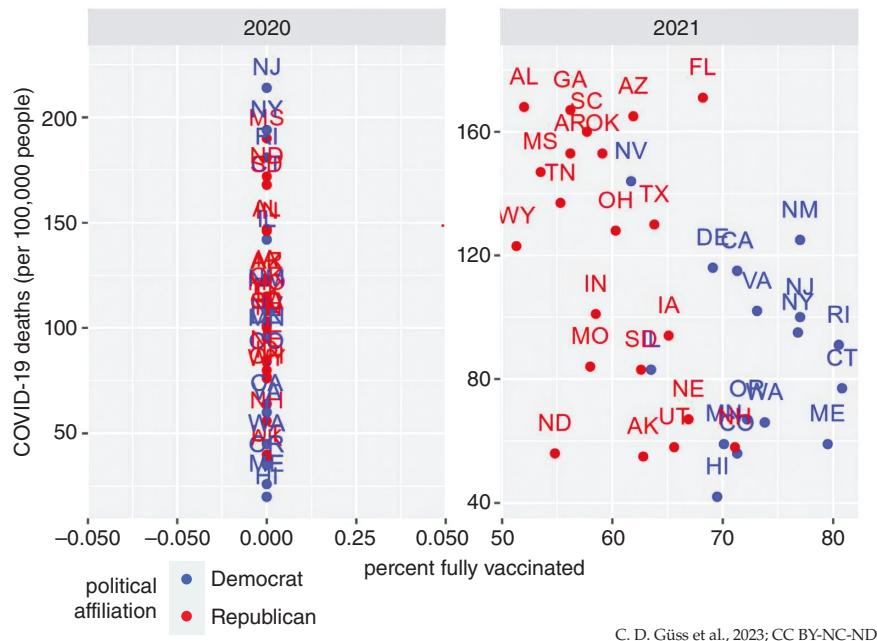
Lights All Askew

The deflection of light by the gravitational field of the Sun was one of three lines of evidence that Einstein identified for GRT. A total solar eclipse would provide a viable test condition, allowing measurements of star positions that would otherwise be impossible to compare. In 1919, two British expeditions were organized to take advantage of an eclipse whose path of

totality would cross Sobral, Brazil, and Principe, an island off the coast of Africa. Astronomer and physicist Arthur Eddington, who led the Principe trip, poetically described the experiment as an attempt to "weigh light." Doing so would require precise calibration of instruments and cooperation of the weather; backup telescopes and the two locations increased their odds.

Fuzzy images made plates from one of the Sobral telescopes unusable, and cloud cover at Principe resulted in only two of its plates showing the reference stars needed for analysis. But the data were judged sufficient to confirm Einstein's GRT prediction. The finding made international news—"Lights All Askew" was a *New York Times* headline, referring to the observed stellar displacement—in part because of its revolutionary import in superseding Newton, but also because of its social significance.

Percentage Vaccinated vs. Deaths by Year



These figures show the association between COVID-19 deaths per 100,000 people and vaccination rates. The left graph shows rates in politically blue and red states during the first year of the pandemic, before the vaccine was developed. The right graph shows the difference the following year, as polarization led to lower vaccination rates and higher death rates in red states. The data show that politicizing vaccines and medical science harmed public health.

In supporting GRT and mounting expeditions to test it, Eddington was bucking prejudice. Einstein's work would be dismissed in Germany because he was a Jew, but at this time, in the immediate aftermath of the first World War, GRT was downplayed in the United States together with other German science. Our political lights make no difference to starlight, but they can all too easily make a difference to how scientists are viewed or how their findings are received by the public.

Pandemic Polarization

Predictive research at the level of an eclipse does not come quickly or easily. Science works by assessing probabilities, and much is uncertain when confronting a new challenge. Even after science ascertains facts, that alone can't determine a course of action. Making policy also involves weighing competing values, a process that makes weighing light look simple. In steering the ship of state, political leaders should look to both information and values to navigate the course forward for human flourishing. However, political polarization skews our view. The COVID-19 pandemic exemplified this dynamic.

Operation Warp Speed, the ambitious American federal initiative to accelerate development, manufacturing,

and distribution of a COVID-19 vaccine, was announced by President Donald Trump on May 15, 2020. Federal requirements for new drugs are strict to ensure safety and effectiveness, but rules were relaxed to allow a shortened testing phase. A lower degree of confidence was reasonably judged to be warranted, given the greater risks of an uncontrolled pandemic. The race to

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create and bring a vaccine to market was accomplished in record time, with emergency use authorization granted in the United States on December 11, 2020. It is estimated that the global COVID-19 vaccination campaign saved 2.4 million lives.

However, the success of science's vaccine-development effort was marred

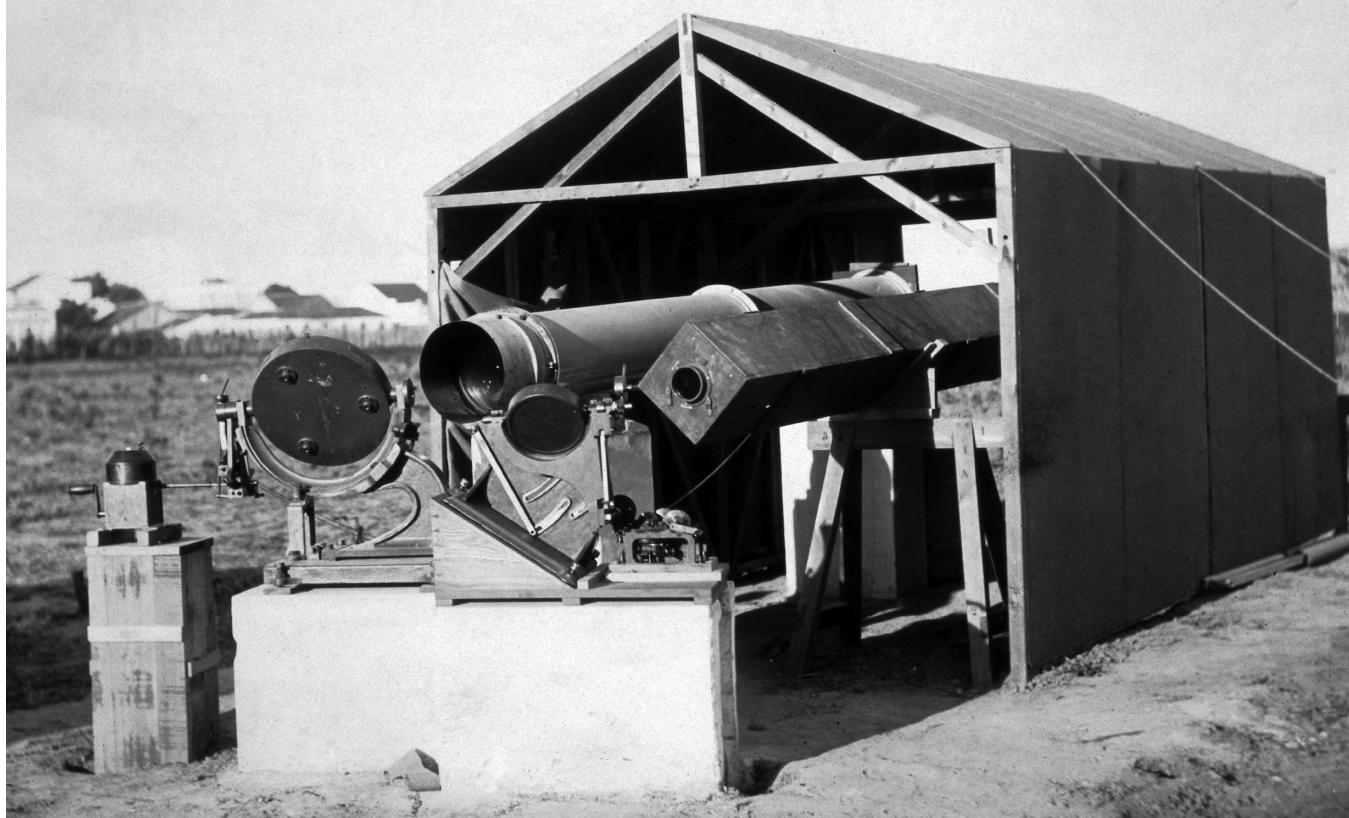
by its politicization. The disintegrating relationship between Trump and White House Chief Medical Advisor Anthony Fauci, who became demonized by far-right conservative antivaxxers, was but one polarizing example. Neither the virus nor the efficacy of the vaccine discriminated along political lines, but social polarization did. Because of how the vaccine became politicized, more Republicans rejected it, resulting in measurably higher death rates (see figure at left). For too many people, ideology eclipsed reality, and they paid for it with their lives.

Objectivity as an Antidote to Othering

The case of pandemic polarization illustrates one way that political partisanship can interfere with acceptance of scientific facts, but ideology that obscures reality can arise from other sources. Religious dogmatism, for example, has often tried to snuff out the light of evolution, denying well-established biological findings. Secular ideologies have sometimes run counter to scientific evidence as well, rejecting nature for a created nurture. When taken to an ideological extreme, there is little difference between the religious zealotry that denies evolutionary accounts of sex, for example, in favor of a literal belief that "God created them male and female," and the zealous social constructivist view that culture creates biological sex.

Ideological polarization is a form of *othering*—viewing individuals in light of group identities, often stereotypically negative, and then treating them as alien to oneself or one's own group. It goes hand in hand with *confirmation biases*, where people see only what supports their preferred view and discount evidence that opposes it. As polarization becomes extreme, the "other" may be dismissed or even, as with Fauci, demonized. Creationists see evolution not just as wrong but as evil, and social polarization leads to a similar us versus them tribalism. Objectivity is an antidote to this social ill, a rational basis for equitable inclusion. For humans to be able to work together and flourish, wise policies require objective assessments of reality.

Disparagement of the pursuit of objectivity, often made with different politicized forms of othering, must similarly be resisted. Unfortunately, one sometimes hears it said that objectivity is a "male" or "Western" or



Science Museum/Science & Society Picture Library

"white" value. Tell that to Maria Mitchell, the 19th-century astronomer who, as the first faculty member of all-female Vassar College and director of its observatory, taught her students to take eclipse measurements with the best of them. Tell that to Subrahmanyan Chandrasekhar, the 20th-century Indian-American theoretical physicist, who advanced understanding of relativity beyond Eddington, showing how a collapsing star could form a black hole. Tell that to Neil deGrasse Tyson, the 21st-century African American astrophysicist and public intellectual, who eloquently explains why objective truth is required for economic and legislative well-being in a pluralistic society.

Nature ignores personal politics. When done properly, science does as well.

Shadow of a Doubt?

Of course, we must acknowledge that science is not always done properly. Scientists are human beings and subject to the usual weaknesses of character and failures of will. They make mistakes. Their own eyes may be clouded by bias. Groups that dislike some scientific finding will often raise such doubts—the tobacco industry's response to the scientific evidence linking smoking and cancer is one well-known example. Less known are opponents of Einstein's

These telescopes and other instruments were used by the 1919 British eclipse expedition in Sobral, Brazil, to measure the deflection of light by the gravitational field of the Sun. These measurements and ones from another team in the island of Principe confirmed the general theory of relativity. Einstein had proposed that a total solar eclipse would provide conditions allowing the relevant observations.

discovery who seek any reason to deny it, but I get as much crank mail about that topic as about evolution. Still, it is a virtuous exercise in science to apply

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a skeptical eye to our own research, so we are duty-bound to at least consider the possibility.

Could such doubt be cast on the eclipse test of GRT? A few commenta-

tors turned the political and religious ideology critique around and pointed it at Eddington, wondering whether his Quaker values blinded him to weakness in the eclipse data. He wanted GRT to be true and wanted to use it to help heal the wounds of war with Germany by valorizing a German scientific advance. Did this religious ideology undermine his objectivity?

It can be difficult to judge the objectivity of scientists in hindsight, but assessment of these concerns by historians of science Daniel Kennefick of the University of Arkansas, Matthew Stanley at New York University, and others demonstrates that the criticisms are misplaced. Eddington's adherence to the Quaker peace testimony was sincere and steadfast; indeed, he risked his professional reputation with his conscientious objection. But Quakerism was a religion of the scientific revolution, and its testimony to truthfulness and the principle that truths must be tested was equally central to his religious convictions. The data back up this assessment: A recent

detailed reanalysis of the expedition records by Girard Gilmore and Gudrun Tausch-Pebody of the University of Cambridge in the United Kingdom further substantiates the original analysis and vindicates Eddington's conclusion. The 1919 eclipse expeditions deserve their fame.

But what about the more general critique against objectivity, typically made from the political extremes, that science itself is just ideology? To mention one notorious example, right-wing creationists, drawing on left-wing postmodern critical theory, have argued that natural science is dogma and evolution is but a narrative of the powerful elite. This sort of claim is absurd. Perfect objectivity is no more obtainable than absolute truth, but science does not seek such godly powers. Part of being objective involves recognizing our own limitations and then devising methods to improve the evidence that ought to be followed. For scientists, objectivity is an aspirational ideal, an asymptote to be approached. The difficulty of eliminating bias is worth the effort to justify trust in scientific results.

Reason for Hope

For the most part, that trust is warranted and appreciated. Data on public trust of scientific expertise, taken since just before the launch of the Soviet Sputnik spacecraft nearly 70 years ago, shows a remarkably stable pro-science culture in the United States. Fundamentalist religious beliefs do correlate with concerns about the negative consequences of science, but for most of that period, ideological partisanship made no difference to belief in the promise of beneficial outcomes from science and technology. But what happens when science becomes politicized? My colleagues and I recently published a study in which we investigated whether the attacks on science during the Trump administration changed those positive attitudes. The polarization was clear: From 2016 to 2020, the survey data showed that the proportion of adults with low or very low trust in science increased, as did the proportion with high or very high trust. More Democrats became trusting. More Republicans grew distrustful.

This result is gloomy, but closer analysis provides a ray of hope. The pattern of polarization occurred because many people in the middle initially had no

strong view either way, but the pandemic made science salient for them and some moved in line with its politicization. For more people, however, seeing science at work in the effort to understand and address the novel virus, and seeing the efficacy of vaccines for COVID-19, made them more appreciative. This shift was not only true of liberal Democrats. Moderate and conservative Republicans slightly increased their negative view of science, but a larger proportion increased their level of trust in scientific expertise.

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Overall, although 12 percent of American adults became more skeptical in response to the Trump-era dismissal of science, 20 percent increased their trust.

This change gives reason for hope that science can overcome political ideology. During the 2024 eclipse, 40 teams of volunteers of the Citizen Continental-America Telescope Eclipse (Citizen CATE) project made polarized-light telescopic observations of the Sun's corona along the full path of totality. Whatever political polarization existed across this swath of the country did not affect their measurements. Science can be unifying. Studying polarization, whether of light or politics, may help us better understand its contours and correct its biasing effects—at least if we do so objectively.

Out of the Shadows

In Plato's famous allegory of the cave, we are asked to imagine people who have lived in a deep cavern with light penetrating only through a passage from its mouth far above. Chained in position, they cannot turn to see objects in their truer form in the light of the Sun, but only the shadows of those objects playing on the cave wall. These cave dwellers, Plato said, may not even recognize how their bonds limit them.

Ideology, whether political or social, can indeed bias us, obscuring or even obstructing our view of the world. Partisans will focus only on what seems to confirm their view. Power may be used to cover evidence. We may close our own eyes to alternatives. Plato proposed philosopher-kings as ideal rulers, but such leaders are not a realistic option, and politicians may not always be the wise leaders we hope for. The way forward requires a collective effort to bring together the special virtues of our different vocational roles.

Science is but one element of sound public policy, but it is essential. Science can break the chains of ideology. Democracy cannot work without objective means of distinguishing facts from fantasy to keep policy grounded in reality. Scientists have a duty to resist ideology and ensure that the light that seeks truth is not eclipsed.

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