How Politics Shaped General Relativity

Gray Matter

BY DAVID KAISER NOV. 6, 2015

On four Thursdays in November 1915 — one lecture each week — Albert Einstein rose to the podium at the Prussian Academy of Sciences to deliver updates on what he came to call his “general theory of relativity.” He was working at a frenzied pace, adjusting details between each presentation. By the end of the month, he had arrived at a form for his equations that physicists still use today. Elegant and crisp, they are brief enough to tweet.

In the 100 years since, Einstein’s theory has been famously successful. Physicists and astronomers have applied general relativity to far-flung reaches of the cosmos, and no experiment or observation has yet revealed a discrepancy. Less commonly understood, however, is how thoroughly the research into this profound, abstruse and seemingly otherworldly theory was shaped by the messy human dramas of the past century.

From the outset, Einstein was not optimistic that his theory would be quickly accepted. “The theory of gravitation will not find its way into my colleagues’ heads for a long time yet, no doubt,” he lamented to a friend in 1915.

Some of the barriers to acceptance were conceptual. Isaac Newton had argued that there was a universal force of gravity, the incessant tugging of one body on another. But Einstein argued that there was no “force” of gravity at all. Space and time were as wobbly as a trampoline; they could warp, bend or distort in the presence of massive objects like the sun. Objects simply moved as straight as they could, flowing through curved space–time. This idea could be hard to wrap your head around.

But other obstacles were political. The turmoil and disruptions of World War I, for example, prevented many people from learning and thinking about general relativity. The theory’s earliest converts included a Russian mathematician being held in a German prisoner-of-war camp, who was unable to enlighten his Russian colleagues for several years; a German astronomer being held in a Russian prisoner-of-war camp, who was unable to complete his test of one of the theory’s key predictions; and another German astronomer, who passed the time while serving in the German Army by finding the first exact solutions to Einstein’s equations, only to succumb to a deadly disease on the Russian front a few weeks later.

The war also controlled how Einstein’s work spread westward. Because he was a German civil servant, neither Einstein nor his letters — nor even German scientific journals — could cross the English Channel amid the naval blockade. Einstein could, however, travel to neutral countries, like the Netherlands. He made frequent trips to Leiden, where he befriended the great mathematical physicist Willem de Sitter and tutored him in general relativity. And de Sitter, in turn, sent a series of detailed primers on Einstein’s work to a Cambridge colleague, the physicist and astronomer Arthur Eddington.
Eddington, a Quaker and conscientious objector, was concerned that wartime resentments were damaging the international scientific community. He leapt on Einstein’s relativity as a means of restoring harmony. As the historian Matthew Stanley has documented, Eddington’s superiors in London and Cambridge lobbied British government officials to let him devote his mandatory wartime service to preparing an astronomical expedition to test one of Einstein’s major predictions, that gravity could bend the path of starlight. By leading a British team to test the work of a German physicist, Eddington hoped to “heal the wounds of war.”

One year after the armistice that ended World War I, Eddington announced that his team’s measurements of the apparent positions of stars during a recent eclipse matched Einstein’s predictions. In an interview soon afterward, Einstein noted that the public recognition of his accomplishment had a political slant. “Today I am described in Germany as a ‘German servant,’ and in England as a ‘Swiss Jew,’” he said. “Should it ever be my fate to be represented as a bête noire, I should, on the contrary, become a ‘Swiss Jew’ for the Germans and a ‘German savant’ for the English.” Here, he shared with a wink, was yet another application of the theory of relativity.

Sadly, events quickly proved Einstein right. Just months after Eddington’s announcement, right-wing political opportunists in war-ravaged Germany began to organize raucous anti-Einstein rallies. Only an effete Jew, they argued, could remove “force” from modern physics; those of true Aryan spirit, they went on, shared an intuitive sense of “force” from generations of working the land. Soon after the Nazis seized power in 1933, they banned the teaching of Einstein’s work within the Reich. Einstein settled in Princeton, N.J.; the German relativity community was decimated.

After World War II, a new generation of physicists in the United States began to focus on relativity from their perch within the “military-industrial complex.” Here, political exigencies accelerated a deeper appreciation of Einstein’s theory, in unanticipated ways.

In one example, physicists and engineers working on enormous radar arrays to detect incoming Soviet missiles calibrated and fine-tuned their new system by sending radar pulses to nearby planets. These researchers realized that if they timed the return echo from the planets with unprecedented accuracy, they could test a subtle prediction of Einstein’s: that gravity slows the speed of light as well as bending its path. For decades, this “time-delay” test provided the most precise measurements available that space-time really did behave as Einstein predicted.

Twenty years later, theoretical physicists briefed United States Air Force generals on a subtle complication with a new military technology, the Global Positioning System. Effects from Earth’s gravity would be stronger on the ground than in orbit, the physicists explained, and hence clocks on the ground would tick more slowly than those aboard satellites. If the clocks disagreed on time, they would also disagree on space, and that could spell trouble for this technology. If left uncorrected, the tiny differences in clock rates would snowball into enormous errors in determining distances. With GPS, the warping of time that Einstein imagined assumed operational significance. (Later, GPS was opened to the commercial market, and now billions of people rely on general relativity to find their place in the world, every single day.)

A century after its creation, Einstein’s beautiful theory continues to inspire lofty thoughts — about black holes, supernovae, the big bang. The history of Einstein’s work, however, reveals how even the most abstract scientific research can be buffeted, derailed and even propelled by the most potent force of all: politics.

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