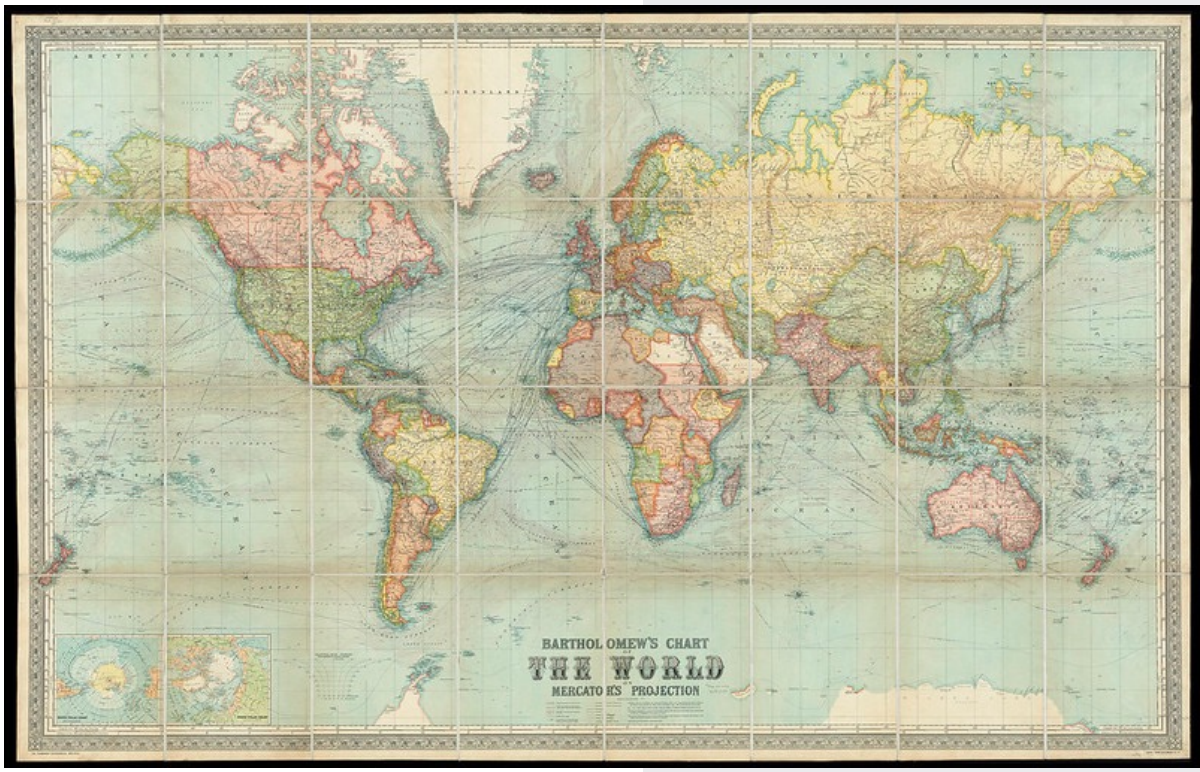
Conclusion: 1905, A World in Motion



Introduction

We have now looked at a small sampling of some of the events of 1905 that turned out to have important effects on empire, geopolitics, gender relations, identity politics, and personal liberty. Some of these events had clear and immediate effects, visible at the time and impossible to ignore. Others appeared inconsequential to most people, but their significance was recognized later through reflection. As a year in flux, 1905 brought about changes in all these realms, including in the realm of one final example - the sciences - and in the ways people understood the physical world around them…

The lane where Einstein lived in Bern, Switzerland

Science and Uncertainty

In December 1999, as the 20th century was ending *Time* magazine named Albert Einstein as the most important person of the century. Born in 1879, Einstein had always excelled at math and sciences. Yet, at 25, he was an unremarkable graduate of a teaching program in mathematics and physics, now working on his Ph.D. at the University of Zurich. He was looking for a teaching gig and working, in the meantime, as an examiner in the Swiss Patent Office. But 1905 turned out to be the most important and productive year of his life. That year, he wrote and published four scientific papers that remain central building blocks in our understanding of the universe and the foundations for much of the science and technology that permeates our lives:

- "On a Heuristic Viewpoint Concerning the Production and Transformation of Light," was submitted for publication on March 18, and introduced the concept of photons. It was the basis for Einstein's award of a Nobel Prize in 1922 and was frequently cited for the rest of the century.
- "On the Motion of Small Particles Suspended in a Stationary Liquid, as Required by the Molecular Kinetic Theory of Heat" was submitted less than two months later. It showed the source and nature of movement of minute particles in what is known as "Brownian Motion".
- The third, "On the Electrodynamics of Moving Bodies" was submitted just six weeks later. This paper contained what became known as the "Special Theory of Relativity" (and was expanded upon in later works, including his 1915 article "On the General Theory of Relativity").
- And finally, in "Does the Inertia of a Body Depend Upon Its Energy Content?," submitted on September 27, Einstein articulated that the relationship between mass (M) and energy, (e) was a function of the speed of light (c), the components of what became the most famous scientific formula of the century: "$E=Mc^2$".

Key Terms:

Albert Einstein

Relativity

Werner Heisenberg

Kurt Gödel

Einstein's residence on the first floor above street level where most of his 1905 papers were written

Albert Einstein, c. 1904-1905

Though each has remained deeply influential, his theory of "special relativity" was particularly disruptive… What does "relativity" actually mean? The laws of physics are fixed and apply to everybody. The speed of light, for example, is fixed at 186,000 miles per second. But in 1905, Einstein argued that for people moving at different speeds, it seems that the speed of light varies. Thus, he showed that it must be *time* that passes differently depending on how fast you are moving in the universe. And since everything in the universe is moving *relative* to everything else, there is no fixed frame of reference. In essence, time moves relative to the observer.

It was a startling idea, and within the group of scientists who wrestled with the underpinnings of our understanding of the universe, Einstein's findings were revolutionary. In the following decades, it was joined by other ideas which similarly undercut existing understandings of physics and mathematics and the very idea of scientific knowledge. In 1927, German physicist Werner Heisenberg (1901–1976) framed the "Uncertainty Principle" as part of his critical work on quantum mechanics. He found that there are limits to what we can know about certain atomic-level particles. If we are sure of its location then we can't know precisely how fast it is moving and if we know how fast it is moving, then we can't know exactly where it is: we have to pick one.

Werner Heisenberg (above); Kurt Gödel (below)

Likewise, in 1930, mathematician Kurt Gödel (1906–1978) showed that no logical system could ever prove itself to be true. This "Incompleteness Theorem" had profound implications for mathematics and formal logic, on which Gödel continued to work when he joined Einstein at the Institute for Advanced Study in Princeton in 1940.

Crowds on a Tokyo street near the train station

Taken together, these ideas marked a fundamental change in the nature of science. The "Scientific Revolution" of the 17th and 18th centuries had been epitomized by the work of Isaac Newton, and had promised a stable, and increasingly known world of nature and the cosmos. Since the Enlightenment of the 18th century, many thought that science was closing the door on doubt, on the 'unknowable.' For hundreds of years, there was confidence that even though many mysteries remained, science would progress and—eventually—humans would fully understand the universe and their place in it. But, starting with Einstein's work in 1905, these papers upended all that.

It may be nothing more than coincidence that these ideas, which undermined the certainty, regularity, and reliability of a stable Newtonian worldview emerged just as the acceleration of social change in the 19th and 20th centuries (what we call 'modernity') was undermining so many other existing assumptions about the world. Globalization, urbanization, industrialization, the expansion of more inclusive forms of political participation, and the creation of mass markets, mass movements, and mass communications – all contributed to a widespread sense of constant change. They suggested the older models of understanding the world wouldn't work anymore (even if few had heard of Einstein, Heisenberg, or Gödel and far fewer could understand their work). Coincidence or not, we can trace a parallel between the erosion of definitive social authority and the implications of new scientific ideas – there are multiple correct answers depending on your perspective. These discoveries were thrilling, and cause for great optimism about exciting discoveries yet to be made. And yet, they also echoed the anxieties of the era. If, as Gödel showed, it's impossible to prove that mathematics is true, what *can* anyone rely on?

Nevskii Prospect and the Admiralty, St. Petersburg, Russia

Hanwell to Brentford tramcar on Boston Road, London

Conclusion

The world of 1906 was considerably different from that of 1904, even if it wasn't clear to most people exactly how at the time. When we are in the flow of many events, gazillions of outcomes seem possible. In this way, we might feel a connection to those living in 1905 – perhaps to their sense of bewilderment about the changes taking place around them, their optimism or anxiety about the future, or even to their efforts to participate in or enact those changes.

But looking back at 1905, hindsight permits us to see how each of these events fit into a larger picture of transformations called "modernity" unfolding across the last two centuries, as well as the significance of the events we have explored in this module and how many of them were connected to one another. We can fairly easily identify the relationship between demands for a place on the global imperial stage, in the Russian government, in the British parliament, in administrative decision-making in India, or answers to our place in the universe. And we can also see how in some ways we are still wrestling with some of the same changes and questions – about global geopolitics, industrialization, political inclusion, and equity – in our world today.

So, alongside both our connection to the sense of uncertainty of 1905, and the longer transformational processes that bind us with that year in the flow of time, it's worth remembering then another lesson from this module… That every year, every day, history happens to people and by people. Just as history was happening in 1905, it is unfolding for us today, too, even when it's hard for us to see.

Calcutta, India

Further Reading

Cassidy, David C. *Einstein and Our World*. 2nd ed. New York: Humanity Books, 2004.

Holton, Gerald. *Einstein, History and Other Passions: The Rebellion against Science at the End of the Twentieth Century*. 2nd ed. Harvard, MA: Harvard University Press, 2000. 129.

Horgan John. *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*. Reading MA: Addison-Wesley, 1996.

Ridgen, John S. *Einstein 1905: The Standard of Greatness*. Cambridge, MA: Harvard University Press, 2005.

Winks, Robin W. and Joan Neuberger. *Europe and the Making of Modernity. 1815–1914*. Oxford: Oxford University Press, 2005.

Image Citations:

Page 1:
John Bartholomew & co., Bartholomew's chart of the world on Mercator's projection, 1914, CC BY 2.0, Norman B. Leventhal Map Center, https://www.flickr.com/photos/normanbleventhalmapcenter/14719827322

Page 2:
Bern, Switzerland, where Albert Einstein lived from 1903-1905, CC BY-SA 4.0, Vitold Muratov, https://commons.wikimedia.org/wiki/File:Kramgasse.mit_Zeringerbrunnen.jpg
Albert Einstein's house in Bern, Switzerland, CC BY-SA 3.0, Dsmntl, https://en.wikipedia.org/wiki/File:Albert_einstein_house_bern.JPG

Page 3:
Lucien Chavan, Albert Einstein, c. 1904-1905, Public Domain, https://en.wikipedia.org/wiki/File:Einstein_patentoffice.jpg
Werner Heisenberg, c. 1933, CC BY-SA 3.0, German Federal Archives, https://en.wikipedia.org/wiki/File:Bundesarchiv_Bild183-R57262,_Werner_Heisenberg.jpg
Kurt Friedrich Gödel, c. 1926, Public Domain, https://commons.wikimedia.org/wiki/File:Kurt_g%C3%B6del.jpg

Page 4:
Crowds on a Tokyo street, near the train station during the celebration of Admiral Togo's visit in October, 1905, Library of Congress Prints and Photographs Division, Washington, D.C., Public Domain, https://www.loc.gov/item/2005678640/
The Newsky (i.e. Nevskii) prospect and the Admiralty, St. Petersburg, Russia, c. 1890-1900, Library of Congress Prints and Photographs Division, Public Domain, https://www.loc.gov/resource/ppmsc.03885/?st=image

Page 5:
Hanwell to Brentford tramcar in Boston Road, c. 1910, Public Domain, https://commons.wikimedia.org/wiki/File:Tram_in_hanwell_boston_road.JPG

Page 5, cont.:
European Quarter, Calcutta, India, 1922, Bain News Service, Public Domain, https://www.loc.gov/item/2014680352/