Horizons

A Global History of Science

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Introduction: The Origins of Modern Science

Where did modern science come from? Until very recently, most historians would tell you the following story. Sometime between 1500 and 1700, modern science was invented in Europe. This is a history which usually begins with the Polish astronomer Nicolaus Copernicus. In *On the Revolutions of the Heavenly Spheres* (1543), Copernicus argued that the Earth goes around the Sun. This was a radical idea. Since the time of the ancient Greeks, astronomers had believed that the Earth was at the centre of the universe. For the first time, scientific thinkers in sixteenth-century Europe started to challenge ancient wisdom. Copernicus was followed by other pioneers of what is often called the 'scientific revolution' – the Italian astronomer Galileo Galilei, who first observed the moons of Jupiter in 1609, and the English mathematician Isaac Newton, who set out the laws of motion in 1687. Most historians would then tell you that this pattern continued for the next 400 years. The history of modern science, as traditionally told, is a story focused almost exclusively on men like Charles Darwin, the nineteenth-century British naturalist who advanced the theory of evolution by natural selection, and Albert Einstein, the twentieth-century German physicist who proposed the theory of special relativity. From evolutionary thought in the nineteenth century to cosmic physics in the twentieth century, modern science – we are told – is a product of Europe alone.[1]

This story is a myth. In this book, I want to tell a very different story about the origins of modern science. Science was not a product of a unique European culture. Rather, modern science has always depended upon bringing together people and ideas from different cultures around the world. Copernicus is a good example of this. He was writing at a time when Europe was forging new connections with Asia, with caravans travelling along the Silk Road as well as galleons sailing across the Indian Ocean. In his scientific work, Copernicus relied upon mathematical techniques borrowed from Arabic and Persian texts, many of which had only recently been imported into Europe. Similar kinds of

scientific exchange were taking place throughout Asia and Africa. This was the same period in which Ottoman astronomers journeyed across the Mediterranean, combining their knowledge of Islamic science with new ideas borrowed from Christian and Jewish thinkers. In West Africa, at the courts of Timbuktu and Kano, mathematicians studied Arabic manuscripts imported from across the Sahara. To the east, astronomers in Beijing read Chinese classics alongside Latin scientific texts. And in India, a wealthy maharaja employed Hindu, Muslim, and Christian mathematicians to compile some of the most accurate astronomical tables ever made.[2]

All this suggests a very different way of understanding the history of modern science. In this book, I argue that we need to think of the history of modern science in terms of key moments in global history. We begin with the colonization of the Americas in the fifteenth century and move all the way through to the present. Along the way we explore major developments in the history of science, from the new astronomy of the sixteenth century through to genetics in the twenty-first. In each case, I show how the development of modern science depended upon global cultural exchange. It is worth emphasizing, however, that this is not simply a story of the triumph of globalization. After all, cultural exchange came in lots of different forms, many of which were deeply exploitative. For much of the early modern period, science was shaped by the growth of slavery and empire. In the nineteenth century, science was transformed by the development of industrial capitalism. Whilst in the twentieth century, the history of science is best explained in terms of the Cold War and decolonization. Yet despite these deep imbalances of power, people from across the world made significant contributions to the development of modern science. Whatever period we look at, the history of science cannot be told as a story which focuses solely on Europe.[3]

The need for such a history has never been so great. The balance of the scientific world is shifting. China has already overtaken the United States in terms of science funding, and for the last few years researchers based in China have produced more scientific articles than anywhere else in the world. The United Arab Emirates launched an unmanned mission to Mars in the summer of 2020, whilst computer scientists in

Kenya and Ghana play an increasingly important role in the development of artificial intelligence. At the same time, European scientists face the fallout from Brexit, whilst Russian and American security services continue to wage cyberwarfare.[4]

Science itself is plagued by controversy. In November 2018, the Chinese biologist He Jiankui shocked the world by announcing that he had successfully edited the genes of two human babies. Many scientists believed that such a procedure was too risky to justify trying on human subjects. However, as the world quickly learned, it is very hard to enforce an international code of scientific ethics. Officially, the Chinese government distanced itself from He's research, serving him with a three-year prison sentence. But in 2021, researchers in Russia are already threatening to replicate his controversial experiment. Alongside issues surrounding ethics, science today, as in the past, suffers from deep inequalities. Scientists from minority ethnic backgrounds are underrepresented at the top of the profession, Jewish scientists and students continue to suffer antisemitic abuse, whilst researchers working outside of Europe and the United States are often denied visas for travel to international conferences. If we are to tackle such problems, we need a new history of science, one that better reflects the world in which we live.[5]

Scientists today are quick to acknowledge the international nature of their work. But they tend to think of this as a relatively recent phenomenon, a product of the 'big science' of the twentieth century, rather than something with a history stretching back more than 500 years. When contributions to science from outside of Europe are acknowledged, they are typically relegated to the distant past, not part of the story of the scientific revolution and the rise of modern science. We hear a lot about the 'golden age' of medieval Islamic science, the period around the ninth and tenth centuries, when scientific thinkers in Baghdad first developed algebra and many other new mathematical techniques. There is a similar emphasis on the scientific accomplishments of ancient China, such as the invention of the compass and gunpowder, both well over 1,000 years ago. But these stories only serve to reinforce the narrative that places like China and the Middle East have little to do with the history of modern science. Indeed, we often forget that the notion of a 'golden age' had originally been invented during the nineteenth

century in order to justify the expansion of European empires. British and French imperialists promoted the false idea that the civilizations of Asia and the Middle East had been in decline since the medieval period, and so needed to modernize.[6]

Perhaps surprisingly, these stories are still just as popular in Asia as they are in Europe. Cast your mind back to the 2008 Beijing Olympics. The opening ceremony began with an enormous scroll unfolding, signifying the invention of paper in ancient China. Throughout the ceremony, a television audience of over one billion watched as China showcased its other ancient scientific achievements, including the compass. Fittingly, the ceremony closed with a spectacular display of another Chinese discovery. Fireworks lit up the sky above the Bird's Nest Stadium, a nod towards the invention of gunpowder during the Song dynasty. Yet throughout the ceremony, there was very little reference to the many scientific breakthroughs that China has contributed to since then, such as the development of natural history in the eighteenth century or quantum mechanics in the twentieth century. The same is true of the Middle East. In 2016, the Turkish President, Recep Tayyip Erdoğan, gave a lecture at the Turkish–Arab Congress on Higher Education in Istanbul. In his talk, Erdoğan described the 'golden age of Islamic civilization', the medieval period in which 'Islamic cities . . . acted as a science center'. Yet Erdoğan was seemingly unaware of the fact that many Muslims, including those living in what is today modern Turkey, had also contributed just as much to the development of modern science. From astronomy in sixteenth-century Istanbul to human genetics in twentieth-century Cairo, the Islamic world of scientific advance continued well beyond the medieval 'golden age'.[7]

Why are these stories so common? Like many myths, the idea that modern science was invented in Europe did not come about by accident. During the middle of the twentieth century, a group of historians in Britain and the United States started to publish books with titles like *The Origins of Modern Science*. Almost all were convinced that modern science – and with it modern civilization – originated in Europe, sometime around the sixteenth century. 'The scientific revolution we must regard . . . as a creative product of the West,' wrote the influential Cambridge historian Herbert Butterfield in 1949. Similar views were expressed

on the other side of the Atlantic. Students at Yale University in the 1950s were taught that 'the West generated the natural sciences . . . the East did not', whilst readers of *Science* – one of the most prestigious scientific magazines in the world – were informed that 'a small circle of Western European nations provided the original home for modern science'.[8]

The politics of all this couldn't be clearer. These historians lived through the early decades of the Cold War, a period in which the struggle between capitalism and communism dominated world politics. They thought about the contemporary world in terms of a strict divide between East and West, and then – whether intentionally or not – projected this back onto the past. During this period, science and technology were widely seen as markers of political success, particularly after the Soviet Union launched Sputnik, the first artificial satellite, in October 1957. The idea that modern science was invented in Europe therefore served as a convenient fiction. For leaders in Western Europe and the United States, it was essential that their citizens saw themselves on the right side of history, as bearers of scientific and technological progress. This was also a history of science designed to convince post-colonial states around the world to follow the path of capitalism, and to steer clear of communism. Throughout the Cold War, the United States spent billions of dollars on foreign aid, promoting a combination of free market economics and scientific development in countries across Asia, Africa, and Latin America. This was intended to counter the foreign assistance programme run by the Soviet Union. 'Western science', when combined with 'market economies', promised nothing less than an economic 'miracle', at least according to American policymakers.[9]

Somewhat ironically, Soviet historians ended up reinforcing a very similar narrative concerning the origins of modern science. They tended to ignore the earlier achievements of Russian scientists working under the Tsars, instead promoting the spectacular rise of science under communism. 'Up to the twentieth century, there was really no physics in Russia,' wrote the President of the Soviet Academy of Sciences in 1933. As we'll see, this was not true. Peter the Great supported some of the most important astronomical observations made during the early eighteenth century, whilst Russian physicists played a key role in the development of the radio in the nineteenth century. Some later Soviet historians did try and highlight earlier Russian scientific achievements.

But at least in the early decades of the twentieth century, it was much more important to emphasize the revolutionary advances made under communism rather than anything achieved under the old regime.[10]

Things played out slightly differently in Asia and the Middle East, although ultimately with similar consequences. The Cold War was a period of decolonization, in which many countries finally gained independence from European colonial powers. Political leaders in places like India and Egypt desperately wanted to forge a new sense of national identity. Many looked to the ancient past. They celebrated the achievements of medieval and ancient scientific thinkers, ignoring much of what had happened during the period of colonialism. It was in fact in the 1950s that the very idea of an Islamic or Hindu 'golden age' started to become popular – not just in Europe, as it had been in the nineteenth century, but also in the Middle East and Asia. Indian and Egyptian historians seized on the idea of a glorious scientific past, one waiting to be rediscovered. In doing so, they unwittingly reinforced the very myth being peddled by European and American historians. Modern science was Western, ancient science was Eastern, or so people were told.[11]

The Cold War is over, but the history of science is still stuck in the past. From popular history to academic textbooks, the idea that modern science was invented in Europe remains one of the most widespread myths in modern history. Yet there is very little evidence to support it. In this book, I provide a new history of modern science, one that is both better supported by the available evidence and more suited to the times in which we live. I show how the development of modern science fundamentally relied on the exchange of ideas between different cultures across the world. That was true in the fifteenth century, just as it is true today.

From Aztec palaces and Ottoman astronomical observatories to Indian laboratories and Chinese universities, this book follows the history of modern science across the globe. However, it is important to remember that this is not an encyclopaedia. I have not tried to cover every country in the world, nor every scientific discovery. Such an approach would be foolhardy, and not particularly enjoyable to read. Rather, the aim of this book is to show how global history shaped modern science. For that reason, I have picked four key periods of world historical change, linking each of these to some of the most important

developments in the history of science. By placing the history of science at the heart of world history, this book also uncovers a new perspective on the making of the modern world – from the history of empire to the history of capitalism, if we want to understand modern history, we need to pay attention to the global history of science.

Finally, I want to emphasize that I see science as very much a human activity. Modern science was undoubtedly shaped by wider world events, but it was nonetheless made through the efforts of real people. These were individuals who, whilst living in a very different time and place, were not fundamentally different from you or me. They had families and relationships. They struggled with their emotions and health. And each of them wanted more than anything else to better understand the universe in which we live. Throughout this book, I have tried to give a sense of that more human side of science: an Ottoman astronomer captured by pirates in the Mediterranean; an enslaved African collecting medicinal herbs on a plantation in South America; a Chinese physicist fleeing the Japanese assault on Beijing; and a Mexican geneticist collecting blood samples from Olympic athletes. Each of these individuals, although largely forgotten today, made important contributions to the development of modern science. This is their story – the scientists who have been written out of history.