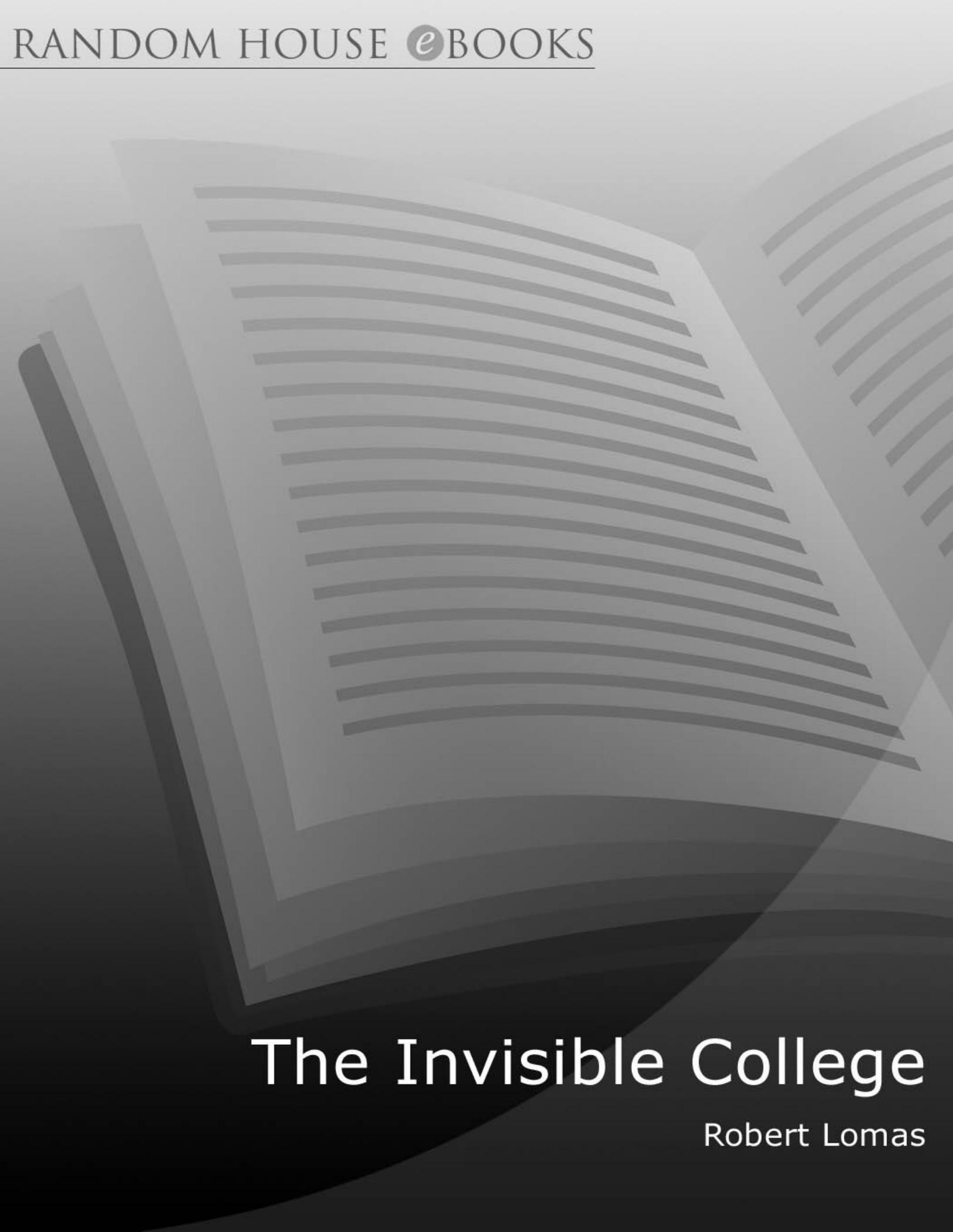


RANDOM HOUSE  BOOKS



The Invisible College

Robert Lomas

About the Book

In 1660 a small group of men, led by Sir Robert Moray, met in London with a secret plan to reshape the world. They were members of the 'Invisible College', better known today as the Freemasons.

Emerging from the horrors of the Civil War, Britain was a society torn apart by political difference, religious ferment and was still immersed in medieval superstition. It was a country which burnt alive at least one hundred elderly women a year on suspicion of witchcraft. Yet this group, who had recently been sworn enemies, managed to bridge their social and cultural differences to found a new organisation dedicated to the scientific study of nature, the Royal Society.

Robert Lomas reveals in compelling detail how the secret tenets and traditions of the Freemasons laid the groundwork for a new revolution, that gave the world modern, experimental science and founded what is still, 350 years later, the pre-eminent scientific institution in the world.

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Copyright

One of the more unusual sources of reference used in this research is William Preston's famous book, *Illustrations of Masonry*, which was first published in London in 1772. This book is difficult for Masons to obtain, and virtually impossible for non-Masons, so to help readers interested in inspecting the original material, the text has been made available at <http://www.robertlomas.com>.

THE INVISIBLE COLLEGE

*The secret history of how the Freemasons founded
the Royal Society*

Robert Lomas

Jointly dedicated to the memory of
Bro. Sir Robert Moray
Freemason, scientist and spy, and
Dr John Hywel Roberts, who inspired me
with a love of history

A handwritten signature in black ink, appearing to read 'Moray'. The signature is written in a cursive style with a long horizontal stroke extending to the left from the start of the word.

Acknowledgements

First Edition

This book would never have been written if not for a casual conversation I had with Norman Macleod, the Assistant Grand Secretary to the Grand Lodge of Antient Free and Accepted Masons of Scotland, during which he asked me the test question, 'Who was the first Freemason made on English soil?' Fortunately, I knew the correct answer, 'Sir Robert Moray' and, reassured, Norman went on to tell me a lot about the importance of Moray's role in the Royal Society and talked eloquently about Sir Robert's many aspects as scientist, courtier, spy and Freemason. I would like to thank Bro. Norman, his colleagues at Scottish Grand Lodge and Robert Cooper, the Grand Lodge Librarian, for the help and encouragement they have given me during the research for this book.

I would also like to thank Jenny Finder and her library staff at the Bradford University School of Management for their continuing assistance and cheerful acceptance of strange and unusual requests for long-lost books.

The structure and shape of the book emerged from a series of interesting discussions with my editor, Doug Young of Headline, and my agent, Bill Hamilton of A. M. Heath, who helped me grasp the importance and far-reaching consequences of the changes which the Royal Society set in motion and turned my vague idea into a firm project.

I would also like to thank Jo Roberts-Miller, Ian Marshall, Alan Butler, Chris Turner and Hugh Morgan for

their help in the long process of editing and preparing the book for publication.

Finally, I would like to thank my wife and children for their ongoing encouragement.

Acknowledgements

Revised Edition

I would like to thank Simon Thorogood of Transworld Publishing for giving me the opportunity to revise this book in time for the 350th anniversary of the founding of the Royal Society. Since it was first published, in 2002, I have learned more about Sir Robert and his role and am grateful for the chance to revisit the book and to include some extra information.

In April 2007 Gresham College invited me to give a Wednesday Evening Public Lecture entitled Sir Robert Moray - Soldier, scientist, spy, freemason and founder of The Royal Society. The event was hosted by Michael Mainelli, the Gresham Professor of Commerce, who also showed me around the college and its records. I am indebted to Professor Mainelli and the staff of Gresham for the additional information about Sir Thomas Gresham and his foundation, which I have been able to add to this volume. The lecture is available as a web cast from Gresham College (<http://www.gresham.ac.uk/event.asp?PageId=45&EventId=589>).

Many Freemasons have listened to my lodge lectures about Bro. Sir Robert Moray and shared anecdotes about his role in early Freemasonry and I am grateful to them for their hospitality, good fellowship and valued information.

Finally I would again like to thank my wife and family for their continuing support.

PROLOGUE

A Cold Winter's Day in Late November

One of the beautiful things about physics is its ongoing quest to find simple rules that describe the behaviour of very small simple objects. Once found, these rules can often be scaled up to describe the behaviour of monumental systems in the real world.¹

Tim Berners-Lee, 1999

The tall gaunt man walked over to the window and looked out. The previous night had been bitterly cold, and the lawns at the side of his apartment were white with hoar frost. Using what warmth there was in his coarse soldier's hands he melted the ice from inside the casement and looked out east, across the privy gardens towards the cluttered roofs of the palace. The dull grey glow of the low winter sun, as it struggled to climb above the horizon, was giving little hope of anything but an overcast winter's day. Still, he thought, perhaps the rain would hold off a little while.

He wasn't in bad shape for a fifty-two-year-old; he tried to keep himself fit and active. He looked towards the sundial, which he had recently constructed for the King in the centre of the lawns, but the light was too diffuse for it to cast any shadow. As he stood shivering in the winter's chill of that November morning he thought about the meeting he had arranged for the coming afternoon. Was he taking too great a risk in bringing together this group of

men who had been sworn enemies for so long? Would the bonds of a single common interest be enough to persuade these men, who had all suffered so much during the recent war, to sit down together and talk? Was he hoping for too much in trying to persuade them to work together in harmony, to support the newly restored King? He shook his head to clear his thoughts.

A good soldier prepares his battle strategy before the onslaught begins and this man was a good soldier. He knew that it is better to capture an enemy army entire, rather than destroy it. He was aware that to fight, to conquer and then to annihilate his old enemies would not help him to achieve his aims. He needed to break their resistance without a battle. Now was the time to apply the lessons learned during years spent as Quartermaster-General, civil engineer and spy in the armies of Scotland and France. He not only had to persuade his long-time antagonists to work with him, but somehow make them believe that it was their own idea to do so.

How could he do this? Perhaps he could persuade one of the more extreme members of the opposition to chair the meeting? Who, he wondered, had the most to gain? Certainly the man who had lost most was Wilkins. He remembered overhearing that garrulous young clerk of Lord Montagu's prattling on, earlier in the week. He was telling how Wilkins, the deposed Master of Trinity College and once favoured brother-in-law to Cromwell himself, was now reduced to preaching for coppers. This ex-Warden of Wadham College was crammed into the squalid lodging of yet another deposed cleric and struggling to survive. Wilkins was reduced to acting as a chaplain for the penny-pinching lawyers of Grays Inn. He presented such a sorry spectacle that he was beginning to attract voyeurs to the Temple church, to marvel at the extent to which the family of the late Lord Protector could be humiliated.

Yes, Wilkins would be flattered to be asked to chair the meeting, indeed if it was put to him in the right way he would accept it as nothing less than his right. Play to the man's vanity, that was the way to present it. In the uncertain world of Restoration England diplomatic skills learned in the service of the French had their uses.

The clatter of horses' hooves and the rattle of a carriage stopping in the gateway, just below his rooms, drew him back from his reverie. Enough planning and scheming. The time for action had come. The King was forewarned; the King's supporters were already setting off towards Bishopsgate; all that was left was to persuade able men, almost destroyed by the bloody events of the Civil War, to work with him. He felt his mouth go dry in anticipation of the task. But if Britain was to survive the threat from the Dutch, he must succeed. He took a deep breath and turned away from the window.

Sir Robert Moray knew what had to be done and how he intended to do it. He dressed carefully, donning the sombre black clothes he had favoured since the death of his wife. Was it almost ten years since she had passed away? He set off across the privy lawns towards the stone steps that led down to the Thames. Catching a sculler by the riverside he paid his fare to be ferried up river, almost to the Tower. There he disembarked, to walk up through the narrow, cluttered, reeking streets of Bishopsgate to the quiet haven of Gresham College.

After listening to a lecture on astronomy from Christopher Wren, Sir Robert Moray went back to the rooms of Laurence Rooke, to the meeting he had been thinking about for so long. The day was Wednesday, 28 November 1660. I don't really know what he thought and felt that cold November morning, but I know the results. That afternoon he created modern science.

Scientific Order from Political Chaos

So far this introduction has been pure speculation, but speculation based in fact. The man I have just described is a lost hero of science. He is responsible for the remarkable development in scientific innovation that has taken place over the last 400 years and this book is the story of my quest to understand what he did and why he did it.

As a young scientist I learned that one of the highest honours to which a member of the scientific community could aspire was to become a Fellow of the Royal Society (FRS). The Royal Society is the oldest and most respected scientific society in the world; its early members' names lived on amid the physics I studied. Looking down the list of early members was like reading the index of a textbook - Hooke's Law, Boyle's Law, Huygens's construction, Newton's Laws, Leibniz's theorem, Brownian motion; and this is ignoring lesser scientists such as Christopher Wren, John Evelyn, John Wilkins, Elias Ashmole, John Flamsteed and Edmund Halley.

But the men who founded this society were not just the first scientists; they were also the last sorcerers. Ashmole belonged to a society of Rosicrucians and was a practising astrologer; Newton studied and wrote about the Rosicrucian concepts of alchemy, and was fascinated by the nature and purpose of King Solomon's Temple; while Hooke carried out magical experiments involving spiders and unicorn's horns.

The Rosicrucians, who took their name from their symbol of a Rosy Cross, taught about the magical harmony of the spheres, which they said indirectly affected the harmony of the world. This ethereal music emitted strange, unseen, cosmic forces that affected the destiny of humans, and its consequences could be foretold from the positions of the stars in the heavens. They also believed that fire could be used as a means to analyse the nature of matter

and could turn base metals into gold. However, they also claimed to hold conversations with angels and demons.

What inspired such an unlikely group of refugees from both sides of the Civil War to meet, form what was to become the world's oldest and most respected scientific society, and then go on to develop the tools of modern science? This was the question which started me on my quest to understand how the Royal Society came to be formed. In an age dominated by politics and religion I wanted to know where this mixture of clergymen and politicians got the idea of forbidding the discussion of these subjects at their meetings. It seemed a weird thing to do.

I confronted these questions as I first read about the puzzling circumstances of this world-changing event. With the attitudes inbred by a scientific education it seemed to me inevitable that the logic of science should succeed in banishing myth and superstition. In 1660, however, this outcome was not so certain. Was it just good fortune that brought so many important fathers of modern science together at this difficult time and inspired them to develop a new positive logic? Or was there something more?

Only five months after Charles II returned to the throne of England a meeting of twelve ill-assorted men kick-started modern science. And they started calling themselves the Royal Society. For scientific method to develop out of a community that believes in magic is unlikely but when you add into the mix the fact that equal numbers of the twelve founder members of this Royal Society had recently been on opposite sides in the brutal English Civil War, such a fortuitous chance meeting of like minds seems not just improbable but impossible.

In the history of ideas there is usually a path which can be followed backwards, showing where the ideas first appear and how they develop. However, if the traditional accounts of the formation of the Royal Society are to be believed, the concept of experimental science developed

fully formed, independently but simultaneously, on both sides during the Civil War. Then, believe it or not, through a common interest in public lectures, all the members of the two opposing groups happened to meet for tea in London on a misty November afternoon. The rest, of course, is history. Here is how historian Sir Henry Lyons reports it:

Three centuries ago at the time of the civil wars a small group of learned men, who were interested in the Experimental, or New Philosophy as it was then called, made it their practice soon after 1640 to meet occasionally in London for talk and discussion at the lodgings of one of their number, or at a tavern conveniently near Gresham College where they often attended the professor's lectures ... On the Restoration of the monarchy in 1660 those who were in London resumed their meetings that had been discontinued in 1658, and others who had been at Oxford joined them; by the end of the year they and a number of their friends having similar interests resolved to constitute themselves a Society of Philosophers, which they succeeded in doing.²

The survivors of a civil war do not seem the most likely people to start up a new science club. If you had been the starving brother-in-law of a dead and replaced dictator would you have been happy to pay a joining fee, in today's money, of about £1,000 and a refresher fee of £100 a week to aid with the creation of visual aids for your weekly meeting? Would you have insisted on inviting members of the opposing side to join you in these meetings? Or would you have been more concerned with preserving your own and your family's safety? Perhaps you would have been too busy trying to make some sort of income. Yet it was in

these circumstances that the Royal Society of London was formed.

In 1660 England was in the aftermath of a bitter civil war. After the death of Oliver Cromwell the country tottered on the brink of fresh conflict, until the controversial decision was taken to invite the King to return. He was forced, however, to promise to behave himself. In this chaotic atmosphere of Restoration London the Royal Society was formed. It had an extremely high joining fee and a hefty weekly refresher fee, to be paid whether or not members attended.

Sir Henry's quotation paints a delightfully romantic picture of a group of gentlemen scientists casually meeting for dinner and discussion while one of the bloodiest periods of English history rages unheeded around them. During the war sons had been fighting their fathers; brothers had been trying to kill each other; great estates had been despoiled; a King had been publicly beheaded; and royal princes had fled to exile. For twelve years the country had been run on the personal whims of a military dictator and only the threat of another civil war had forced Parliament to restore the King. Yet we are supposed to accept that these learned men, like an eye of calm in the midst of these furious storms, sat down together to chat about how to develop a radical new philosophy of experimental science. Only the perfect vision of hindsight can make this seem natural.

When Sir Henry Lyons wrote his definitive history of the Royal Society in 1944 he was concerned with recording *what* had happened. But he didn't ask the question that has interested me since I first read his account. *Why* was it created?

Its founders questioned the basic premises of religion and theology. Yet they managed to avoid conflict with the extreme fanatics who were forcing their views on everybody else. Having successfully avoided the notice of the Covenantors, the Levellers, the Fifth Monarchists, the

Papists and the followers of the *Book of Common Prayer*, they were able to investigate such heretical matters as the practicality of witchcraft – and nobody challenged them.

Historian Arthur Bryant credits Charles II with a zeal for experimental science that led him to inspire the Royal Society:

With the return of the King, who had little use himself for abstract religious formulas, and preferred to test everything by his own keen commonsense, the new generation came into its own. Shortly after the Restoration, the Royal Society was founded in Gresham College, and the King became its first patron. When its members placed a spider in the midst of a circle of unicorn's horn, and the insect, disregarding the hallowed beliefs of centuries, 'walked out' – as the Society's minutes briefly record – something momentous happened.³

This account of the King's personal interest is charming but unlikely. The experiment Bryant describes was an important step away from magic towards science, but the King was never the major driving force that Bryant implies.

It was no small feat for the founders of the Royal Society to develop a questioning, scientific philosophy at the time of the civil wars. To constrain a spider using the horn of a mythical beast (in reality the horn was that of a rhinoceros) was to practise witchcraft and to flout convention. Just twenty-three years earlier, during the rule of the Long Parliament (1645–7), Matthew Hopkins, the Witchfinder General, executed 200 old women for practising witchcraft. Magic and miracles were part of everyday life. Witchcraft was an acceptable explanation for ill fortune. Historian George Trevelyan writes that before the Restoration 'it would have been difficult to find more than a handful of

men who openly avowed disbelief in the miraculous sanctions of the Christian faith'.⁴

Yet by 1667 the official historian of the Royal Society, Bishop Thomas Spratt, speaking on behalf of its founders, wrote that the ancient miracles of bible times were privileged phenomena, unusual examples of God's interference with his creation, unlikely to be repeated. 'The course of things goes quietly along in its own true channel of natural causes and effects,' he wrote.⁵

The founders of the Royal Society avoided the problems of faith by accepting the Church's view on God and the soul, but questioned everything else. But, if they developed their questioning views during the time of Matthew Hopkins, they must have kept quiet about them or they would have been persecuted. Yet for these ideas to appear fully formed, in 1660, they must have been growing for a considerable time. How did the members of the Royal Society gain the freedom to test and refute witchcraft, and publicly laugh at 'Popish miracles', as evidence of superstitious belief?⁶

Why had nobody noticed these ideas germinating? Why, within the first few weeks of the Restoration, did science suddenly break free of the stifling dogma of religious belief and the repressive superstition of magic, which had gripped it for hundreds of years? How did it manage never to look back?

This change in attitude was vital. In the seventeenth century religion was undergoing a revolution. For the previous thirteen hundred years the Church had systematically built an imperial faith, loosely related to the teachings of Christ and strongly supported by a verbal theology. To preserve its power the Church had to protect that theology. To keep their dogma intact and pure, churchmen were extensively trained in methods of argument and disputation known as logical deduction. The

Church controlled all the universities and set the agenda for education. This control can be seen in their treatment of Galileo's famous gravity experiment (said to have been conducted from the Leaning Tower of Pisa). His results showed that bodies of different weights fell at the same speed but his conclusion was 'logically' disproved by the negative 'thinkers' of the Inquisition. Using theology to disprove experimental observation is something we find difficult to understand today, but that is because the whole basis of thinking about physical events changed during the seventeenth century.

That change came about because a group of men met in London and decided to set up a society to study the mechanisms of nature. To make sure they were not distracted by dogma they forbade the discussion of religion and politics at their meetings. From this group, modern experimental science grew.

There had to be more to this story than the superficial record revealed, and so it proved to be. This book tells the story of my quest to discover the political, economic and religious background to the formation of the Royal Society and how, in the process, I uncovered the hidden motives of one man, Sir Robert Moray. But before I could hope to understand how the influence of the Royal Society came about, I needed to look at the status of science before that fateful meeting of 28 November 1660.

CHAPTER 1

A World before Science

A new and unprecedentedly effective form of knowledge and way of doing things appeared suddenly in Europe about 400 years ago. This is what we now know as science.¹

Bryan Appleyard

SCIENCE IS NOT common sense. Your eyes tell you that a chair is a solid object that you can safely sit on, but science tells you that the material of the chair is made up of many small parts with spaces in-between them. You could fall through these spaces. Yet you sit on the chair and it feels just as solid as it looked; but you still believe the scientist who explains that it is mainly empty space lightly sprinkled with atoms, even though the atoms are far too small for you to see.

If you stand on a pebbly seashore, idly tossing stones out to sea, you expect to see your missiles fall in a curve into the near distance before plopping satisfyingly into the waves. You don't expect the stones to fly off in a dead straight line and disappear towards the horizon. But science tells you that any object continues to move in a straight line with unchanging speed unless a force acts upon it. Unless you are an astronaut you have never seen this happen and yet you believe it to be true.

If a stranger, offering to turn all your base metal into gold, stopped you in the street you would be suspicious and

think you were being tricked. Yet when British Nuclear Fuels turns chunks of uranium into weapons grade plutonium you accept the miracle as an everyday event.

In each of these examples we are prepared to believe in things quite different from what we see happening around us. We do this because we have been brought up in a society that accepts scientific explanations of the world.

Science is a way of thinking that not only explains events that have been observed but also predicts new facts that may be undreamed of. In 1687 Sir Isaac Newton put forward a new theory of gravity. It is still in use today, for example, in working out the orbits of the satellites that bring us our television signals, although not those that control our satellite navigations systems, as they need the higher level of accuracy that Einstein's theory provides. But when Newton first published his ideas he contradicted two of the current theories about comets. The more popular one was that comets are a signal from an angry God warning that He will strike sinners and bring disaster. A less popular, and less dramatic, idea had been put forward by Johannes Kepler. He said that comets are celestial bodies that move in straight lines across the heavens. Now according to Newton's theory, some comets move in hyperbolas or parabolas, never to return, while others move in ellipses and come back again and again. At the time this was an incredible thought. However, the Astronomer Royal, Edmund Halley, used Newton's theory to observe a comet in the sky and predict when it would return. Seventy-two years later, it did return and Halley's Comet has been eagerly watched by succeeding generations ever since. Halley's successful prediction did much to encourage the use of science as a way of thinking about the world.

Until the sixteenth century people believed magic was the best way to explain how the world worked. Queen Elizabeth I had a court magician called John Dee. He first

came to the notice of Elizabeth's elder sister Queen Mary, when he tried to bewitch her and she, in turn, imprisoned him. When Dee was freed he took up with another alchemist, Edward Kelly. They travelled about Europe, indulging in a bit of wife swapping and seeking an elixir of eternal life. When Dee returned to England, in a state of poverty he claimed to have invented this elixir. His method of developing the magical liquid was different from the way a modern pharmacologist works. Dee said that he worked with an angel by the name of Uriel, who was privy to all God's knowledge of the world. Now such a responsibility is not normally given to just anyone and so Dee had to persuade the angel to part with this knowledge. He used the following incantation to summon the angel. (I suggest you don't try this spell at home, just in case it still works!)

Facilius Sine Comparatione a Deo impetrandum
foret, vel a bonis spiritibus, quicuid homini utile
reputare

The angel spoke his own language, which he taught Dee to read and write. As well as giving Dr Dee the recipe for the elixir of eternal life this angel also predicted that Britain would have a vast empire. Dee recorded these conversations in various manuscripts.

He carried out magical levitation displays using an obsidian stone which came from South America and talked to his pet angel using a conjuring table which was engraved with the Enochian alphabet (the script used by the angels). These artefacts are now in the British Museum but, sadly, they seem to have lost their magical powers. (I did try reciting Dee's incantation above the table but it remained stubbornly mute.)

Despite his strange choice of research colleagues and his predilection for conjuring tricks Dee was a competent mathematician. He secured his position as court seer at the

court of Elizabeth when he revealed himself to the new queen as a master of electional astrology. Using the magical knowledge he had acquired from his conversations with angels he convinced the Queen that he could calculate the most fortuitous date for her coronation, a date when the stars would favour her reign. He later advised the queen against adopting the Gregorian calendar, on the basis of his calculations.

Dee's mathematical methods and astronomical observations were at the cutting edge of Elizabethan technology, yet he was a firm believer in magic. However, Dee outlived Elizabeth, so obviously his elixir didn't work for her. Elizabeth, the Virgin Queen, left no direct heirs and her crown passed to the line of the Stuarts. The new King, James I, sent Dee packing. Dee died soon afterwards, and remains dead to this day, yet another sad victim of the failure of his elixir of eternal life.

It was during the reigns of the Stuart Kings that magic died and science replaced it.

Winston Churchill said of James, the first Stuart King of England:

He came to England with a closed mind and a weakness for lecturing. England was secure, free to attend to her own concerns, and a powerful class was now eager to take a hand in their management. Who was to have the last word in the matter of taxation? Was the King beneath the law or was he not? And who was to say what the law was? The greater part of the seventeenth century was to be spent in trying to find answers to such questions.²

This questioning process involved civil war and regicide before answers were found, but in the midst of the battles between King and Parliament we are expected to believe

that modern science suddenly popped into being. No reason is given as to why this should be. Why a country which burned alive at least 100 elderly women a year, on suspicion that they were causing disease by casting the 'evil eye', should spontaneously develop a critical mass of discerning scientists is never questioned.

Belief in magical forces did not die instantly, not even among the founders of the Royal Society. It was still alive and well during the Civil War. In 1657, when Christopher Wren, later to become a founder of the Society, gave his inaugural lecture as Professor of Astronomy at Gresham College, he spoke of how London was particularly favoured by the 'various celestial influences of the different planets; both as the seat of the mechanical arts and trade and the liberal sciences'. No modern professor of astronomy would dream of suggesting that the planets were capable of celestial influences, let alone that they might influence the future prospects of a city and its sciences.

Even the King, who in his spare time had become the patron of modern science, thought it perfectly normal to pay an astrologer to cast a horoscope for the best time to lay the foundation stone of the new Saint Paul's, after the Fire of London. Yet in this intellectual climate science began.

The Eternal Sky, Religion and Knowledge

The word science comes from the Latin word for knowledge, *scientia*. Modern science has two main functions: it enables us to know things and it enables us to do things. The success of science, as a means of searching for truth, is judged on how well it enables us to cope with our environment, and modern science has been very successful in improving our standard of living. We now judge science by how well it solves our problems, because the ground rules moved in the seventeenth century. Before

the Royal Society changed our worldview, however, philosophers thought that a statement was true if enough people maintained a strong enough belief in it.

In 1589, when Galileo performed his famous experiment to see if heavy objects fell faster than light objects, his results showed that both fell equally fast. These results, however, were denounced by the Inquisition on the grounds of dogma, without any supporting evidence. The belief system that allowed this to happen sprang from an unholy alliance between the wisdom of Aristotle and the Church's assertion that it possessed the great Truth of Salvation. The Church's Truth said that God had made the world for the benefit of man and had sent His own Son to ensure men understood His message.

But what had Aristotle, a Greek philosopher who had been dead for hundreds of years before the birth of Jesus, got to do with Christian Truth? This question puzzled me so I decided to look at how this worldview, held by many people in the sixteenth century, developed.

Before the seventeenth century people believed that the earth was the centre of the universe; that the sun, the stars and the planets moved in circles around it; that the stars were made from an imperishable celestial fire; that they were arrayed throughout the universe on great transparent crystal spheres; and that the world had been created at precisely half past four on the afternoon of Thursday, 22 October 4004 BCE.

Aristotle comes into this story, even though he died in 332 BCE, because he was such a popular and prolific writer. Many copies of his writings survived the collapse of the Greek empire, and were collected in Alexandria by Ptolemy. They took on an important role in Arab culture and eventually were brought back to Europe by the Crusaders. So Aristotle's writings became the basis of a medieval rediscovery of classical learning.

Aristotle presented his views on science in two books, *Physics* and *On the Heavens*. His ideas are based on two important phenomena: the movement of animals and the movement of the heavenly bodies. Living things move but dead things do not. It follows, therefore, that all movement is the result of the action of Will, either animal or divine. This led him to a worldview dominated by causes and purposes. All things above the moon are incorruptible and eternal; while all things below are subject to generation and decay. The earth is the centre of the universe and is made up of four elements: fire, earth, air and water. The stars, revolving in pure circles on their crystal spheres, are made up of a fifth heavenly element. Everything has a purpose and it is the task of the philosopher to discover these purposes.³

Aristotle, no matter how much classical dons like to praise him for his accuracy of observation, cannot always be trusted implicitly. He insisted that women have fewer teeth than men. He married twice but looking into his wives' mouths and counting their teeth never seemed to have occurred to him. Perhaps he was afraid they might bite him. They would have had good cause because he also believed that children are healthier if they are conceived when the wind is in the north. (I have a whimsical image of him sending both Mrs Aristotles out from the marital bed to look at the weather vane whenever they cuddled too close to him. Or perhaps he didn't trust their base instincts and went out to check for himself, which in those days of naked sleeping leads me to worry whether or not his preparedness for the act of conception survived the ravages of exposure to the cold north wind.) Some more of his outlandish claims are that the bite of a pregnant shrew is dangerous to horses; that insomniac elephants can be sent to sleep by rubbing their shoulders with salt, olive oil, and warm water (would you dare try it?); and that a man

bitten by a mad dog will not go mad, but any other animal will.

Aristotle had many failings as an impartial observer but Christianity had no better way to explain the nature of the stars. Until 1266 Christian myth simply could not match the self-consistent and logical framework of Aristotle's splendid cosmology. In that year Thomas Aquinas wrote his theological Great Theory of Everything. In *Summa Theologiae* he accepted and improved on Aristotle's theories. Aquinas insisted that the cause of the universe is God's intention that man should be saved from sin and hell and God carried out this aim by the personal intervention of His Son, Jesus Christ. Aquinas concluded that knowledge of the world could only be an expression of the knowledge of the love and infinite wisdom of God. No mere human could question this Divine Will since its truth was not based on human confirmation but on the authority of God. An attitude like this does not encourage casual questions, and inconvenient facts that do not fit into the Church's view of this world must be discarded, because if the facts don't fit this theory then it must be the facts that are in error. God cannot be to blame. This sort of reasoning was how the Church justified its treatment of Galileo.

The Persecution of Galileo

In 1633, Galileo (if not the inventor of the astronomical telescope certainly its first professional user) fell foul of theology. He was summoned to Rome and forced by the Inquisition to make the following public statement:

I, Galileo, kneeling before you, most Eminent and Reverend Lord Cardinals Inquisitors-General against heretical depravity throughout the whole Christian Republic, having before my eyes and touching with my hands the Holy Gospels, swear that I have always

believed, do believe, and by God's help will in the future believe, all that is held, preached, taught by the Holy Catholic and Apostolic Church. But whereas after an injunction had been judicially intimated to me by the Holy Office to the effect that I must altogether abandon the false opinion that the sun is the centre of the world and immovable, and that the earth is not the centre of the world and moves, and that I must not hold, defend, or teach in any way whatsoever, verbally or in writing, the said false doctrine.⁴

The Inquisitors-General of the Holy Catholic and Apostolic Church had total blind faith. They knew that the earth sat immovably at the centre of their universe; and this mistaken view held firm against a mass of contrary evidence from their own observatories.

The Church, following the Jewish tradition, defines Easter as the first Sunday, after the first full moon, after the spring equinox. To plan their ecclesiastical calendars the leaders of the Church need to be able to predict the dates of full moons many years ahead. Now the cycle of the moon is unrelated to the solar calendar, which makes Easter a movable feast that can vary from 21 March to 23 April, dependent on the phase of the moon and the exact day of the vernal equinox.

In the fifteenth century Cosimo de Medici, the ruler of Florence, commissioned a rising young draughtsman called Egnatio Danti to build a solar observatory to predict the date of Easter. It consisted of a hole in the roof of a dome that would focus the sun's rays on to a scale on the floor of the building. By reading the scale it was possible to know the exact day of the equinoxes. Such solar observatories, known as *meridana*, were built into many churches, the

most famous being within the dome of St Peter's Basilica in Rome.⁵

Systematic observations of the path of the sun's rays within these *meridana* soon showed that the sun did not revolve around the earth in a perfectly circular orbit, as Aristotle and Aquinas had taught. It could clearly be seen that the shape of the sun's image changed from a circle to an ellipse with the movement of the seasons. During winter, when the sun was low in the sky the sunlight hit the hole at a different angle from the rays of the higher summer sun. The dogma of the Church said the earth was fixed and the sun rotated about it in a perfect circle, since God could not make anything that was less than perfect. For this to be true the shape of the sun's image projected by the ecclesiastical *meridana* should have remained a perfect circle. It didn't.

But that wasn't all. The priestly keepers of these observatories also noticed that the angle between the earth and the sun changed slightly with time. (We call this phenomena precession and it is caused by a slight wobble in the axis of the earth.) If you follow the logic of Galileo's forced confession there is only one acceptable explanation for this behaviour. To support their faith the seventeenth-century Church, and its Inquisitors-General, had to publicly profess a belief that the entire universe dances and turns about the immovable throne of their Pope.

Giovanni Cassini was an astronomer in the seventeenth century who worked for one of these immovable Popes. By combining the data from St Peter's *meridana* with his own telescopic observations he was able to predict accurate orbits for Mars and Venus and also find several new moons going round Saturn. He used mathematical techniques that assumed the planets and the earth were moving in elliptical orbits about the sun. But he never ever dared to give an

opinion on the earth's immobility. Perhaps he didn't want to have to make a public confession of his errors.⁶

When modern science was born, the most relevant and powerful knowledge was about God, the Devil, Heaven and Hell. To make a mistake about these matters involved punishment by eternal damnation. This naturally made theologians careful. Theological knowledge could not afford to be fallible; it must be beyond doubt. This is the intellectual environment where the Royal Society took root. It was not the most favourable climate to encourage an open, questioning attitude towards the workings of nature.

Revolutionary Ideas

As science grew away from superstition and magic it gave birth to technologies. This gave it greater political importance. The strength of the Tudor monarchs was built on the technology of artillery and the use of gunpowder. The invention of the mariner's compass enabled ships to navigate to the New World of the Americas. Ever since, the main interest most rulers have shown in science is how to use it to increase the power of their weapons of war, or improve the strength of their military forces.

The year the Royal Society was born, religion was an important issue in England. One of the causes of the bitterness of the Civil War was difference in doctrine between the two sides. Indeed, it was the disarray of the various religious factions that enabled General Monck to bring about the Restoration. Any form of fanaticism can lead to an intolerant society. If you are an intense believer in any religious idea you might be prepared to face martyrdom, you might seek a life of great hardship and even enjoy a happy death if you believe it is your route to paradise. You may inspire converts, create armies, promote hatred of any dogma that your cause does not accept and