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CHAPTER 7

The Sorcerer's Apprentice

God is subtle but he is not malicious.
ALBERT EINSTEIN[1]

Continue east about four hundred yards from the end of Oxford Street, take a turn into Museum Street and then, at the end, right into Great Russell Street, and you quickly come to the gate of the British Museum. Dodging the tourists, walk up the front steps and through the bag-checkers into the main reception. To your left is the main staircase, a massive two-tier, stone ensemble as wide as a house. At the top stands the Roman gallery, and as you pass through the rooms you move across the centuries – Early Medieval, Late Medieval, Middle Ages, Rooms 41, 42, 43 . . . In Room 46 you will find the Tudor collection, and there, in the far left exhibition cabinet, lies something quite extraordinary. Walk up to it and crouch down. On a glass shelf at waist height, settled on a plastic cradle, is the crystal ball of the alchemist and philosopher John Dee. No more than three inches in diameter and perfectly smooth, it looks black from some angles, translucent from others. Behind it, a few inches away, stands an electronic thermometer and humidity-sensor, its digital display flashing and a red LCD blinking discreetly.

After withdrawing your gaze from the ball's depths and retracing your steps, back from the museum to the tarmac beyond, the Nikons and the Sony camcorders, as you wander through the exhaust fumes of Oxford Street and the twilight of the late twentieth century you have straddled the divide between myth and science, metaphysics and physics, from magic to mechanic, from John Dee to Isaac Newton.

Newton did not distinguish between these things so readily as we do now. For twenty-seven years, from 1669 until he left for London in 1696, Newton pursued a vast collection of themes both scientific and alchemical, as well as subjects as seemingly diverse as biblical chronology, numerology, history and mythology. Newton seems to have led a double life during the 1670s – the scientific inquirer, moulder of a new approach to science, a revolutionary genius and far-sighted revealer of truth, coexisted in covert harmony with the occultist, the seeker of the ancient flame of wisdom and arcane knowledge. He juggled the responsibilities of his position in the academic world with his clandestine and totally heretical ideas, keeping hidden his unorthodox and socially unacceptable religious views.

Newton's earliest interest in alchemy stemmed from the Grantham apothecary shop, and he learned from the kindly Mr Clark a great deal about the apothecary's art. From his schooldays, Newton loved to create strange concoctions, not simply from curiosity but also because he was a hypochondriac (a facet of his character that grew more pronounced as he grew older). Wickins was witness to some of his methods in Cambridge: 'He sometimes suspected himself to be inclining to a consumption, & the medicine he made use of was the Lacatellus Balsam which, when he had composed himself, he would now & then melt in quantity about a quarter of a pint & so drink it.'[2] This, it turns out, was a delicious combination of turpentine, rose-water, beeswax, olive oil, sack and red sandalwood. Newton considered it so powerful that, as well as drinking it, he often applied it externally, finding it useful for 'green wounds' and 'the bite of a mad dog'.[3] He also wrote in praise of the curative powers of opium.[4] Isaac Barrow was keen on the drug and probably introduced him to it.

In his boyhood fascination with odd draughts, we may also see the early rationalist. He kept meticulous records of his experiments and noted any recipes he came across in the apothecary's books or specialised treatments that Clark himself had heard about or contrived. Later, sometime during the early 1660s, he became interested in what was considered 'conventional chemistry', as opposed to alchemy. The difference between the two disciplines was subtle. Chemists and alchemists dealt with the same compounds, even used the same apparatus and shared inherited knowledge; what lay between them was approach and intent.

Chemistry was considered by many as rather vulgar – a gross and unsubtle pursuit. Alchemists considered themselves superior to chemists principally because of its practitioners' belief that alchemy required an interaction between experiment and experimenter and that to be a successful alchemist one had to be pure of spirit, to 'receive' understanding by divine transmission. The fifteenth-century alchemist Thomas Norton said of this talent, 'A most wonderful majesty and archimajesty is the tincture of sacred alchemy, the marvellous science of the secret philosophy, the singular gift bestowed upon men through the grace of Almighty God – which men have never discovered through the labour of their own hands, but only by revelation and the teaching of others.'[5]

By becoming spiritually involved with a 'divine' process, the alchemist believed he could share in its divinity. Whereas alchemists were in pursuit of mythical goals and wrapped their work in mysticism and occult meaning, 'chemists' worked in a manner which passed as empirical (at least for the time) and, most importantly, they were not usually motivated by greed or the pursuit of dreams as were many charlatan alchemists. Instead, chemists were considered to be little better than craftsmen or tradespeople. Apothecaries, dyemakers, tanners, brewers and distillers all practised chemistry within their narrow specialisms, and their techniques formed collectively the canon of chemical knowledge.

Alchemy evolved into chemistry as practised later by rationalists and post-Industrial Revolution 'scientists', but Newton was travelling in the opposite direction. First he absorbed the limited arena of conventional chemistry, then he moved on to what he considered the more exciting realm of alchemy – a subject which must, to his eyes, have held almost limitless potential.

During Newton's life and until the work of Lavoisier, Dalton, Priestley and others in the late eighteenth century, the intellectual (as opposed to the motivational) foundations of chemistry and alchemy overlapped. Those who tried to get to the root of chemistry inevitably found themselves faced with a wall of alchemical lore, and those who wished to acquire the philosophers' stone either followed a confusing path through myth and magic or else they built on a very limited chemical tradition. So 'chemists' such as Robert Boyle were as involved in alchemical pursuits as much as they were with chemistry experiments, and many alchemists inadvertently developed concepts and practical skills later requisitioned by the chemist.

Newton began his studies in alchemy and chemistry around 1667. In typical fashion, he compiled a glossary, or dictionary, which included chemical names, apparatus and a list of terms, in all about 7,000 words in length, with each term and name having a brief definition.[6] The dictionary is almost exclusively 'chemical' in content, and in this single document is to be found almost the entire chemical knowledge of the time. But even then, shortly after returning to Cambridge and some two years before acquiring the Lucasian Professorship, he was aware of the need for secrecy. In the dictionary there are a number of sensitive terms which fit into the alchemical school rather than formal chemistry – words such as *Anima*, meaning the innermost aspect of the personality, and *Elixar* [*sic*], meaning the elixir, the mythical panacea or cure-all sought by many alchemists. Strikingly, all of these entries are left undefined.*

As well as cataloguing the foundations of the discipline, Newton later kept to his usual technique of absorbing as much information about the subject as he could before venturing into the realm of experiment himself. His mentor in this new field of study was Robert Boyle, at the time acknowledged as the greatest living authority in the field of chemistry.

As an undergraduate, Newton had made notes on Boyle's work, and he would probably have cited him along with Descartes as one of his intellectual forebears. But Boyle's influence upon Newton continued and grew as Descartes's waned.

Although Robert Boyle did not revolutionise chemistry to the extent that Newton upturned physics, comparisons may be drawn between the ways in which the two men used alchemy. Boyle practised alchemy as well as chemistry and utilised many of the esoteric aspects of the former to push forward the theoretical limits of the latter. What he laid down as formative concepts, Lavoisier, Priestley and others later confirmed by experiment and put to practical use. Boyle was an atomist who believed that the shapes and natures of individual atoms created differences in chemical behaviour. He proselytised the concept of basic elements that could be combined into groups (molecules) which could be broken down again and rearranged – all hypotheses later integral to the chemical revolution of the late eighteenth and early nineteenth century.

* These omissions may of course have been simply due to his not having discovered suitable definitions at this stage.

Born the fourteenth child and youngest son of the first Earl of Cork in 1627, Boyle led the life of a wealthy aristocrat. He was educated by a tutor at home and then at Eton and showed an early flair for languages, becoming fluent in both French and Latin by the age of eight. As a teenager he travelled Europe with an older brother, Francis, and a tutor, making a grand tour of Italy and France which lasted from 1638 until soon after his seventeenth birthday. In Italy he discovered the work of the recently deceased Galileo (who had died in 1642) and became interested in science. Then, when his father died suddenly, he and his brother were called back to England and Robert lived quietly in Dorset, where he practised alchemy and dabbled in a range of scientific and pseudo-scientific experiments for the best part of a decade. In 1654 he moved to Oxford, where he conducted experiments with a vacuum pump designed and built for him by Robert Hooke, and he became one of the founders of the 'Invisible College' – the earliest form of the Royal Society.

Newton and Boyle met publicly for the first time in 1675,* and their publicly recorded correspondence began a year later, when Newton became interested in Boyle's 'Of the Incalescence of Quicksilver with Gold', published in the Royal Society journal, ***Philosophical Transactions***.

Boyle had begun his alchemical experiments some twenty years before Newton, in 1646, and, as well as writing a collection of secret texts, he had already published several books. The most important and influential was ***The Sceptical Chymist***, published in 1661, in which he laid the cornerstone of many of his theoretical ideas in chemistry and made a clear and definitive distinction between chemistry and alchemy. Although he was a practising alchemist, enamoured of the art, he did not see it as influencing his chemical work. For his own reasons, and perhaps not merely for the sake of clarity, Boyle insisted on separating the two fields and treating each differently. He published his chemical discoveries freely, but kept most (though not all) of his alchemical findings to himself and his close circle of friends and associates (including Newton).

* They may have met earlier than 1675 at secret meetings of alchemists at Ragley in Warwickshire, the home of Viscountess Conway, under the aegis of Henry More.

Boyle and Newton had very different approaches to public awareness of alchemy. Although Boyle did not shout his alchemical discoveries from the rooftops, he was not nearly so secretive about his work as Newton. Indeed, 'Of the Incalescence of Quicksilver with Gold' dealt with alchemical themes, and when Newton heard that Boyle wanted to make it available to a wider readership he railed against the idea. In a letter sent to Henry Oldenburg, the Secretary of the Royal Society, with the explicit instructions 'keep this letter to yourself', Newton strongly recommended that Boyle should not communicate his alchemical findings to the world:

> It may possibly be an inlet to something more noble, not to be communicated without immense damage to the world if there should be any verity in the hermetic writers, therefore I question not but the great wisdom of the noble author will sway him to high silence till he shall be resolved of what consequence the thing may be either by his own experience, or the judgement of some other . . . that is of a true hermetic philosopher . . . there being other things beside the transmutation of metals (if those great pretenders brag not which none but they understand).[7]

After they became friends, Newton often suggested that Boyle should disguise his authorship of papers, and tried to spread his own insecurities and paranoia to the older man. Boyle seems to have ignored this advice. He was a wealthy man, and from an old and powerful family: perhaps this insulated him from fears of exposure as a magician. Like Newton, he was a devout Christian, but he had refused to take holy orders (he despised the taking of oaths in general), and because of this, in 1665, he had denied himself the provostship of Eton.

Boyle was not stimulated by the same intense desire to rediscover 'lost secrets'. He was a far more extrovert and socially well-adjusted man who pursued knowledge for the sake of it from a position of extreme comfort and financial security. In some respects he anticipated the stereotype of the 'gentleman scientist' which became familiar in Georgian and early Victorian times through men like Erasmus Darwin and his more famous grandson Charles. It is easy to see why Newton was so careful about concealing his own interest

in alchemy – he was terrified of losing the things he had struggled to acquire. Boyle could afford to be carefree.

Newton began to gather his research materials and to buy laboratory apparatus during a succession of trips to London. During the first of these, sometime during late 1669, he was introduced to a network of alchemists and specialist book-dealers who could obtain important texts from all over Europe.

He would take the stagecoach at the Rose public house in Cambridge and end his journey at the Swan tavern in Gray's Inn Lane, Holborn. From there it was only a short trip to Little Britain, an area famed as the literary centre of the capital.

His most useful contact was one William Cooper, a man of impeccable reputation but also a dealer in illegal and highly sought-after manuscripts. Through Cooper, Newton acquired some of the most important alchemical tracts available at the time anywhere in Europe, including the ***Theatrum Chemicum*** by Lazarus Zetzner in six volumes and a collection by Eirenaeus Philalethes called ***Ripley Reviv'd***, based upon the works of the fifteenth-century English alchemist George Ripley, that was only later published in England (in 1678). The bookseller obtained all of these through the underground network of alchemists and experimenters in London and beyond.*

On this first trip to London Newton bought and himself took back to Cambridge a set of chemicals (costing £2) and ordered two furnaces to be delivered to his rooms in Trinity. One of these was made of tin and cost seven shillings; the other, of iron, was priced at eight shillings. These provided Newton with the basic materials for setting up his own laboratory. The furnaces arrived early in the New Year and were duly installed in the rooms he shared with the ever-tolerant John Wickins. But, more importantly, by making contact with Cooper and other dealers in the capital, Newton had also tapped into a wholly secret society of alchemists that had flourished for centuries and secretly pervaded all strata of society, extending tendrils into many diverse areas of intellectual life.

The original founders of the Royal Society, a group that evolved

* Eirenaeus Philalethes has been shown only in this century to be the London alchemist George Starkey, who was a friend of the scholar Samuel Hartlib and practised alchemy until the 1660s.

into the very epitome of empirical, 'conventional' science, may in their early days have called themselves the 'Invisible College', but the real invisible college was the network of nameless adepts who kept alight the alchemical flame. These men operated covertly within the same city as the Royal Society – London – and included many of their number.

The London alchemists of the mid seventeenth century had centred around Samuel Hartlib. Hartlib had arrived in England from Polish Prussia in 1625 and had immediately begun to infiltrate the existing network of alchemists and magicians via contacts already established between the English and their European counterparts during the past century or more. The Hartlib Circle, as the group became known, grew in importance during the 1640s and '50s and included Sir Kenelm Digby (author of ***A Choice of Rare Secrets and Experiments in Philosophy***, published by William Cooper in 1682), George Starkey (Eirenaeus Philalethes), Thomas Vaughan (Eugenius Philalethes), Hartlib's son-in-law Frederick Clodius, and Robert Boyle.

The Hartlib Circle aimed to rationalise alchemy by marrying alchemical lore with the intellectual framework of mechanical philosophy; they may thus be thought of as providing the link between vague, personalised medieval alchemical practice and the foundations of empirical chemistry. Alchemy was recognised by most practitioners as an amalgamation of the spiritual and the practical, but the spiritual side had usually predominated. Europe was littered with laboratories where alchemists had slaved over the flames in attempts to realise their dreams, but, until Hartlib and his associates, very little attempt had been made to develop a rationalised alchemical system.

The most famous member of the Hartlib Circle was not Hartlib himself (he was more a facilitator) but Robert Boyle. As well as being almost certainly the ablest experimenter, he was also the most accomplished natural philosopher of the group, a man who represented the ideals and philosophies of the circle in their most intellectual form. His ***The Origine of Formes and Qualities***, published in 1666, was a distillation of all the Hartlib Circle had achieved during the previous three decades and provided Newton with an intellectual framework for his own alchemical explorations.

Another key figure in the movement, and the most likely man to have linked the Hartlibians and Newton, was Henry More. When

he was not in Cambridge, More spent as much time as he could at the home of his pupil and close friend Anne Finch, the Viscountess Conway. The Viscountess provided More with rooms at her country estate of Ragley, in Warwickshire, where he could host meetings to discuss and experiment. Ragley soon became a focal point for the Hartlib Circle and also for a growing body of intellectuals interested in alchemy who remained on the periphery of the group. Gatherings of such thinkers continued to be popular long after Hartlib's death in 1662, and may have been frequented by Newton during his early alchemical career.

Sadly, there is almost no Newton correspondence from the early 1670s referring to anything alchemical,* but it is known that he left Cambridge for extended periods on a number of occasions during those years, and his appearance at gatherings at Ragley would have been quite in keeping with his yearning for discovery and his known association with Henry More.

The alchemists of the period referred to one another by codenames. Thus within the surviving correspondence of this group we have a mysterious 'Mr Petty', a 'Mr Gassend' and, most intriguingly, references from Newton to a 'Mr F'.

It now seems likely that Mr F. was Ezekiel Foxcroft, a fellow of King's College, Cambridge, between 1652 and 1675. He was a close friend of More and was described by contemporaries as 'being interested in chemistry'.[8] The only surviving correspondence between him and Newton is an alchemical manuscript entitled 'Manna', copied in an unknown hand, at the top of which Newton has written, 'Here follows several notes & different readings collected out of a MS communicated to Mr F. by W.S. 1670, & by Mr F. to me in 1675.'[9]

Further into the document, Newton gives us a rare insight into his own feelings about alchemy and his approach to the art:

> For alchemy does not trade with metals as ignorant vulgars think, which error has made them distress that noble science; but she has also material veins of whose nature God created

* However, this is an unusual gap in the sequence of his letters, suggesting that there was once a collection of correspondence that has since been lost.

handmaidens to conceive & bring forth its creatures . . . This philosophy is not of that kind which tends to vanity & deceit but rather to profit & to edification inducing first the knowledge of God & secondly the way to find out true medicines in the creatures . . . the scope is to glorify God in his wonderful works, to teach a man how to live well . . . This philosophy both speculative & active is not only to be found in the volume of nature but also in the sacred scriptures, as in Genesis, Job, Psalms, Isaiah & others. In the knowledge of this philosophy God made Solomon the greatest philosopher in the world.[10]

Newton may have contributed texts to the network, although this has never been established beyond doubt. In a perverse way, he would have been more relaxed about submitting alchemical conclusions to the scrutiny of his peers within the secret society than he was about offering his 'scientific' papers to the Royal Society. This is almost certainly because of the covert nature of the process. Newton guarded his privacy jealously and could not stand being challenged over his ideas. Years later he disliked dealing with anyone but Henry Oldenburg in preparation for any of his publications through the Royal Society. Most significantly, as an alchemist, he too could hide behind a pseudonym. Revealingly, his was 'Jeova Sanctus Unus' – One Holy God – based upon an anagram of the Latinised version of his name, Isaacus Neuutonus.

So, armed with his knowledge of the mysteries, his early, tentative links with the alchemical underworld established and a study filled with furnaces, laboratory equipment and chemicals, what did Newton actually set out to do?

To the modern eye, his earliest experiments seem decidedly prosaic, but he was feeling his way into the subject, following the clearly defined path laid down by his predecessors – in particular Robert Boyle. Yet, from the earliest experiments, Newton's methodical approach distinguished him from almost all of the thousands of alchemists who predated him. From the start he applied his practised methods of note-taking, meticulous attention to detail and a genius for observation.

He began by opening a laboratory notebook.[11] The earliest experiments are almost certainly from 1669 and, in keeping with the alchemical tradition, they are concerned with the nature of metals.* In particular, he was trying, like many before him, to find a way of 'opening' metals – to make them change their characteristics.

Of all materials, mercury was the most important to the alchemist, for, by tradition, a substance called 'philosophers' mercury' (sometimes 'our mercury') was the vehicle by which metals could be transmuted. According to Charles Nicholl in his book ***The Chemical Theatre***:

There are two directions in which alchemical mercury leads us. On the one hand, it is a complex elaboration of a chemical substance, its various qualities referring back to the properties of quicksilver, or 'common mercury' . . . But there is another direction entirely, away from chemical matter. Mercury is not, finally, a substance, or even many substances: it is a process . . . All these [alchemical writings] point to one crucial idea: that transformation is something intrinsic and contained inside matter . . . Each stage of this self-devouring, self-generating process bears the name 'mercury'. Mercury, in short, is alchemy itself.[12]

To the modern chemist this has little concrete meaning, as mercury is merely another element in the periodic table. But the alchemist, working long before the periodic table was elucidated and the atomic structure of elements unravelled, believed that certain elements possessed mystical powers simply because they had visibly impressive chemical and physical properties.

Of the seven metals used by the alchemist (gold, silver, iron, tin,

* A word about dating Newton's manuscripts: Newton very rarely dated any of his alchemical work, and the best indicator for the date of a manuscript is the style and size of his handwriting. The scholar B. J. Dobbs has divided Newton's handwriting into six periods. 1. 'Very early', 1667–69: the handwriting here is almost microscopic, perpendicular and meticulous. 2. 'Middle early', 1670–75: the writing is fuller and more rounded. 3. 'Late early', 1675–80: bolder and more rounded still. 4. 'Bad ink', 1680–81: a period during which Newton used poor-quality ink which has rendered his writing now almost illegible. 5. 'Middle confident', 1682–92: far larger, sloping and more confident. 6. 'Late', 1693–1727: small again, but different in nature to the 'Very early' period.

mercury, lead and copper), mercury was the only one which existed in the liquid state at room temperature. When each of the other six metals was heated individually, they too liquefied, which alone implied to the medieval mind that there was a 'mercurial principle' in each of the metals and that therefore there must be something special about mercury. The adept Elias Ashmole described the substance as 'that universal and all-piercing spirit, the one operative virtue and immortal seed of worldly things, that God in the beginning infused into the chaos, which is everywhere active and still flows through the world in all kinds of things by universal extension'.[13]

Mercury was viewed as nothing less than the first matter, the *prima materia* of metals. The *prima materia* was the holy spirit of alchemy, the essence that lay at the heart of matter, the spirit pervading the material, and it had to be released from 'dead', inert, metals via transmutation. The concept is an ancient one and had been expressed in Taoist philosophy some 2,300 years before Newton's day:

> There is a thing confusedly formed,
> Born before heaven and earth.
> Silent and void
> It stands alone and does not change,
> Goes round and does not weary.
> It is capable of being the mother of the world.[14]

The concept of the *prima materia* was also analysed by Jung during his extensive study of the psychological meaning of alchemy. He concluded that 'The basis of the opus, the *prima materia*, is one of the most famous secrets of alchemy. This is hardly surprising since it represents the unknown substance that carries the projection of the autonomous psychic content.'[15] And, in Newton's era, the adept Thomas Vaughan waxed lyrical on the subject:

> First, that the first matter of the stone is the very same with the first matter of all things. Secondly, that in this matter all the essential principles, or ingredients of the elixir, are already shut up by Nature, and that we must not presume to add anything to this matter, but what we have formerly drawn from it; for the stone excludes all extractions, but what distil immediately from its own crystalline universal minera. Thirdly, and lastly, that the philosophers have their peculiar secret metals, quite different from the metals of the vulgar, for where they name mercury they mind not quicksilver, where Saturn, not lead, where Venus and Mars, not copper and iron.[16]

Small wonder, then, that Newton's first experiments involved an attempt to produce this apparently most useful of substances, philosophers' mercury.

He took as his guide Boyle, who had already conducted experiments with mercury, but Newton pushed the principles further, applied them with far greater care, and spread his net much wider.

Boyle's instructions for the production of philosophers' mercury involved dissolving common mercury in nitric acid followed by the gradual addition of lead filings. Newton followed the instructions precisely and produced a white precipitate, a colourless solution and a silver substance at the bottom of the crucible. But, upon testing, he found that the silver metal was just the mercury he had added originally (released from the solution by the addition of lead, which is more reactive with the nitric acid). There was nothing stunning in that discovery.

He then tried adding different metals to the solution of quicksilver in nitric acid. With tin he again produced the silver metal and a colourless solution, and with copper a blue solution along with the silver metal. Quickly, he realised that all he was doing was obtaining purified mercury (the silver metal) and dissolved compounds of the metals he was adding. It was all very disappointing. After that, he gave up following the traditional line of reasoning and tried using heat to alter the product.

Newton later told Conduitt that John Wickins helped him. Wickins was physically stronger and assisted in moving 'kettles' and manning the furnace as well as transcribing experiment notes. In a rare comment upon his life with Newton, Wickins tells us of his room-mate's 'forgetfulness of food, when intent upon his studies; and of his rising in a pleasant manner with the satisfaction of having found out some proposition without any concern for or seeming want of his night's sleep which he was sensible he has lost thereby'.[17] Sadly, Wickins recalled nothing of what Newton was actually doing, and in any case he may not have understood what he saw.

With this second set of experiments, Newton was again disappointed, producing a precipitate along with purified but perfectly ordinary mercury. (How Newton or any other alchemist could have distinguished between 'common' mercury and what he saw as philosophers' mercury is impossible to tell. We can only assume that he tested it to see if it exhibited the powers ascribed to it by alchemical tradition.)

After spending several months on these experiments, Newton abandoned Boyle's methods and turned to his own, this time using antimony as his starting material.

The element antimony is found in a natural ore called stibnite (Sb_2S_3). The alchemist was interested in the substance because, when purified, antimony appeared to have an affinity with gold (and some other metals), forming a type of amalgam which they called a *regulus* (from the Latin for 'petty king').

The reguli – crystalline compounds with striking arrangements of radiating shards – were produced by blending purified antimony with various reducing agents – materials which changed the oxidation state of the antimony (and therefore some of its chemical properties).* Initially, the exciting thing about reguli for the alchemist was their appearance: in particular, the regulus produced by processing antimony with iron produced a star-like crystal configuration which they dubbed the *Star Regulus of Antimony* or the *Regulus of Mars*.

Newton would have learned about the reguli from the fifteenth-century alchemist Basilius Valentinus, who wrote at length about the Star Regulus of Antimony in his tract ***The Triumphal Chariot of Antimony***, from which Newton copied sections into his notebook (Keynes MS 64). Valentinus said of the substance:

> Many have esteemed the Signed Star of Antimony very highly, and spared neither labour nor expense to bring about its preparation. But very few have ever succeeded in realising their wishes. Some have thought that this Star is the true substance of the Philosophers' Stone. But this is a mistaken notion, and

* The oxidation state of a substance is linked to the number of electrons available for reaction or 'spaces' available to receive electrons in an atom during chemical reactions, and consequently plays a part in the way elements react together and the types of compounds they may form.

> those who entertain it stray far afield from the straight and royal road, and torment themselves with breaking rocks on which the eagles and the wild goats have fixed their abode. This Star is not so precious as to contain the Great Stone; but yet there is hidden in it a wonderful medicine.[18]

Newton described his method of producing this regulus in one of his earliest essays on alchemical practice, in which he said:

> These rules in general should be observed. 1st that the fire be quick. 2dly that the crucible be thoroughly heated before anything be put in; 3dly that metals be put in successively according to their degree of fusibility – iron, copper, antimony, tin, lead. 4thly that they stand some time after fusion before they be poured off accordingly to the quantity of regulus they yield – iron, copper, tin, lead. 5thly that no salt be thrown on, unless upon iron to keep it from hardening . . . 6 that if you would have the saltpetre flow without too great a heat, you may quicken it by throwing a little more saltpetre mixed with 1/8 or 1/16 of charcoal finely powdered.[19]

We know from a letter Newton wrote to Oldenburg in January 1672 that he had produced this mysterious substance sometime before the end of 1670.* Although he may have been pleased with the result, he also realised it was little more than a step on the way to the dreamed-of philosophers' stone and not an end in itself.

The Star Regulus of Antimony is of particular interest in any effort to link Newton's alchemical researches with his elucidation of the law of universal gravitation. As the name implies, the regulus does look like a star, and its radiating shard-like crystals (Plate 9) may be imagined as lines of light radiating from a starlike centre. But the crystal may just as easily be visualised as representing shards or lines of light pointing inwards – a star at the centre with lines of light, *or force*, travelling *towards* its centre.

* In this letter Newton proposed a number of uses for the substance. One application was as a material for making mirrors to improve a reflecting telescope he was constructing at the time.

Newton, we should recall, probably first produced the Star Regulus of Antimony sometime during 1670, only four years after deriving a mathematical relationship describing the receding force involved in planetary motion. We know that the development of this simple relationship into the full-blown theory of gravity as it appeared in the ***Principia*** of 1687 came about via a collection of influences, experimental verification and inspiration during the 1670s and 1680s. The creation of the Star Regulus was probably one step along this road – a subconscious contribution to the slow process of realisation firstly of attraction and then of universal gravitation.

By the mid-1670s Newton had been experimenting with alchemical processes for at least five years and, after composing thousands of words of experimental notes, brief conclusions and huge piles of recipes – both original and transcribed from the alchemical canon – he felt ready to write a substantial document describing his findings. This was the 'Clavis', 'the Key', dated around 1675 – a document about 1,200 words in length and the distillation of his first five years of research.[20]

Some doubt has been cast upon the originality of the 'Clavis', and there have been suggestions that it was simply another of Newton's transcriptions (perhaps from Barrow or Starkey). But there are several aspects of the document that are clearly Newtonian. First, there is the most obvious Newton hallmark: meticulous instructions, precise measurements and recorded time periods. Newton's attention to detail can be seen in his laboratory notes, where he records mixing granules of components on a 'looking-glass that none of them might be lost', and dividing individual crystals 'with the point of a knife'.[21] Second, there are comparisons between this and the more expansive 'Praxis' – the apotheosis of his alchemical contribution, written some eighteen years later (see Chapter 10).

Although the 'Clavis' was a thorough and carefully contrived work of its type – a rare example of the empirical meeting the alchemical – it was only a stepping-stone for Newton, a summary of his preliminary forays into the alchemical world. From this he was to go on to build a body of profoundly important work which was to lead him both to the edge of acceptable inquiry and into scientific realms previously undreamed of.

The work was made easier by the acquisition of a genuine laboratory. In 1673 Newton and Wickins had moved to rooms at E-4 Great Court, close to the Great Gate of Trinity. Attached to the rooms was a wooden 'shed' clearly visible in drawings made at the time. The rooms seem to have been chosen deliberately because of this annexe, which was quickly turned into a laboratory and filled with the furnaces and shelves of chemicals which had once cluttered up Newton's living-quarters. But still the work was often physically dangerous, and years of effort could be easily lost through negligence. A fire one morning sometime during the winter of 1677–8, when Newton made a rare appearance at the college chapel, destroyed a collection of papers both scientific and alchemical and almost burned down the entire laboratory.

For some early chroniclers of Newton's life, this incident explained the lack of material success during the decades of Newton's labours with alchemy. Stukeley, hearing from one of his sources that the great scientist had delved to the very heart of *chemistry* and had written a *Principia Chemicum*, says that Newton was 'explaining the principles of that mysterious art upon experimental and mathematical proofs and he valued it much, but it was unluckily burnt in his laboratory which casually took fire. He would never undertake that work again, a loss much to be regretted.'[22]

Others have suggested that the destroyed papers were an early version of the ***Opticks***. The antiquary and Newton devotee Abraham de la Pryme, who was an undergraduate at Cambridge during the 1690s, was probably the first to circulate this idea when he wrote:

> but of all the books that he ever wrote there is one of colours & light established upon thousands of experiments which he had been 20 years of making, & which cost him many a hundred of pounds. This book which he valued so much & which was so much talked of had the ill luck to perish, & be utterly lost just when the learned author was almost at putting a conclusion to the same after this manner: In a winter's morning leaving it amongst his other papers, on his study table whilst he went to chapel, the candle which he had unfortunately left burning there too, catched hold by some means of other papers, & they fired the aforesaid book, utterly consumed it, & several other valuable writings which is most wonderful did no further mischief.[23]

The lost document, if there was one, could have been a treatise on optics, but this story might also have been an attempt to disguise the truth. Both Stukeley and Pryme had almost certainly heard unpalatable rumours while Newton was still alive. It is quite possible that, by manipulating the tale, they managed neatly to dismiss Newton's alchemical interests (Stukeley referring to them as 'chemistry'), as well as quashing any hint that he continued with his experiments: 'He would never undertake that work again.'

Stukeley certainly could not have been more wrong. If nothing else, Newton's description of his experiments in the 'Clavis' confirm the direction in which he was heading during the mid-1670s. In his unique way, he was correlating traditional wisdom with his own findings. In another early paper, he drew up a list of forty-seven axioms derived from his alchemical reading and experiments.[24] Next he analysed their obscure imagery based upon his own observations.

> Concerning Magnesia or the Green Lion. It is called Prometheus & the Chameleon. Also Androgyne, and virgin verdant earth in which the Sun has never cast its rays although he is its father and the moon its mother: Also common mercury, dew of heaven which makes the earth fertile, nitre of the wise . . . It is the Saturnine stone.[25]

Always critical, he could easily sort out the good from the bad. On one occasion, in the margin of a manuscript, he wrote, 'I believe that this author is in no way adept.'[26]

But what did he really gain from these experiments? They were preliminary, that much is certain, but even in these earliest attempts he was gaining an instinctive awareness of possible forces at work in the universe for which conventional mechanical theory (still dominated by Descartes's notions of matter and spirit) had no explanation. He was seeing things in the crucible that could not be explained by Descartes or by an orthodox appraisal of simplistic atomism. What we can discern from these early observations and from his writings about the mechanical philosophy demonstrates that Newton was then beginning to realise that the universe was a far broader canvas than even he had dared to imagine.

* * *

Newton was a good Puritan, but, craving learning for the greater glory of his God, he had dived into the murky, heretical pool of alchemy believing that there he could rediscover the secrets of Nature. Religious zeal was one of his prime motivators, and, like almost all other thinkers and uneducated folk of his day, he lived and died believing wholeheartedly in divine guidance. Writing in his notebook in 1664, he had commented, 'He [God] being a spirit and penetrating all matter, can be no obstacle to the motion of matter; no more than if nothing were in its way.'[27]

If anything, his fundamentalism became more pronounced in later life. He never swayed from his assertion that God was responsible for maintaining planetary motion through the device of gravity. Although he formulated a theory to describe mechanical motion, including the movement of planets in their orbits, he could not explain *how* this worked or *why*; he believed that a basic tenet of intellectual life was that some things will always be unknowable. Although in many intellectual areas Newton was generations ahead of his time, his notion of God was as simplistic and as orthodox as the next person's. In the notebook, under 'Of God', he wrote, 'Were men and beasts etc made by fortuitous jumblings of the atoms there would be many parts useless in them, here a lump of flesh there a member too much. Some kinds of beasts might have had but one eye, some more than two.'[28]

Within the broad sweep of Christianity there has always been room for certain forms of unorthodox beliefs, some of which conflict with the Established Church over what, to the outsider, seem only matters of detail. However, Newton's own brand of Christianity was one of the more extreme and was quite unacceptable to orthodox Anglicans of the seventeenth century.

Newton was an Arian. The Arian doctrine had its origins in the teachings of a fourth-century Alexandrian priest named Arius, and held (in defiance of orthodox Trinitarianism) that Jesus and God are not of one substance but that Christ, although divine, was created by God as *the first creature*.

Sometime between 1672 and 1675, Newton set out twelve points of faith that formed the foundations of his Arianism. These included the argument that:

> There is nowhere made mention of a human soul in our Saviour [the Bible] besides the word, by the meditation of which the

word should be incarnate. But the word itself was made flesh & took upon him the form of a servant . . . It was the son of God which he sent into the world & not a human soul that suffered for us. If there had been such a human soul in our Saviour, it would have been a thing of too great consequence to have been wholly omitted by the Apostles.[29]

To the dispassionate observer such distinctions between Arian doctrine and orthodox Christianity may seem unimportant, but to Newton a commitment to Trinitarianism was tantamount to blasphemy, and he found himself torn by the clash between his personal devotions and the legal requirements of the college. In signing for his BA in 1665 he had had to attest to an acceptance of the Thirty-Nine Articles of the Anglican Church. In 1667 he had signed again as he received his fellowship, agreeing to embrace the 'true religion of Christ', and he signed once more upon receiving his MA the following year. Finally, in 1669, he had promised, as a requirement of the Lucasian Professorship, to take holy orders at some point in the near future. But he continued to balk at the prospect. In a battle between his conscience and his career, he was willing to sacrifice all he had worked for. In a letter to Oldenburg in 1675 he informed the Secretary of the Royal Society that he would soon have to cease his payments of subscription: 'For the time draws near that I am to part with my fellowship, & as my incomes contract, I find it will be convenient that I contract my expenses.'[30]

Newton was walking on eggshells. During the seventeenth century, religious orthodoxy was an important social factor, influencing careers and the fulfilment of ambitions. Toleration on a wider scale had grown out of the Civil War, allowing Protestants and Catholics to live together with a degree of harmony. But within the individual denominations adherence to the sacred texts was paramount, and radical thinking along the lines of Newton's beliefs would have been perceived as dangerous, even divisive. In the hands of a man of his wilfulness and intellectual rigour, it would have been viewed by his rivals as a potential threat to the status quo.

In 1674 Newton's friend the Cambridge fellow Francis Aston applied for exemption from taking holy orders – for his own, still rather obscure, reasons. His request was refused, because agreeing was seen by the Trinity authorities as setting a precedent which would destroy the college's reputation as a repository for young clerical talent. At the same time, Newton's own situation was becoming untenable. Tongues were wagging, and any further reluctance to be ordained would have signalled to his academic colleagues that he was trying to conceal something. But help came once more in the form of his old allies Humphrey Babington and, most importantly, Isaac Barrow.

At Barrow's suggestion, Newton applied directly to Charles II for a special dispensation to allow him to continue as Lucasian Professor of Mathematics but without a fellowship (the specific aspect of his college career that required the taking of holy orders). There was no precedent for this and his chances of success were slim, but he had little choice.

The situation was complicated by the fact that he could tell no one the real reasons for the difficulty he faced – not even Barrow, who was the King's Chaplain and a devout Trinitarian. Barrow must therefore have defended Newton entirely because of his unique talent, without knowing the reasons for the younger man's difficulty. Fortunately for Newton, Barrow was in the right place at the right time: as Chaplain, he had the ear of the King. Although less able to influence Charles, Babington was of assistance because he was still a senior fellow and involved in the decision-making processes of the college on such matters. Together, he and Barrow were able to smooth a very rocky path.

In early March 1675 Newton visited London to apply for a special dispensation and, astonishingly, by the end of April he had it. His Majesty had granted the Lucasian Professor and all subsequent holders of the chair exemption from holy orders and was willing 'to give all just encouragement to learned men who are & shall be elected to the said professorship'.[31]

No one was more surprised than Newton himself. He had expected a fight, and, true to form, he had gone to extraordinary lengths to prepare for it. Since 1672 he had spent time away from his alchemical experiments and had investigated deeply buried, anachronistic aspects of theology, ancient wisdom and the canon of comparative religion, immersing himself in the netherworld of biblical roots. And once again, true to his nature, he allowed it to take him over. What had begun as a means of self-defence had developed into an obsession taking him deep into the origins of modern civilisation.

He followed his established method. He studied the documentary evidence, analysed it, and then produced his own deductions in a notebook divided into headings.[32] By asking himself the direct question What does the Bible actually say on the matter of the Holy Trinity? he pinpointed what he saw as two major flaws in the Trinitarian credo. Together these led him to believe that Trinitarianism was a deliberate, calculated lie, perpetrated through the ages by a series of self-interested pontiffs.

The first fault he highlighted was that Trinitarianism cannot be supported completely by scriptural analysis. Newton filled his notebook with quote after quote extracted from the Bible supporting his case. From II Corinthians 4:4, for example, he listed the reference to Christ as 'the image of God'. He then added the first chapter of Paul's epistle to the Hebrews, in which it is said, 'Thou [Christ] has loved righteousness & hated iniquity, therefore God, even *thy* God, has anointed thee with the oil of gladness above thy fellows.' In the margin to this passage in his notebook, Newton wrote, 'Therefore the Father is God of the Son.'[33]

According to Newton, the second problem with Trinitarianism was that it was counter-logical. He shared the view of his contemporaries that certain phenomena described in the Bible could never be understood, or might be explained only with divine knowledge. Among these were the ability to turn water into wine, the gift of healing by touch, virgin birth and resurrections. These, according to Newton, did not defy logic; but three equalling one and one equalling three definitely did.

As he saw it, Trinitarianism was an institutionalised contrivance, and to prove it he reached further and further back, to the roots of the doctrine, to reveal the origins of the deceit.

Eventually he found it. The blasphemy, he concluded, had begun with the Council of Nicea convened in 325 by the Roman emperor Constantine. Constantine's objective had been to clarify various ambiguities within the Christian doctrine as it blossomed into a global religion. During the council, a dispute had arisen between the Alexandrian priest Arius, who believed that God and Christ were separate entities, and the Bishop of Alexandria, Athanasius (later beatified by the Church), who argued for the notion of Homoousion – the doctrine that God and Jesus are of the same substance. The council agreed with Athanasius, and the doctrine of Homoousion was generally adopted. But that was not the end of the matter: the feud continued for several decades, with the rival camps of Arius and Athanasius fighting over the conceptual framework of Christianity. Because of the self-interested scheming and the temporal ambitions of corrupt ministers, the Arian view gradually became outlawed and the official line of the Council of Nicea was adopted by the Roman Catholic Church.

The unravelling of this thread of corruption reinforced further Newton's hatred for Catholicism. A reading of The Revelation of St John the Divine – the Book of Revelation – led him to agree with radical Puritanism's identification of the Devil with the Catholic Church and the 'Day of Reckoning' with the eventual establishment of the 'True Church', after the destruction of the 'Evil One', Rome. Little wonder, then, that Newton felt an almost physical disgust with the notion of taking holy orders. The Anglican Church had retained so much of Catholicism that he found offensive, including the most despised concept of all, the belief in a Holy Trinity – Father, Son and Holy Ghost, one and indivisible, three in one, one in three: a notion which was in itself anathema to any self-respecting mathematician.

Newton's researches appeared in ***Observations upon the Prophecies of Daniel***, published posthumously in 1733, but large sections of his writings have been lost. He is known to have prepared a text called the 'History of the Church', but it was never published and disappeared sometime during the nineteenth century. All that can be traced is a bundle of about 800 pages of rough notes and drafts sold in the Sotheby auction of 1936 to a Gabriel Wells as Lot 249. About half of this lot is now in the Yahuda Manuscript Collection of the Jewish National and University Library in Jerusalem, referenced as Yahuda MS 15. Other sections (in some cases mere scraps) are to be found in libraries scattered around Europe and secreted away in private collections. From what can be pieced together from these, 'History of the Church' embraced the twin obsessions of Newton's religion notebooks and other writings – his view of the incarnation of Christ and the creation of what he refers to as the 'false image' or 'the Whore of Babylon', the Roman Catholic Church.

But why was Newton so fanatically opposed to the concept of the Trinity? Such obsessiveness could not be based only upon a distaste for the illogical. Would it be unreasonable to suggest that he wanted to identify himself with Christ? After all, was he not the only child of a dead father, born on Christmas Day and (so he believed) possessed of unparalleled ability and unique talents? And could it be that identification with his long-dead father – a man he had never known, but whom he knew was uneducated – was so repugnant to him that he could not contemplate the notion of a Trinity, a concept involving not just attachment to 'the Father' but the sharing of identity? Newton, the man who had adopted the pseudonym 'One Holy God', was a perpetual loner. He could not even show love towards his mother; he felt only disgust at her betrayal. The possibility of unity or amalgamation could only engender further feelings of abhorrence in this most individualistic and private of men.

Isaac Newton's view of God and the universe was not pantheistic – he did not regard the concepts of 'God' and 'universe' as identical. Nor was he a Gnostic in the one true sense of the term – he didn't believe that the spirit or soul can be redeemed or liberated from the material world by the acquisition of 'spiritual' knowledge. But, although unconventional by any standards of the time, his belief was consistent. He was enamoured of the Puritan concept of the twinned worlds of God's works and God's word, and he saw the Creator's presence – if not his 'being' – in all things. Life was a riddle to be understood, a code to be cracked, as a duty to the divine. As God was part of all Nature and all learning, God was also history, the present and the future. Consequently, Newton believed the unravelling of the *true* past to be his duty in the same way that it was his destiny to understand the workings of light, of gravity, of alchemy and mathematics. He called this 'the duty of the first moment', and he believed in what can only be described as an 'alchemical history'.[34]

An understanding of alchemical history not only revealed the meaning and purpose of existence, but, through analysis of the 'true past' (as revealed through study of the Bible), it could lead to the decoding of biblical prophecy, and elucidate the wisdom of the ancients.

Newton shared the view of many intellectuals of the period that the most ancient civilisation was also the most knowledgeable, the most pure, the most advanced. 'So then the first religion', he wrote, 'was the most rational of all others till the nations corrupted it. For there is no way without revelation to come to the knowledge of a deity but by the frame of nature.'[35] According to his own religious

faith, this ancient civilisation was that of Israel, the land of the Old Testament, the world of Moses and Ezekiel. The rest – the Romans, the Greeks, the Assyrians – were mere copyists, followers. The chronology of the history of humankind had therefore to be reappraised and rewritten.*

Although this may seem madness to us, it was of the greatest importance to Newton, for the simple reason that he needed to justify his whole world-view, to reveal the falsehood that was Trinitarianism, because in so doing he could confirm his subconscious belief that he was superhuman.

The way into the chronology was of course the Bible, and in particular the Book of Revelation, about which Newton wrote in his notebook, 'There is no book in all the scriptures so much recommended & guarded by providence as this.'[37] And, as always, the only way he could analyse the text properly was to establish rules. He created fifteen of them, and the key to the system was the same as his approach to science – to reduce everything to its simplest form. An example is the ninth rule:

> It is the perfection of all God's works that they are done with the greatest simplicity . . . And therefore as they that would understand the frame of the world must endeavour to reduce their knowledge to all possible simplicity, so it must be in seeking to understand these visions.[38]

His conclusions were nothing if not diverse. He reasoned that because God's work and God's word came from the same Creator, then Nature and Scripture were also one and the same. Scripture was a communicable manifestation or interpretation of Nature, and as such could be viewed as a blueprint for life – a key to all meaning.

He also reached conclusions about the theological detail. He

* Newton wrote a long and clumsy book on the subject called ***The Chronology of Ancient Kingdoms Amended***, which was published posthumously in 1728 by his nephew-in-law John Conduitt. As the title suggests, its contents reappraise the time-scales and the interdependence of the great civilisations of history; however, one scholar has said, 'Newton's ***Chronology*** is such an incredibly difficult work to decipher, that it will probably have to be passed one day through a computer.'[36]

believed in the literal truth of the Creation story – that the world was made in seven days by a divine hand – but he qualified this with an ingenious addendum. Nowhere in the Scriptures, he reasoned, does it say that all seven days were of equal length: because during the first two days there was no Earth and therefore no twenty-four-hour day based upon planetary rotation, the length of a 'day' could be anything the Lord wished.

He went against the intellectual trend of the time by dismissing the fashionable simplistic notion of devils and demons and held the rather modern view that evil spirits are manifestations of a disordered mind and that the Devil is an illusory figure created by human imagination. Yet he also followed what would now seem totally irrational theories in order to develop his fifteen rules. In this he was greatly influenced by the ideas of the writer and mystic Joseph Mede.

Mede was a Puritan proselytiser who developed a technique for dating the events of the Bible and interpreting the prophecies. He wrote a book called ***A Key to the Apocalypse***, published in 1627, which proposed a method by which 'days' in the Old Testament could be interpreted as 'years', so enabling him to chronicle the various proclamations of the prophets and, most importantly, date the 'end of the world'.

Blending Mede with his scientific understanding and powers of critical analysis, Newton arrived at some ingenious interpretations of biblical events. A prophecy concerning the Saracen monarchy serves as an example.

The Old Testament refers in detail to the torment inflicted by a wrathful God in the form of a plague of locusts. For reasons that remain unclear, Newton decided that the locust could be taken as being symbolic of the Saracen monarchy. Knowing that the life-span of the locust was five months, two life-spans equalled ten months, or 300 days, and so he deduced in his amended chronology of the past that the Saracen Empire had lasted 300 years – a figure that fitted neatly with the historical fact that the Saracens had acted as aggressors towards the Roman Empire between 637 and 936, for 300 years (give or take a year).

Using similar reasoning, and juxtapositioning chronologies derived from their iconoclastic interpretation of the Scriptures, Joseph Mede (and others, including Henry More) had concluded that the end

of the world would come sometime during the second half of the seventeenth century. This was arrived at by the following argument.

According to their Puritan ideals, the Antichrist was the Roman Catholic Church. In the Book of Revelation, the reign of the Antichrist was prophesied to last 1,260 days (mentioned as forty-two months, 1,260 days or three and a half years). This was interpreted as 1,260 years. The date at which the Roman Catholic Church took control of the Christian movement they agreed to place during the reign of the Roman Emperor Theodosius (about AD 400). Consequently, the end of the world was expected sometime during the final decades of the seventeenth century, and certainly no later than AD 1700.

Newton strongly disagreed with much of this scheme. For him, the start of the evil reign of the Roman Catholic Church was to be dated not from the Church's earliest origins but from its peak – a date that varied according to different versions of his scheme. In one set of notes he placed this date around AD 800 and used Mede's figure of 1,260 years (taken from Revelation) to place the end of the world sometime during the twenty-first century. In another version he dated the height of the Roman Catholic Church precisely to the year AD 609 and took a period of 1,290 years from Daniel to place the Jews' return to reclaim Jerusalem during 1899. He then took a further prophecy from Daniel – that the return to Jerusalem would be followed precisely forty-nine years later by the second coming of Christ, placing this singular event sometime during 1948.

In still further refinements and adaptations he used a variety of starting dates and alternative numbers of days/years taken from various prophets and arrived at different dates for the end of the world.*

Initially, these prophetic interpretations appear strangely at odds with Newton's normally strict rationalism, but he had given them very careful thought. Following a line of intellectual development dating back to Paracelsus, Newton did not see this form of prophecy in the way we perceive it today.[39] To him it was not a fairground gimmick or party trick but a demonstration that humankind was governed by Providence.

Intellectuals had long tried to 'prove' the existence of an all-

* Some of his reworking of this theme is recorded in his notes in Keynes MS 5 in the library of King's College, Cambridge.

pervading Creator by reason alone. Descartes and the philosopher and alchemist John Dury had many arguments about how 'scepticism' (perceived at the time as an insidious plague leading to atheism and hell) could be fought. Descartes chose mathematics; Dury, like Newton, relied upon biblical prophecy.[40]

In spite of his obvious conviction and dedication, Newton's surviving writings on the subject are a rambling muddle (like his shambolic ***Observations upon the Prophecies of Daniel***). Yet this work and other seemingly illogical pursuits occupied him until the day he died. Even during the last weeks of his life he was tinkering with his ideas of prophecy and biblical interpretation, constantly reappraising the date at which the Day of Judgement would come, seeing it as an event that was preordained but at the same time one whose date humans might deduce.

This demonstrates both the radical difference between the intellectual perspectives of the seventeenth and twentieth centuries and, perhaps more importantly, the dark well of Newton's own personal insecurity – his need to prove himself different from other men.

Just as science and alchemy offered shelter and solace from a world which, at the root of his being, he did not much care for, Newton also found a home within religion. He believed wholeheartedly in the notion that God had created the world and controlled events with a divine hand, but he did not like the outcome – principally because, to him, humankind had the habit of constantly tarnishing Creation. Aside from his desire to affirm his own unique nature, by retreating into the Scriptures he could identify a purer universe and could delight in predicting when the whole ugly edifice of the contemporary world would fall.

The clearest manifestation of this desire is the enormous effort he poured into his reconstruction of the plan of the Temple of Solomon, seeing this as a paradigm for the entire future of the world.

Newton, like many other thinkers of his era, believed the religious edifices of ancient civilisations were more than mere places of worship. The ancients had not expended such enormous effort simply to preserve their culture and their world-view: they had constructed temples and monuments as Earthly representations of the universe. (Examples of those still in existence may include stone circles found throughout Europe and the Great Pyramid at Giza.[41])

To Newton, the most profound ancient was King Solomon, whom

he called 'the greatest philosopher in the world'.[42] The temple that Solomon originally built around 1000 BC, on a site in Jerusalem already sacred to the Jews, was the most hallowed symbol of wisdom and faith long before Newton put his own personal interpretation upon it. Almost from the time of its construction until the Enlightenment, some 3,000 years later, it was as revered as the Pyramids or Stonehenge had been by the pagan faithful who built them.* Newton, however, asserted that Solomon had deliberately designed his temple with privileged eyes and the guidance of the Lord, not only as a paradigm for the universe but as a pattern for the future of the human race. So, taking descriptions of the temple from the Book of Ezekiel, in not one but three different languages, he set out to draw its floor plan, seeing this as a key to the wisdom of the ancients and a route to elucidating biblical prophecy. What he ended up with was an elaborate diagram (Plate 11) which he believed represented a plan for the future of the world.

Newton believed that the dimensions and geometry of the floor plan gave further clues to time-scales and pronouncements of the great biblical prophets (especially Ezekiel, St John the Divine and Daniel). Combining this floor plan with his interpretations of Scripture allowed him to produce an even more detailed outline for a revised chronology of both the past and the future, with new dates for such events as the end of the Catholic Church's domination on Earth, the second coming of Christ and the Day of Judgement.

As well as providing information for his prophetic interpretations, the configuration of Solomon's Temple also influenced Newton in developing his image of gravitation.

Newton described the heart of the ancient temple as 'a fire for offering sacrifices [that] burned perpetually in the middle of a sacred place',[44] visualising it as a fire around which the believers assembled. He called this arrangement a prytaneum, and described the way it represented the cosmos by saying, 'The whole heavens they reckoned to be the true & real temple of God & therefore that a prytaneum might deserve the name of his temple they framed it so as in the

* So potent has been the notion that God and his universe can be represented by geometry that the principle has survived into relatively modern times – it is visible in the construction of cathedrals and churches throughout the world.[43]

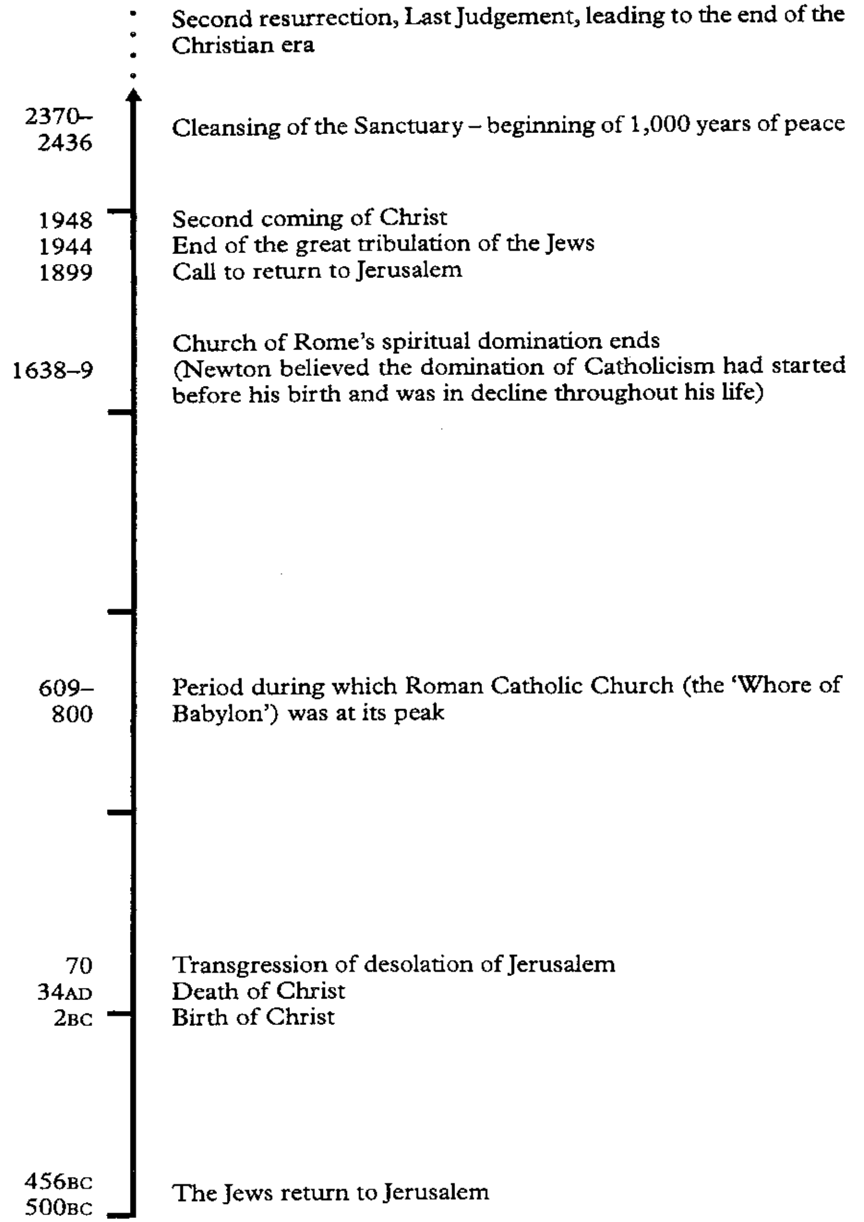

Figure 6. Newton's chronology in brief outline. (Although begun during the 1670s, Newton continued his work of interpretation until the month of his death in 1727.)

fittest manner to represent the whole system of the heavens.'[45]

Although Newton was not alone in his belief that the temple was a microcosmic model, it has been suggested by at least one Newton scholar that the image of a fire at its centre with disciples arranged in a circle around the flames acted as another stimulus to Newton's concept of universal gravitation.* Key to this is the idea that, instead of simply seeing the rays of light as radiating *outwards* from the fire, Newton might instead have visualised them as a force *attracting* the disciples *towards* the centre. It is further implied that the similarity between this and the 'lines of force' suggested by the shape of the Star Regulus of Antimony could not have escaped him. In this scheme, the parallels between the solar system and the temple are apparent: the planets relate to the disciples, and the temple fire (sometimes called 'the fire at the heart of the world'[46]) is the model for the Sun.

During the mid-1670s, when Newton was first investigating ancient lore, his view of gravity was still a long way from the all-embracing concept expressed in the ***Principia*** a decade later. He had concluded that the receding force experienced by a planet in circular motion was described by the inverse square law, but he had yet to reach a detailed conclusion about the nature of an attractive force that countered this. His deep immersion in alchemical experiment and the ancient roots of theology must now have influenced his thinking towards a broader view of the universe, offering him possibilities beyond the realm of orthodox teaching and accepted philosophy. If the suggestive pattern of the Star Regulus and the arrangement of the prytaneum at the heart of Solomon's temple offered nothing in the way of quantitative empirical information for his elucidation of universal gravitation, they may nevertheless have provided signposts along the way to his grand conclusions.

These markers may have been subconscious and only manifested themselves later, as the ideas that led Newton to the principle of universal gravitation came together during the 1680s. There is no

* This suggestion is explored in great depth by the late Professor B. J. Dobbs in her highly academic treatise ***The Janus Faces of Genius: The Role of Alchemy in Newton's Thought*** (Cambridge: Cambridge University Press, 1991), but Newton scholars around the world are still divided as to the validity of the idea.

surviving record of an explicit reference to the Star Regulus or the Temple of Solomon to support the idea that they may have symbolised an attractive force, but, as we have already seen, the concept of gravitation did not come to him in a blinding flash of inspiration: it was arrived at by a process of gradual awakening over a period of two decades. And in one respect it is not surprising that there is no explicit record of how Newton's religious discoveries led directly to the formulation of the concept of universal gravitation. By the time these subconscious triggers had played their part (perhaps as late as the mid-1680s, when Newton was starting to write the ***Principia***) he had already encapsulated the groundwork in strict mathematical language and could express it in orthodox terms. He then had no need, nor incentive, to explain this source of inspiration.

Newton perceived himself as the new Solomon and believed that it was his God-given duty to unlock the secrets of Nature, whether they were scientific, alchemical or theological. Such efforts were his reason for living, his mission, and he could not rest until he had fulfilled his dream. Even though he was submerging himself in the arcane world of alchemy and the Scriptures, he could still find stimulation in orthodox science, for this too was a manifestation of God's meaning and God's plan. It was also a crucial ingredient in the development of his most important ideas. But in its more open world he would, by the very nature of his exposure, meet unexpected opposition and some most unwelcome challenges.