Edmond Halley

Born: 8 Nov 1656 in Haggerston, Shoreditch (near London), England
Died: 14 Jan 1742 in Greenwich (near London), England

Edmond (or Edmund) **Halley**'s father was also called Edmond (or Edmund) Halley. He came from a Derbyshire family and was a wealthy soap-maker in London at a time when the use of soap was spreading throughout Europe. There is some confusion over both the date and year of Halley's birth. The confusion over the date is simply due to the change in calendar (29 October by the calendar of his time). The confusion over the year is less easy to decide, but we give 1656 which Halley himself claimed as the year of his birth.

Halley's father last much in the great fire of London, which was in the year in which Halley was ten years old. His father still could afford a good education for his son and Halley was tutored privately at home before being sent to St Paul's School. It was at St Paul's School that Halley showed his talents to the full, being [16]:-

... equally distinguished in classics and mathematics, [*he*] *rose to be captain of the school at fifteen, constructed dials, observed the change in the variation of the compass, and studied the heavens so closely that it was remarked by Moxon the globe maker 'that if a star were displaced in the globe he would presently find it out'.*

So Halley entered Queen's College Oxford in 1673, when he was seventeen years old, already an expert astronomer with a fine collection of instruments purchased for him by his father. He began working with Flamsteed in 1675, the Astronomer Royal, assisting him with observations both at Oxford and at Greenwich. Flamsteed, in a paper of 1675 published in the *Philosophical Transactions of the Royal Society*, remarked:-

Edmond Halley, a talented young man of Oxford, was present at these observations and assisted carefully with many of them.

Halley made important observations at Oxford, including an occultation of Mars by the Moon on 21 August 1676, which he published in the *Philosophical Transactions of the Royal Society*. It is a little unclear what happened to Halley's undergraduate career, but what is certain is that he gave up his studies in 1676 and sailed to St Helena in the southern hemisphere in November of that year. The most likely explanation is that with the opening of the Royal Observatory at Greenwich in 1675, Flamsteed undertook the task of mapping the northern hemisphere stars and Halley decided to complement this programme with undertaking a similar task for the southern hemisphere.

Such a task could not be undertaken without financial support, and indeed Halley obtained such support from his father and from no less person than King Charles II who provided a letter asking the East India Company to take Halley and a colleague to St Helena (the southern-most territory under British rule). Other important men also supported the venture, including Brouncker who was president of the Royal Society and Jonas Moore who had been a major influence in the founding of the Royal Observatory.

The weather in St Helena proved less good for astronomical observations than Halley had hoped, but despite this his eighteen month spell on the island resulted in his cataloguing 341 southern hemisphere stars and discovered a star cluster in Centaurus. During the voyage [16]:-

... he improved the sextant, collected a number of valuable facts relative to the ocean and atmosphere, noted the equatorial retardation of the pendulum, and made on St Helena, on 7 *November* 1677, *the first complete observation of a transit of Mercury.*

He proposed using transits of Mercury (and even better of Venus) to determine the distance of the Sun and therefore the scale of the solar system using Kepler's third law. Halley returned to England in 1678 and published his catalogue of southern hemisphere stars. Despite not having graduated from Oxford he found himself with the reputation of one of the leading astronomers. Honours quickly came his way. He became a graduate of the University of Oxford on 3 December 1678 without taking the degree examinations, the degree being conferred on the command of King Charles II. He was also elected a member of the Royal Society on 30 November 1678 becoming, at the age of 22, one of its youngest ever Fellows.

In 1679 the Royal Society sent Halley to Danzig to arbitrate in a dispute between Hooke and Hevelius. Hooke claimed that Hevelius's observations, made without telescopic sights, could not be accurate. Hevelius at this time was 68 years old and must have been somewhat dismayed to find that a 23 year old man had been sent to judge him. However, Halley was [1]:-

... a man of great natural diplomacy...

and after two months checking the observations Hevelius was making, he declared them to be accurate.

The fame and recognition which Halley achieved so quickly did nothing to endear him to Flamsteed who, despite his praise for Halley in his student days, soon turned against him. Having the Astronomer Royal as an enemy is not the best recommendation for a young astronomer, even one as famous as Halley, who would soon pay the price.

Halley did not seek a teaching post at this stage, preferring the freedom to travel and undertake research without commitments. In 1680 he set out on a European tour with a school friend, Robert Nelson. Halley observed a comet while near Calais and travelled to Paris where, together with Cassini, he made further observations in an attempt to determine its orbit. Much of 1681 Halley spent in Italy. Back in England in the following year Halley married Mary Tooke, while his father remarried (Halley's mother having died ten years earlier).

Not only did marriage bring financial responsibilities to Halley, but his father's marriage seems to have been a total disaster and as a consequence of this support from his father soon dried up. Further personal problems followed, for in March 1684 his father vanished and was found dead five weeks later. Halley had to administer his father's personal estate and he became involved in family, property and legal matters which are described fully in [12].

Just before his father disappeared, Halley had been involved in an exciting piece of research. He had shown that Kepler's third law implied the inverse square law of attraction and presented the results at a meeting of the Royal Society on 24 January 1684 . Wren, Hooke and Halley then discussed whether it could be shown that the inverse square law implies elliptical orbits for the planets, but failed to come up with a proof. Halley's work on these problems was disrupted during the following weeks by the difficulties surrounding his father's disappearance and death, but by August 1682 Halley was pursuing the problem further by visiting Newton in Cambridge. There he discovered that Newton had already achieved a proof of this and of other highly significant results but did not seem to be going to publish them.

Chapman writes in [11]:-

... Halley ... had the genius to recognise the even greater mathematical genius of Newton, to urge him to write the Principia Mathematica, and then pay for the costs of publication out of his own pocket because the Royal Society was currently broke ...

Glaisher, in an address delivered in Cambridge in 1888, spoke of the role which Halley played in getting Newton's *Principia* published:-

... but for Halley the Principia would not have existed. ... He paid all the expenses, he corrected the proofs, he laid aside his own work in order to press forward to the utmost the printing. All his letters show the most intense devotion to the work.

By now Halley was certainly not a rich man and although in the end his financial outlay which allowed the *Principia* to be published was reimbursed from the sales, he now sought an academic post. In 1691 he applied for the vacant Savilian Chair of Astronomy at Oxford. Given his outstanding research in astronomy, one would have expected him to be appointed to this chair but Flamsteed was strongly against the appointment.

Flamsteed was not well disposed towards Newton particularly since he felt that Newton had not given sufficient credit to observations made by the Royal Observatory in his theory of the moon. Halley's close association with Newton lowered him still further in Flamsteed's eyes. However, the argument that Flamsteed used against Halley was one which he undoubtedly believed in sincerely, writing to Oxford that Halley would [7]:-

... corrupt the youth of the university.

Flamsteed was quite right in believing that Halley's view of Christianity was at odds with the standard view of that time which required a literal belief in the Bible. Newton also complained to Halley about the fact that Halley doubted the scientific correctness of the biblical story of the creation. Despite Halley vigorously claiming that his beliefs were conventional, David Gregory was appointed to the chair.

The lack of an academic post did not hold Halley back in his scientific work. Indeed he worked for the Royal Society in various roles, being editor of the *Philosophical Transactions* from 1685 to 1693. He published frequently important results through the Society's publications. In 1686 Halley published a map of the world showing the prevailing winds over the oceans. It has the distinction of being the first meteorological chart to be published. Another innovative piece of work was the mortality tables for the city of Breslau which he published in 1693. It was one of the earliest works to relate mortality and age in a population and was highly influential in the future production of actuarial tables in life insurance.

From around 1695 Halley made a careful study of the orbits of comets. Newton favoured comets having parabolic orbits, but Halley believed that elliptical orbits might exist. Using his theory of cometary orbits he calculated that the comet of 1682 (now called Halley's comet) was periodic and was the same object as the comet of 1531, and 1607. He later also identified this comet with one which appeared in 1305, 1380, and 1456. In 1705 he published his prediction that it would return in 76 years, claiming that it would appear in December 1758. It was not an easy calculation for Halley had to take into account the perturbations to the orbit produced by Jupiter. Although Halley had been dead for fifteen years by 1758, he achieved lasting fame when the comet was observed on 25 December 1758 (very slightly later than Halley expected).

Newton became Warden of the Royal Mint in London in 1696 and he used his influence to have Halley appointed as deputy controller of the mint at Chester in the same year. It was a post he held for two years before it was abolished. After leaving the mint at Chester, Halley was given the command of a warship, the Paramore Pink, by William III. This was not as strange as it sounds, for Halley had been working on determining the longitude using variation of the compass and this was the main purpose of the voyage, although he was also required by William III to [16]:-

... attempt the discovery of what land lies to the south of the western ocean.

He sailed from Portsmouth in November 1698 but problems with his crew forced him to return, having reached Barbados. In September 1699 he sailed again making a thorough exploration of the Atlantic shores. After his return in September 1700, Halley published charts of the variation of the compass, giving the first charts with lines of equal declination plotted.

Back on the Paramore Pink in 1701, Halley investigated the tides and coasts of southern England. Further journeys followed, for Queen Anne sent him to inspect the harbours around the Adriatic, and another journey saw him travel to Trieste to advise on fortifications.

Halley was appointed Savilian professor of geometry at Oxford in 1704 following the death of Wallis. This certainly did not please Flamsteed who had written (see for example [13]):-

Dr Wallis is dead - Mr Halley expects his place - who now talks, swears and drinks brandy like a sea captain.

Halley's inaugural lecture proved a great success. It was described by Thomas Hearne (see [5]):-

Mr Halley made his inaugural speech on Wednesday May 24, which very much pleased the generality of the University. After some compliments to the university, he proceeded to the original and progress of geometry, and gave an account of the most celebrated of the ancient and modern geometricians. Of those of our English nation he spoke in particular of Sir Henry Savile; but his greatest encomiums were upon Dr Wallis and Mr Newton ...

This lecture is described in [24] as:-

... of abiding interest from the mathematics standpoint.

In 1710, using Ptolemy's catalogue, Halley deduced that the stars must have small motions of their own and he was able to detected this proper motion in three stars. This achievement is described in [1] as his:-

... most notable achievement in stellar astronomy ...

Halley played an active role in the events and controversies of his time. He supported Newton in his controversy with Leibniz over who invented the calculus, serving as secretary of a committee set up by the Royal Society to resolve the dispute. Halley did much to calm disputes, but also seemed to go out of his way to make his dispute with Flamsteed worse. In 1712 he arranged with Newton to publish Flamsteed's observations long before they were complete. To make matters worse, Halley wrote a preface, without Flamsteed's knowledge, in which [11]:-

... he attacked Flamsteed for sluggishness, secretiveness, and lack of public spirit.

In 1720 he succeeded Flamsteed as Astronomer Royal, a position he was to hold for 21 years despite being 64 years old when appointed. Flamsteed's widow was so angry that she had all her husband's instruments from the Royal Observatory sold so that Halley would not have the use of them.

At the Greenwich Royal Observatory Halley used the first transit instrument and devised a method for determining longitude at sea by means of lunar observations. He observed the Moon through one complete 18-year saros. Earlier observations of the Moon were made only at conjunction or at opposition to the Sun and it was these earlier observations on which Newton's lunar theory had been based. However, Halley has been criticised for his work as Astronomer Royal. Some claim that he made valueless observations which were no more accurate than those of Flamsteed. It has also been claimed that Halley's observations were carelessly carried out. For example in [16]:-

Halley took no account of fractional parts of seconds of time, and considered 10" *of arc 'as the utmost attainable limit of accuracy'. His clocks were besides ill-regulated, and his system of registration unmethodical.*

In [22], however, Ronan argues that the criticisms are unfair. He lists in that article Halley's achievements as Astronomer Royal.

Halley's other activities included studying archaeology, geophysics, the history of astronomy, and the solution of polynomial equations. He was an integral part of the English scientific community at the height of its creativity.

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