The Reverend Thomas Bayes FRS: a Biography to Celebrate the Tercentenary of his Birth

by

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Abstract

Thomas Bayes, from whom Bayes Theorem takes its name, was probably born in 1701 so that the year 2001 would mark the 300th anniversary of his birth. A sketch of his life will include his family background and education, as well as his scientific and theological work. In contrast to some, but not all, biographies of Bayes, the current biography is an attempt to cover areas beyond Bayes's scientific work. When commenting on the writing of scientific biography, Pearson (1978) stated, "it is impossible to understand a man's work unless you understand something of his character and unless you understand something of his environment. And his environment means the state of affairs social and political of his own age." The intention here is to follow this general approach to biography.

There is very little primary source material on Bayes and his work. For example, only three of his letters and a notebook containing some sketches of his own work, almost all unpublished, as well as notes on the work of others were known to have survived. Neither the letters, nor the notebook, are dated, and only one of the letters can be dated accurately from internal evidence. This biography will contain new information about Bayes. In particular, among the papers of the 2nd Earl Stanhope, letters and papers of Bayes have been uncovered that were previously not known to exist. The letters indirectly confirm the centrality of Stanhope in Bayes's election to the Royal Society. They also provide evidence that Bayes was part of a network of mathematicians initially centered on Stanhope. In addition, the letters shed light on Bayes's work in infinite series.

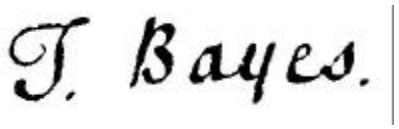
1. Introduction

The year 2001 probably marks the 300th anniversary of the birth of Thomas Bayes (1701? – 1761). This biography is written in celebration of this anniversary. There are already several biographies or biographical sketches of Bayes; a 19th Century biography appears in Fisher (1857) and some 20th Century biographies are given in Anderson (1941), Barnard (1958), Dale (1991), Edwards (1993), Hacking (1970-80), Holland (1962) and Pearson (1978). When commenting on the writing of scientific biography Pearson (1978), in lectures given over the 1920s and early 1930s, stated,

> "… it is impossible to understand a man's work unless you understand something of his character and unless you understand something of his environment. And his environment means the state of affairs social and political of his own age."

In their own biographies of Bayes, both Holland (1962) and Pearson (1978) took this statement to heart. My intention is to follow this general approach to biography while including new information on Bayes that was not available to either of these two authors.

In order to maintain the flow of the text, I will present the complete biography with little discussion of other biographies of Bayes that have been written. The current biography will rely on all known source material related directly to Bayes including new material recently discovered in the Stanhope papers held at the Centre for Kentish Studies. Since there is very little primary source material on Bayes, filling in the details in some areas of his life will require some conjecture. I will make explicit where conjectures are made and support them with evidence both from sources contemporary to Bayes or from later authors. There are some differences between this biography and others of Bayes that have been written. Some of the more important differences will be noted in the text.



Signature of Thomas Bayes from a letter in the Centre for Kentish Studies

2. Religious Background

Thomas Bayes was a Presbyterian minister. To understand the context in which Bayes lived and worked, it is first necessary to know something of English religious dissent or nonconformity in the late 17th and early 18th Centuries. For our purposes the central issue was the use of the *Book of Common Prayer* that Thomas Cranmer, Archbishop of Canterbury, completed in 1549 for use in the Church of England. After Mary took the throne min 1553, Cranmer was burned at the stake for heresy and the *Book of Common Prayer* was officially abandoned. In 1559, one year after Elizabeth I ascended the throne, the prayer book was reinstated and an Act of Uniformity was passed that required all churches in England to use the *Book of Common Prayer* for worship services. This continued until the period of the Commonwealth (1649 – 1660) when the monarchy was overthrown. At that time congregations were allowed to use their own forms of worship. Two years after the restoration of the monarchy in 1660 another Act of Uniformity was passed that again required the use of the *Book of Common Prayer* for worship services. About 2,000 clergy refused to conform to the terms of the Act and were ejected from their positions. These clergymen were often taken on as private chaplains by local gentry and so

were able to continue preaching and ministering to their followers. From the events stemming from the later Act of Uniformity, the term Nonconformist or Dissenting minister takes its name. The year following the 1688 revolution that put William and Mary on the throne of England, an Act of Toleration was passed that allowed Protestant Nonconformists or Dissenters freedom of worship. One condition was that Nonconformist meetinghouses, or chapels as they were subsequently known, had to be licensed for worship. This freedom of worship was not extended to Roman Catholics. Further, all Nonconformists were banned from holding any public office and were excluded from the universities. As a result of this ban, Nonconformist ministers developed their own institutions, called "dissenting academies," for the education of those wishing to enter the ministry and for sons of members of Nonconformist or Dissenting congregations. The best of these academies rivaled the universities in terms of the quality of education. Sons of Nonconformist parents were also sent to Scottish universities, where the ban was not in effect, or to Holland, usually the University of Leiden.

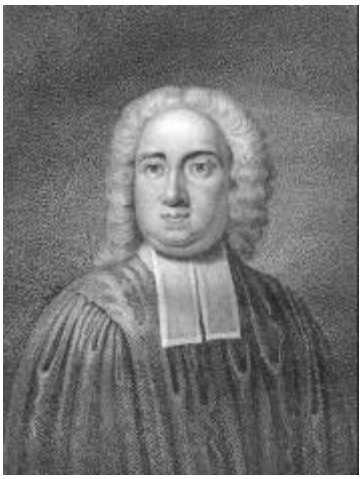
3. Family Background

Thomas Bayes came from a prominent Nonconformist family of Sheffield in the north of England. Well before Thomas was born, the family had made its fortune in the cutlery industry for which the town was famous. Pedigrees with some biographical information for the Bayes family and the allied families of Cotton and Wordsworth may be found in Clay (1894-5) and biographical material relating to the family's time in Sheffield may be found in Leader (1897) and Leader (1905-6).

Richard Bayes (1596 – 1675), a great-grandfather of Thomas Bayes, was a successful cutler in Sheffield. In 1643 Richard Bayes served in the rotating position of Master of the Company of Cutlers of Hallamshire. The company, under its act of incorporation, had authority over the cutlery industry for the area in and around Sheffield. Richard was sufficiently well off that he sent one of his sons, Samuel Bayes (1635 – 1681) to Trinity College Cambridge during the Commonwealth period; Samuel obtained his degree in 1656. Samuel became the vicar of Grendon in Northamptonshire. Another son, Joshua Bayes (1638 – 1703) followed in his father's footsteps in the cutlery industry, also serving as Master of the Company in 1679. By the second generation there is considerable evidence of wealth, influence and religious nonconformity. Evidence of Joshua Bayes's wealth comes from the size of his house, the fact that he employed a servant and the size of the taxes that he paid. His influence may be taken from his activities in the town government. The two brothers were prominent Nonconformists. Following the 1662 Act of Uniformity, Samuel Bayes was ejected from his parish, eventually living in Manchester (Matthews, 1934). Joshua Bayes was closely involved in the erection of one Nonconformist chapel in Sheffield and had two sons-in-law involved in another Sheffield chapel. One son-in-law, Elias Wordsworth (d. 1723) was the founder of this second chapel and the other, John de la Rose was the minister in it.

The second son of Joshua Bayes (1638 – 1703) was another Joshua Bayes (1671 – 1746). Biographical details for the younger Joshua may be found in Wilson (1808-14, vol. 4) and *Dictionary of National Biography* (Stephen and Lee, 1921-22). In 1686 the younger Joshua Bayes entered a dissenting academy where he studied philosophy and divinity. Located in the north of England, this academy had been established by Richard Frankland who had been ejected from a curacy in the Church of England in 1662 (Matthews, 1934). Due to official government-sanctioned religious persecution, the academy changed locations at least four times over three differ-

ent counties. At least one of these locations was near Sheffield. Bayes left the Frankland academy in 1694 and went to London where he was among the first group of Presbyterians in London to be ordained publicly to the ministry. In 1706 Bayes became the assistant minister at St. Thomas' Street Chapel in the London suburb of Southwark. He also served as an assistant at the Leather Lane Chapel in Hatton Garden, London. On the death of the minister at the Leather Lane Chapel in 1723, Bayes became the minister there. Joshua Bayes was well respected, both as a preacher and as a man of learning.



Joshua Bayes (1671 – 1746)

Joshua Bayes and his wife Anne née Carpenter were married some time, probably within days, after their marriage license was issued on October 23, 1700. There is no known surviving record of their marriage in Church of England registers and so it is likely that they were married in a Nonconformist chapel. At that time a chapel marriage would have been unusual, though not unheard of (Steel, 1973). A chapel marriage would be consistent with the nature of his ordination – both acts, in the way they were carried out, could be seen as the exercise of new or reclaimed religious rights. Joshua and Anne Bayes had seven children. In their order of birth the children were: Thomas (died 1761 aged 59), Mary (died 1780 aged 76), John (died 1743 aged 38), Anne (died 1788 aged 82), Samuel (died 1789 aged 77), Rebecca (died 1799 aged 82) and Nathaniel (died 1764 aged 42). Of the seven Bayes siblings, only Anne and Rebecca had any surviving children. Through their mother Anne (Carpenter) Bayes, who was from London, the siblings had some London cousins. Nathaniel and Susannah Carpenter were children of Anne's brother Nathaniel Carpenter and Samuel Wildman was the son of Anne's sister Susannah and her husband Watkinson Wildman.

None of the birth or baptismal dates for Thomas Bayes, or any of his siblings, is known. It is likely that all the Bayes children were baptized in Nonconformist chapels, perhaps in the chapel where their father assisted, rather than in the Church of England. None of the registers of the Nonconformist chapels for the time period in which Joshua Bayes ministered at them have survived. The earliest records for the chapel at Leather Lane date from 1835. The records from St. Thomas Chapel, Southwark date from 1724, immediately after Joshua Bayes left. This is not unusual for many early Nonconformist congregations. In fact, the records from the chapel in Tunbridge Wells that Thomas Bayes ministered to date from 1830. Many early registers were kept secret, or not at all, for fear of religious discrimination. Another factor was that Nonconformist registers were not considered legal registers of birth. Some Nonconformist families had their children baptized in the chapel only, some in the local parish church and some in both. The Bayes children are probably one example of the first situation. An example of both is Thomas Bayes's cousin Elias Wordsworth, son of Elias Wordsworth (d. 1723); Thomas left this cousin £20 in his will. The younger Elias was baptized on April 24, 1695 in the Nonconformist chapel founded by his father. On the same day he was also baptized according to the Church of England rite in St. Peter's Church in Sheffield. In view of this discussion of Nonconformist records, as well as the date of the parents marriage and the date of Thomas Bayes's death (April 7, 1761), all that can be said about Bayes's birth date is that it is probably between July of 1701 and April of 1702.

The extended family had a variety of occupations as seen from wills and London directories. The Carpenters were innkeepers in Friday Street and the Wildmans were goldsmiths in Cheapside. Both Friday Street and Cheapside are near St. Paul's Cathedral in London. In the Bayes family, the eldest son, Thomas entered the ministry. The next eldest, John Bayes took up the law. He was admitted to Lincoln's Inn to study law in 1733 and was called to the bar in 1739 (*Records of the Honorable Society of Lincoln's Inn*). The younger sons went into trade. Samuel Bayes was a linen draper operating in Cheapside and his brother Nathaniel was a grocer operating in Snow Hill. By 1759 Samuel Bayes had gone into partnership with another, or sold his business. He eventually moved south of London to Clapham. Among the daughters, Mary never married; Anne Bayes married Thomas West, a London mercer or dealer in textiles; and Rebecca Bayes married Thomas Cotton, an attorney in Hackney. Of interest is a further Presbyterian connection. Thomas Cotton was the son of another Thomas Cotton (1653 – 1730). The elder Thomas was the Presbyterian minister at Dyott Street in Bloomsbury from 1699 to 1727 (*Dictionary of National Biography*).

The general London society in which Joshua Bayes and, by extension, his family moved may be summed up by Coomer's (1946) description of London Dissenting ministers:

> "These were men of high academical attainments, many of them educated in Scottish or Dutch Universities. Some twenty or thirty possessed and adorned the dignity of a Scottish doctorate of divinity. The social circle in which they moved was an elevated one, and peers and peeresses were attendant in their ministrations."

The Bayes family of Thomas Bayes's generation was a wealthy one and close knit in its wealth. When their father Joshua Bayes died in 1746 leaving an estate of £10,000, nearly the entire estate was split among the siblings. As the siblings died one by one, they tended to leave their fortunes to their siblings or to nephews. For example, Nathaniel Bayes received £1,600 from his father. He received an additional £400 when his brother Thomas died. He must have been as astute businessman. At his death in 1764 he held in excess of £5,000 in assets. Apparently leaving no children, his estate was divided among his surviving siblings, nieces and nephews. Mary Bayes inherited £1,800 from her father and received another £600 held for her by her father. Over her lifetime she received more inheritances from her siblings. At her death in 1780 she had an estate of £4,000. It was split among her surviving siblings and two nephews. As more siblings died, the bulk of the money tended to go to Bayes Cotton, the son of Rebecca (Bayes) and Thomas Cotton.

The family had made its fortune in Sheffield in the cutlery trade. By the time of Joshua Bayes (1671 – 1746), the family's wealth was held instead in a variety of investments. Joshua apparently invested in mortgages. His daughter Mary, at her death, held her money in 3% bank annuities. These investments remained intact as they were passed through wills to the next generation. This can be seen from a complex legal dispute played out in the Chancery Court that carried over several years in the mid-18th Century. Thomas Bayes and his brother Samuel Bayes, acting as executors to their father's estate, were briefly involved as minor players in this court action in 1749. Circa 1735, Joshua Bayes had lent £1,500 to Thomas Gibson and Henry Jacomb at 4% interest; the two borrowers used as collateral a stake they had in a property in Wiltshire that was worth £41,000. The property in Wiltshire was actually collateral received by Gibson and Jacomb on money owed to them. When Joshua Bayes died in 1746, the sons administered the

£1,500 investment as part of the estate. The original lawsuit was initiated by someone else and had its connection with the Wiltshire property.

4. Early Life and Education

Normal entry to ministry in the Church of England was through a degree taken at Oxford or Cambridge. Since ministry in the Church of England was not of interest to him and neither Oxford nor Cambridge was an option open to him, Thomas Bayes took one of the educational paths open to Nonconformists of his day. He trained for the Presbyterian ministry at the University of Edinburgh, entering that university in 1720 (Dale, 1991, p. 7).

Prior to his studies at Edinburgh, Bayes probably received earlier educational training from John Ward (1679? – 1758). The evidence for this assertion is circumstantial. Joshua Bayes and John Ward were friends, at least to the extent that in 1720 Bayes received from Ward a copy of a book written by Robert Ainsworth on the antiquities collected by John Kemp, a Fellow of the Royal Society (Ainsworth, 1720). Ward had assisted Ainsworth with the book, providing Ainsworth with descriptions of some parts of the collection as well as other information. Ward briefly described his assistance in this endeavour to Thomas Bayes in a letter written in Latin dated May 10, 1720. A translation of the relevant section of the letter is:

> "Recently I gave your father a book about some principals of ancient things, compiled partly through my own and partly through a friend's efforts. This, I suppose, he will send to you shortly."

In the other direction of the friendship, when Ward wrote his *Lives of the Professors of Gresham College*, Joshua Bayes helped to pay for the printing in advance by being a subscriber to the publication (Ward, 1740). With regard to friendship in general, Birch (1766) says in a biography of Ward:

> "He [Ward] continued in his employment in the navy office till the summer of the year 1710, when he thought proper to resign it; and finding no other means of gratifying his zeal for the acquisition of knowledge, was induced to undertake the education of a certain number of the children of his friends; chusing rather, as he expressed himself, to converse even with boys upon subjects of literature than to transact the ordinary affairs of life among men. For this purpose he open'd a school in Tenter Alley in Moor Fields, which he kept for many years."

In the 1720 letter from Ward to Thomas Bayes, much of the content was devoted to advice from Ward on how Bayes could improve his Latin composition so that it is likely that Bayes studied with Ward at his school until he enrolled at the University of Edinburgh. The only piece of evidence that is against Bayes being Ward's student is that a list of his students exists, covering the years 1715 to 1731. Thomas Bayes does not appear on the list. The list may be incomplete; or Bayes may have attended the school only between 1710 and 1715 and then had private tutoring from Ward afterward.

What is also apparent in the letter from Ward to Bayes is that at the time the letter was written Bayes was reading classical authors in both Greek and Latin. According to Timpson (1859), Bayes was the best Greek scholar that Richard Onely had ever met. Onely was the Church of England rector of the parish of Speldhurst near Tunbridge Wells. This is probably an

error since Onely did not arrive at Speldhurst until after Bayes's death, and there is no reason to assume that they knew each other before Bayes arrived in Tunbridge Wells. The reference was probably to Bayes's successor at Tunbridge Wells, William Johnston.

Ward was appointed Professor of Rhetoric at Gresham College in 1720 and elected Fellow of the Royal Society in 1723. The college was founded in 1579 by Sir Thomas Gresham for the delivery of lectures that were free to all who cared to attend. The professorships, seven in all, were in the areas of divinity, music, astronomy, geometry, physics, law and rhetoric. The duties of the professor were not onerous – one or two lectures per week. One other stipulation was that professors had to be unmarried and live in college (Weinreb and Hibbert, 1983). In view of Birch's comment that Ward kept his school for many years, he may have taught at this school while he maintained his professorship.

Some time after leaving Ward's school, Thomas Bayes entered the University of Edinburgh early in 1720. There are two records of him dated February 27, 1719. My interpretation is that this is the old style of dating in which the new year began, or the year turned, on March 25. February 27, 1719 is then February 27, 1720 in the modern calendar. One of the records for Bayes on that day is the setting up of his library account, which amounted to £3. The other is a list of students of Colin Drummond, the Professor of Logic and Metaphysics, on which Bayes appears. Another record shows that Bayes's entrance to the library was sponsored by James Gregory, the Professor of Mathematics. Unfortunately, there is no list of Gregory's students. However, Ward says in his letter dated May 10, 1720 approximately 2½ months after Bayes arrived in Edinburgh:

> "The order which you follow in the rest of your studies I cannot but highly approve of. In occupying yourself simultaneously with both mathematics and logic you will more clearly and easily notice what and how much each of these excellent instruments contributes to the directing of thought and sensation."

That Bayes studied mathematics with James Gregory in the first year he arrived at Edinburgh is then a reasonable conclusion. Over 1720 and 1721 Bayes also attended lectures on history given by Professor Charles Mackie.

Gregory was part of a family of mathematicians. His uncle, an eminent mathematician also named James Gregory, had been Professor of Mathematics at Edinburgh in the 17th Century. His brother, David Gregory was another eminent mathematician. David Gregory had been Professor of Mathematics at Edinburgh until 1691 when he left his position subsequently becoming Savilian Professor of Astronomy at Oxford. His brother James took over the professorship at Edinburgh in 1692 and remained in that position until 1725 when he retired due to age and ill health. Another brother, Charles Gregory was Professor of Mathematics at the University of Aberdeen. The abilities of the James Gregory who taught Bayes have been described in Grant (1884):

> "He seems to have been an able teacher, but did not otherwise add to the reputation of the Gregory family."

James Gregory was succeeded at Edinburgh by Colin Maclaurin, who arrived there late in 1724.

The main reason that Bayes was at Edinburgh was to study divinity and to prepare for the ministry. Bayes entered Divinity Hall in 1720, the same year he arrived at the university. Clearly,

it was the family's intention that Thomas enter the ministry; it was his father who recommended him to the divinity school. By the time he left Divinity Hall he was licensed to preach but not ordained as a minister; presumably his ordination took place in London with the participation of his father. Thomas Bayes remained at Edinburgh until at least 1722 and possibly to 1723. The latest recorded information on Bayes at Edinburgh is that, as part of his divinity training, he delivered analyses, or exegeses, of two different biblical passages. Both passages were sets of verses from the Gospel of Matthew. The earlier is dated January 14, 1721 and the later is dated January 20, 1722. Again these may be dates in the old calendar style so that in the modern calendar they would correspond to the years 1722 and 1723 respectively.

Bayes did not go to Edinburgh alone. Attending the university at the same time were his friend Skinner Smith and his cousin Nathaniel Carpenter. Skinner Smith was another student of John Ward; he also received a letter from Ward in May of 1720. Like Bayes, Skinner Smith studied divinity at Edinburgh. Soon after leaving Edinburgh, Skinner Smith became the minister at the Old Dissenting Chapel in Cirencester. After holding this pastorate from 1726 to 1729, Skinner Smith moved to Abingdon where he remained until his death in 1748 (Murch, 1835 and Summers, 1905). He was described as a "gentleman of great piety and learning, and a serious evangelical preacher." Nathaniel Carpenter was admitted to the Edinburgh University Library on January 27, 1719, a month before his cousin. He is also mentioned briefly by Ward in his letter to Bayes. This cousin may have died young. When his father, also Nathaniel Carpenter, died in 1753, only the daughter Susannah was mentioned in the will.

After studies in Edinburgh, Thomas Bayes returned to London. There is, however, a five-year gap between the last Edinburgh records and the first London records. The first record from London dates from 1728. Thomas Bayes appears on a list of approved Presbyterian ministers in London and area submitted to the Body of Protestant Dissenting Ministers of the Three Denominations. This was a group or committee that included Presbyterians, Independents and Baptists. It met regularly to discuss problems that the denominations encountered. Joshua Bayes was often a member of this committee and sometimes chaired its meetings. In the 1728 list, Thomas Bayes was described as an approved minister but unfixed in terms of a chapel or pastorate. He was also described as "residing at Mrs. Deacle's" rather than with any member of his family. She was probably the widow of a John Deacle who died in 1723. This John Deacle was sufficiently wealthy to have a funeral sermon preached for him at the Presbyterian chapel in Crosby Square (Grosvenor, 1723). Subsequently, Bayes became an assistant to his father at the Leather Lane chapel; he appears this way on a 1732 list of approved Presbyterian ministers submitted to the Body of Protestant Dissenting Ministers (see also Wilson, 1808-14, and the John Evans List). Bayes remained in London working with his father until perhaps 1734, or slightly later, at which time he moved to Tunbridge Wells.

5. Religious Beliefs

Thomas Bayes was a Presbyterian minister and as such it is expected that he would hold religious views common to his fellow Presbyterians. However, among the Presbyterians of the 18th Century, there was a variety of religious positions that emerged early in the century. The extent of this variety may be set against a background of Christian orthodoxy. One of the tenets of orthodoxy was the doctrine of the Trinity. This doctrine holds that there are three natures to God: Father, Son and Holy Spirit. Of importance here is the relationship of God the Father and God the Son in the person of Jesus Christ. In the doctrine of the Trinity, Father and Son are co-

equal and eternal. Departing from this path of Christian orthodoxy are beliefs that carry the labels of Arian, Socinian and Unitarian. Arians believed in a supreme God. God the Son, or Jesus, was a lesser God that was pre-existent to his worldly birth. Socinians also believed in a supreme God, but held that Jesus was not pre-existent and that he became a lesser God. Unitarians believed in one God only; the divinity of Jesus was denied. Arianism and Socinianism grew and flourished, though not without some tension, among Presbyterians throughout the 18th Century. Unitarianism emerged only in the latter part of the century. See Wiles (1996) for a much fuller discussion.

Many Presbyterians in the 18th Century strayed from orthodoxy on the doctrine of the Trinity. By the end of the century the Unitarian church had emerged as an entity. Many of the Unitarian chapels had evolved from, and taken over the buildings of, congregations that had previously been Presbyterian. This evolution, at least in the first half of the century, did not occur smoothly. One early episode in this evolution began 1719 in Exeter when two Nonconformist ministers were excluded from all Presbyterian pulpits in the city on suspicion of Arianism. A conference among the three dissenting Protestant denominations was held at the Salters' Hall meetinghouse in London to discuss the situation and to provide advice on how congregations should proceed in the future. The conference was deeply divided on how to handle the issue. Several prominent Nonconformist divines, including Joshua Bayes (James, 1867), abstained from taking part. The end result was that it was up to the individual congregations to determine the orthodoxy of their minister (Coomer, 1946). An example of the fallout over the Salters' Hall controversy is that the congregation at the Founders' Hall meetinghouse terminated the services of a Presbyterian minister, who for 19 years had given Sunday evening lectures at their chapel. His views in the controversy had differed with the views of their permanent pastor (Williams, 1922). What became apparent from the Salters' Hall controversy was the power to appoint and dismiss a minister lay in the hands of the trustees of the meetinghouse and the pew-holders (those that paid rents on the pews) of the chapel.

Perhaps consistent with the fact that he declined to be involved in the Salters' Hall controversy over Arianism and how to handle it, Joshua Bayes was known as a moderate Calvinist who was tolerant of a variety of views (Wilson, 1814-18). The theological views of Thomas Bayes are less certain though there is strong evidence of Arianism. The first hint comes from Timpson (1859) who states that Bayes was not "evangelical in his doctrine." Fuller evidence comes by looking at who Bayes's friends (in a wide sense) were. A brief list that might substantiate the claim of Arianism includes James Foster, John Hoyle, Richard Price, William Whiston and perhaps Skinner Smith. I will deal with his friends in order of the increasing amount of evidence they provide towards Bayes's Arianism.

Skinner Smith and Bayes appear to have been friends while students at Edinburgh. Ward, in his letters to each of them, uses the Latin word *comes* (companion) to describe their relationship. As noted previously, Skinner Smith's first appointment was at the chapel in Cirencester. This was a Socinian chapel (Evans, 1897, p. 661). However, there is nothing to connect Bayes to Skinner Smith after their university days together.

James Foster was a Nonconformist minister, originally from Exeter. The two Presbyterian ministers who were expelled from their pulpits in Exeter in 1719 were his friends. Foster probably also had Arian views (*Dictionary of National Biography*). His connection with Thomas Bayes is that Bayes, among many others, subscribed to the publication of Foster's last and greatest publication *Discourses on all the Principal Branches of Natural Religion and Social Virtue*

(Foster, 1749-52). Without the subscriptions to this publication Foster would have died penniless.

The case for John Hoyle is through Bayes's will. For Price, it is through the will and the fact that it was Price who presented Bayes's now famous paper to the Royal Society. With regard to wills, there was a tendency in the Bayes family to leave small amounts of money to Nonconformist ministers that presumably the testator admired. Both Mary Bayes and Nathaniel Bayes each left £100 to Michael Pope. Four years prior to the death of their father Joshua, Michael Pope became the assistant at the Leather Lane Chapel. On Joshua Bayes's death Pope became the pastor at Leather Lane. At her death, Mary Bayes lived in Stoke Newington, nowhere near the chapel where her father had been minister. In his will Thomas Bayes left £200 to be split between John Hoyle and Richard Price. Hoyle was the minister at Stoke Newington from 1748 to 1756. When Hoyle left Stoke Newington to take up a position in Norwich (Browne, 1878), Richard Price became the pastor at Stoke Newington. Both chapels eventually became Unitarian churches; both Hoyle and Price were known Arians (Evans, 1897).

William Whiston
(1667 – 1752)

The connection between Thomas Bayes and William Whiston is that they had breakfast together at Bayes's home or lodgings in August of 1746. It was not the breakfast itself that is of importance but the topic of conversation that Whiston reported (Whiston, 1749). The conversation centered on whether the Creed of Athanasius would be read in the Tunbridge Wells chapel associated with the Church of England. If so, Whiston was going to leave the service when this creed was read. Bayes informed Whiston that since the priest had not read that particular creed on the previous appointed day for it, which was Christmas Day, it was unlikely to be read on the current day that was appointed for it. The problem with the Athanasian Creed for Arians was that it explicitly lays out in detail the doctrine of the Trinity and ends with, as stated in the *Book of Common Prayer*: "This is the Catholic Faith, which except a man do faithfully and steadfastly believe, he cannot be saved." Whiston was an Arian (Wiles, 1996). He had begun his career as a Church of England vicar. He gave up his parish when he succeeded Newton in the Lucasian chair in Mathematics at Cambridge in 1703. In 1710, he was removed from his professorship because of his Arian views (*Dictionary of National Biography*). It is interesting to note that besides Bayes's probable Arian views, he knew what was happening in the local services of the Church of England.

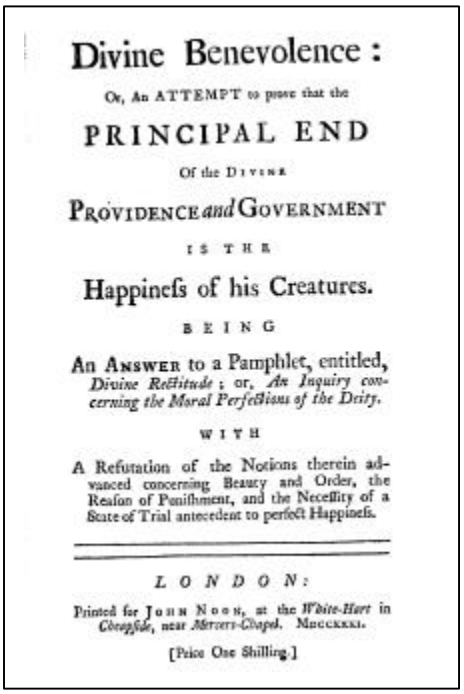
6. Theological Work

Bayes's first publication was a theological work, entitled *Divine Benevolence* ([Bayes], 1731). Since no author appears on the title page of the book, or anywhere else, it is sometimes considered to be of doubtful authorship. For example, the *National Union Catalog* of the United States ascribes authorship to Joshua Bayes. However, Thomas Bayes was the author of this work. Bayes's friend, Richard Price refers to the book in his own work *A Review of the Principal Questions in Morals* (Price, 1948, p. 248) and says that it was written by Thomas Bayes.

In *Divine Benevolence* Bayes was trying to answer the question of the motivating source of God's actions in the world. The tract was written in response to a Church of England theologian, Dr. John Balguy, who claimed in his own writings, summarized by Doddridge (1822), that

"God always does that which is right and fit, and that all his moral attributes, viz. justice, truth, faithfulness, mercy patience, &c. are but so many different modifications of rectitude."

Bayes attributed the source of God's action in the world to God's goodness or benevolence. As noted by Pearson (1978), Bayes had a problem when trying to explain this as the source of God's actions when there was pain and evil present in the world. To get around this problem, Bayes defined what he meant by "God's goodness" by first defining what he did not mean by it ([Bayes], 1731, p. 70):



Divine Benevolence:

Or, An ATTEMPT to prove that the

PRINCIPAL END

Of the DIVINE

PROVIDENCE *and* GOVERNMENT

IN THE

Happineſs of his Creatures.

BEING

An ANSWER to a Pamphlet, entitled, *Divine Rectitude*; or, *An Inquiry concerning the Moral Perfections of the Deity.*

WITH

A Refutation of the Notions therein advanced concerning Beauty and Order, the Reaſon of Puniſhment, and the Neceſſity of a State of Trial antecedent to perfect Happineſs.

LONDON:

Printed for JOHN NOON, at the *White-Hart* in *Cheapſide*, near *Mercers-Chapel*. MDCCXXXI.

[Price One Shilling.]

> "If we conceive of the goodness of God as an unbounded inclination to create happiness, and consequently suppose he has made the world as happy and as perfect as he possibly could, there are undoubtedly abundance of *phœnomena*, the consistence of which with this supposition we cannot discern, and which we shall find some difficulty to perswade men are not compatible with it:"

In the next sentence he defined what he meant by divine goodness:

> "But if we only conceive of the divine goodness a most kind affection towards his creatures, and as inclining him to confer upon that universe of creatures he has made the greatest happiness of which they are capable, still supposing that their original capacities were fixed by his will and pleasure, we shall find it much easier to satisfy our selves, that there is nothing in any appearances of providence contrary to the most perfect goodness of the divine nature."

Bayes's tract was followed by that of another Nonconformist minister, Henry Grove. He argued that the source of divine action was wisdom rather than rectitude or goodness.

By today's standards the argument seems almost irrelevant. At the time that it occurred, it created considerable attention. In his own lectures on theology Philip Doddridge (1702 – 1751) referred to the controversy as "celebrated" (Doddridge, 1822). Richard Price, writing in the 1780s lamented the fact that Bayes's tract was out of print (Price, 1948, p. 248) and Toulmin (1814) described the tract as one that "excited attention." The controversy went out of fashion by the late 18th Century. A footnote in Doddridge (1822), written by Andrew Kippis (1725 – 1795) says,

> "This controversy, though much celebrated in its time, is now nearly forgotten."

7. Tunbridge Wells

In Thomas Bayes's day, Tunbridge Wells was chiefly a tourist town. A very brief description of the town in the mid-18th Century, as part of a larger description of the County of Kent, is from the November 1749 edition of *London Magazine*, p. 492:

> "Tunbridge, 7 miles S.E. of Sevenoak, has a market on Friday. The town of itself is but indifferent, and the streets ill paved; but what renders it famous, is the medicinal wells, about 5 miles from it, called Spelhurst [sic] -wells, but commonly Tunbridge wells, which occasion an annual resort of abundance of people of fashion, some for health, but more for diversion: And here many houses are built in a bottom between 2 hills, call'd Mount Sion and Mount Ephraim, with a handsome chapel of ease."

The chapel of ease refers to the local Church of England chapel that was built for the local residents, but which remained under the control of the parish church in nearby Speldhurst.

A wide variety of visitors or tourists arrived at Tunbridge Wells between the spring and fall every year. Writing in 1745, Elizabeth Montagu (1809, v. 3, pp. 8 – 9), who came for both health and diversion, described the variety of people there. In terms of nationalities that year there were Hungarians, Italians, French, Portuguese, Irish and Scots. In terms of religious beliefs there were Jews and Roman Catholics as well as "quaint Puritans, and rigid Presbyterians." It is unlikely that she was ever in social contact with Bayes; she concluded her description of the variety of people at Tunbridge Wells with,

> "I never saw a worse collection of human creatures in all my life. My comfort is, that as there are not many of them I ever saw before, I flatter myself that there are few of them I shall ever see again."

In 1749 she wrote more positively. To one friend she wrote (p. 82),

> "the variety of persons and characters make Tunbridge an epitome of the world."

And to another (p. 90) she wrote,

> "Tunbridge seems the very parliament of the world, where every country and every rank has its representatives."

She goes on to say to the same recipient,

> "For my part, I am diverted with the medley; the different characters are amusing, especially at the balls …"

The wide variety of nationalities that arrived in Tunbridge Wells undoubtedly came through London. The metropolis was relatively close, about 36 miles (or 58 kilometers) away. Visitors could arrive either by private carriage or by the service available in London. From the 1730s to the 1760s, carriages came once a day to Tunbridge, not Tunbridge Wells, leaving London from the Bell Savage Inn in Ludgate Hill (London Directories). The service ran every day in

the summer and on Mondays and Fridays only in the winter. Presumably travelers to Tunbridge Wells would change carriages at Tunbridge.

Among the many visitors to Tunbridge Wells was Philip Stanhope (1713 – 1786), 2nd Earl Stanhope. A brief biography of him appears in *Public Characters*. Of relevance to the biography of Bayes are Stanhope's intellectual interests and family background. Stanhope's father had died when he was seven and he was put under the guardianship of his uncle Philip Dormer Stanhope (1694 – 1773), 4th Earl Chesterfield. Though the younger Stanhope was keenly interested in mathematics, Chesterfield thought the study of belles-lettres was much more important and would not allow his ward to study mathematics. Once he came of age, Earl Stanhope took up mathematics with a great deal of enthusiasm and became an accomplished mathematician. Even before the age of 20, Stanhope's interests and abilities were described by a contemporary as (Newman, 1967, p. 105):

> "[He] knows a great many things very well, but they are not such as young people generally have a relish for. He has read a good deal of Divinity, Metaphysicks, and Mathematicks. He is really pious, sober, chaste, and honest."

Stanhope had a London house in Duke Street. The family seat, however, was at Chevening near Sevenoak, about 12 or 13 miles (19 to 21 kilometers) from Tunbridge Wells. Chevening and Sevenoak were considered close enough to Tunbridge Wells that they both appear in some guides for the general area (Burr, 1766, p. 226, for example).

Stanhope visited Tunbridge Wells in his early twenties, or perhaps sooner. There are two slightly different descriptions, by Elizabeth Montagu, of his visit in 1736. The descriptions are of the same visit but from different editions of her letters. Climenson's (1906, p. 18) version of Montagu's letter is:

> "The person who was most taken notice of at Tunbridge as particular is a young gentleman your Grace may be perhaps acquainted with, I mean Lord Stanhope. He is always making mathematical scratches in his pocket-book, so that one half the people took him for a conjuror, and the other half for a fool."

An earlier edition (Montagu, 1809, vol. 1, p. 25) is slightly different in substance but contains further information:

> "The person most noticed for singularity at Tunbridge was Lord —: he is always making mathematical scratches in his pocket-book, so that one half of the people took him for a conjuror. His is much admired and commended by his acquaintance, which are few in number. I think he had three at the Wells, and I believe he did not allow them above a sentence a piece in the whole day, the rest he left Lady — to say, who, I believe, doe not acquit herself ill of the office of spokeswoman. She seems to be very good natured, sensible, and of a more communicative temper than his lordship."

It is uncertain when Bayes first met Stanhope. They definitely were on professional or social terms in Tunbridge Wells and they definitely discussed mathematical problems when they met. A note written by Stanhope on a scrap of paper that is among Stanhope's surviving papers in the Centre for Kentish Studies reads:

"Theorem mentioned to me at Tunbridge Wells by M^{r} Bayes Aug. 12. 1747.
$\dot{y} = y - \frac{1}{2}\ddot{y} + \frac{1}{3}\dddot{y} - \frac{1}{4}\ddddot{y} + \frac{1}{5}\dddot{\dddot{y}} - \frac{1}{6}\ddot{\dddot{y}} + \&c$"

The dot over the *y* denotes the fluxion or differential y/t and the number of dots under the y denotes the order of differencing in terms of Newton's forward differences. A brief discussion of this result is left to §9.

For the people of fashion who were there for diversion, typical daily activities at Tunbridge Wells are described by [Onely] (1771), the rector of the parish church in Speldhurst:

> "The morning is passed in an undress; in drinking the waters, in private or public breakfastings, which are sometimes given by one of the company, in attending prayers at the chapel [the chapel of ease], in social converse on the parade, at the coffee-house, in the public rooms, or bookseller's shop; in raffling for, cheapening and buying goods, at the milliners, turners, and other shops; billiards, cotillon dances, private concerts, cards, or some adventitious curiosity and novelty; a painter, a musician, a juggler, a fire-eater, or philosopher &c. After dinner, all go dressed to the parade again, and the rooms, to tea, in private parties, or in public – At night to a ball or assembly, and sometimes to a play. The ball nights are, *Tuesdays* and *Fridays*; and assemblies and cards every other night, except *Sundays*."

One of the "philosophers" who regularly came to town was William Whiston. After his ejection from Cambridge, described briefly in §5, he operated as a private chaplain and itinerant lecturer. In Tunbridge Wells, he initially preached at the chapel of ease (Barton, 1937, p. 218). Because of his heretical views, he later hired rooms from which he gave lectures on millennial prophesies. He also made models of the tabernacle of Moses and the temple of Jerusalem and lectured on these at Tunbridge Wells as well as other places. Bayes may have first met Whiston on one of his visits to Tunbridge Wells. They may also have met earlier in London prior to Bayes's move to Tunbridge Wells. Whiston lectured on astronomy and religious subjects in various London coffee houses early in the century (*Dictionary of National Biography* and Wilson, 1882).

As noted in *London Magazine* the main part of the town was in a valley between two hills, Mount Sion and Mount Ephraim. The wealthy tourists tended to rent accommodation on the northern hill, Mount Ephraim. By the 1760s the fashionable lodging places for the season had changed from Mount Ephraim to Mount Sion (Benge Burr, pp. 102 – 107). Of Mount Sion, Sprange (1780, p. 7) writes,

> "A very good Presbyterian Meeting-House is situated about the middle [of Mount Sion]; and at the top of it [Mount Sion] a large grove of fine elms; which is frequently used by invalids and others both for walking

Mount Sion Meetinghouse in the 1990s

> or riding, when either the rays of the sun are two [sic] powerful, or the weather too precarious, to venture out to a greater distance."

The Presbyterian meetinghouse or chapel was built in 1720 and opened at the beginning of August of that year (Archer, 1720). The first minister of the chapel was John Archer. The license to have the chapel was obtained in April of 1721 (Kent Quarter Session Records). Among the trustees for the chapel was a man named John Jeffery. John Archer remained the minister of the Mount Sion Chapel until his death on September 23, 1733. Archer had been ill near the end of his life and his services were taken by some of his friends. Benjamin Mills, who preached Archer's funeral sermon a week after Archer's death described how he came to preach the sermon (Mills, 1733, p. 4).

> "But it hath pleased God, in the Course of his sovereign Providence, to direct, that what I intended as an Assistance to my worthy Friend in his Inability for publick Service, should be changed into his Funeral Sermon."

Where the historical sources have commented, they have all been in agreement that Thomas Bayes succeeded John Archer at the Mount Sion chapel in Tunbridge Wells. There has, however, not been agreement on the time that Bayes arrived, with dates as early as 1731 being given. See Dale (1991, p. 395, fn 17) for a discussion. Bayes probably arrived in Tunbridge late in 1733 or early 1734 soon after the death of John Archer. None of the historical sources comment that there was a significant gap between Bayes's ministry and Archer's in Tunbridge Wells.

When Thomas Bayes came to Tunbridge Wells, being single he probably lodged with a Nonconformist family as he did with Mrs. Deacle in London. One likely location now bears the address 69 London Road. The house, with ownership ascribed to John Jeffery, or Jeffry, appears on Bowra's 1738 map of Tunbridge Wells (Centre for Kentish Studies). This was the same John Jeffery who was a trustee of the Mount Sion Chapel. According to Roger Farthing of Tunbridge Wells, who searched deeds related to this house, it was a lodging house in Bayes's day and was owned by the Jeffrey family from the late 17th century. John Jeffery's daughter Sarah subsequently owned the house. Bayes's tie to the family, and hence the house, is through his will. Bayes left a legacy to John's daughter Sarah. She received £500, a tidy sum of money in the 18th Century, as well as "my watch by Ellicot and all my linen and wearing apparel and household stuff …" Baptized on January 24, 1724 in Tunbridge, Sarah Jeffery was at least 20 years younger than Bayes. It is likely that the legacy to Sarah Jeffery was in gratitude for support that the family had given Bayes as trustees of the chapel. If Bayes did indeed hold Arian beliefs, then he needed the support of the trustees to retain his position as minister of the chapel.

69 London Road, Tunbridge Wells

The legacy may also have recognized the support and help he would have received during illnesses that he had at times over the 25 years or more that he may have lodged with the Jefferys. Bayes, as he noted in a letter to Stanhope, was definitely ill, perhaps seriously, in 1755. All that is known further of Sarah Jeffery the legatee is that she married twice, both husbands also having the surname Jeffery.

Bayes also left money to two others named Jeffery – Richard and another Sarah Jeffery. These were the children of a Richard Jeffery and they shared a legacy of £100. They were also more than 20 years younger than Bayes. Sarah and Richard were baptized, also in Tunbridge, on October 17, 1726 and January 21, 1725 respectively. Although there are no parish records that I can find that would show it, the two fathers, John and Richard, were probably brothers. There is also a strong Nonconformist connection with the family of Richard Jeffery. Richard married a woman named Sarah, as did John Jeffery. Of interest here is that the maiden name of the Sarah who married Richard was Scoones; Thomas and John Scoones were also trustees of the Mount Sion Chapel when it opened in 1720. Also, when this Sarah Jeffery died in 1770, William Johnston, who was Bayes's successor at the Mount Sion Chapel, preached her funeral sermon (Johnston, 1771).

Although he was well respected as a minister (*Protestant Dissenter's Magazine* and Toulmin, 1814), Timpson (1859) says of Bayes that he was not a popular preacher. This would have been a distinct disadvantage to a Presbyterian minister. His main duties were connected to the Sunday services. A typical service had psalm singing, prayers, scripture reading and a sermon. Out of a service that would have lasted an hour and a half to two hours, one hour was devoted to the sermon (Coomer, 1946). Many preachers spent considerable time preparing their sermons.

Though he remained in Tunbridge Wells until his death, Bayes gave up his ministry at the Mount Sion Chapel to William Johnston in 1752. If indeed Bayes was an Arian, the change in ministry also marks a distinct change in theology. Johnston was a pupil of Philip Doddridge; Doddridge preached at the chapel when Johnston was installed as the minister. Doddridge was a leader of orthodoxy among the Presbyterians.

The presence of Doddridge and wills for various members of the Bayes family show that Thomas Bayes's family and some of his acquaintances did not share his probable Arianism. His father Joshua, uncle Nathaniel Carpenter and brother-in-law Thomas West all subscribed to Doddridge's *Family Expositor* (Doddridge, 1739-56), a paraphrase of the New Testament with notes for further Bible study and reflection. As noted already, Thomas Bayes's brother Nathaniel and sister Mary left money to Michael Pope who followed Joshua Bayes as the minister at Leather Lane; Pope was a popular minister who was described a liberal but probably orthodox (Wilson, 1808-14, vol. 4). John Ellicott, from whom Bayes bought his gold watch, and John Noon, who published both of Bayes's books, were both subscribers to the *Family Expositor*.

Philip Doddridge
(1702 – 1751)

The change in ministry at the Mount Sion Chapel is also related to an event in the chapel that began three years before. By the mid-1740s there was a desire for an Independent chapel in Tunbridge Wells. It had grown out of some small house meetings for scripture reading and prayer. In 1749 some Independents, according to Timpson (1859),

> "engaged the Presbyterian chapel, from the Rev. Mr. Bayes, its minister. They enjoyed the gospel preached by ministers sent from London for nearly a year, until Easter Sunday in 1750, when Mr. Bayes resumed his pulpit, disliking the doctrine of the Independents and they again attended at the Established church, for the sake of the Lord's Supper."

The next year, the principal players from the Independents' side, who are described in Timpson (1859), obtained a license to have a dissenting meetinghouse associated with one of their own homes. In 1752 another license was obtained for a new building to serve as an Independent chapel (Kent Quarter Session Records).

Strange (1949) interprets the events surrounding the Independents' use of Mount Sion Chapel as a desire on the part of Bayes to retire from the ministry; Holland adopted this interpretation. In view of William Johnston's orthodoxy following on Bayes's Arianism, the two events may also be interpreted as mounting tension within the Presbyterians of Tunbridge Wells over Bayes's probable heterodoxy. Since he was independently wealthy and did not need the financial support of his congregation at the chapel, Bayes bowed out of the ministry. As will be seen in §10, illness may also have been a factor.

When Joshua Bayes died, he left his son Thomas not only a sizable fortune but also his library. At Thomas Bayes's death his library went to William Johnston. Timpson (1859) states,

> "He bequeathed his valuable library to his successor, the Rev. William Johnson [sic], M.A., who became minister of the chapel in 1752."

There is no mention of this bequest in Bayes's will. It is likely that it was a gift made by Bayes's executors, his brother Nathaniel and his nephew Joshua Cotton. Following on the Arian versus orthodox divide within the family, Nathaniel Bayes may have wanted at least his father's theological books to go someone with orthodox religious views within Presbyterianism.

8. Election to the Royal Society

Before being put up for election to fellowship in the Royal Society it was normal to attend a meeting of the Society under the sponsorship of another fellow. In this way the candidate could be introduced to those who would vote on the nomination. Such was the case with Bayes. John Belchier, an eminent surgeon at Guy's Hospital in London, brought Bayes to his first meeting on March 25, 1742. Two weeks later on April 8, Bayes's nomination certificate was signed by Philip Stanhope, 2nd Earl Stanhope, followed by Martin Folkes, Sir James Burrow, Cromwell Mortimer and John Eames. Interestingly, the minutes of the meeting (Royal Society, Journal Books) show that Eames had not signed the certificate, but the surviving certificate has his signature on it. It is likely that Eames signed the certificate at the end of the meeting after the minutes had been recorded. This would indicate that Eames was not the primary sponsor for Bayes's fellowship, but knew of him or his work. The certificate reads:

> "The Revd Thomas Bays of Tunbridge Wells, Desiring the honour of being Elected into this Society, we propose and recommend him as a Gentleman of known merit, well skilled in Geometry and all parts of Mathematical and Philosophical Learning, and every way qualified to be a valuable member of the same."

It was posted so that fellows could politic over the upcoming election. The election took place on November 4 and Bayes was duly elected. He was admitted Fellow a week later. On his admis-

sion he paid the normal admission fee and then an additional amount of twenty guineas as a life-time payment in lieu of regular dues.

Pearson (1978) has been the one who has speculated the most about this election. Unfortunately Pearson's discussion is tainted with the misapprehension of what constituted the mathematical work that Bayes had published anonymously. Most biographers of Bayes attribute the nomination and election to the book published anonymously in 1736 ([Bayes], 1736). Pearson was unsure of the publication and mentioned two other books, one published in 1741 and the other in 1751. With regard to the certificate and the signatures that appear on it, Pearson (1978) commented,

> "Now these appear to be the most extraordinary set of names to be attached to the certificate of the minister of a non-conformist chapel in Tunbridge Wells!"

Pearson (1978) was wondering how a scientific nonentity, who was not part of the political, social or ecclesiastical establishment, could be put forward by some of the establishment itself. At the time of the election Folkes was the President of the Society and Mortimer was the Secretary. Over twenty-five years later Burrow became President of the Society. To try to address this issue, Pearson examined some of the known religious beliefs of the Fellows to ascertain what the prevalence was of those with a Nonconformist religious persuasion in the Society. He came up with a very short list and took the discussion no further. However, Pearson concluded quite rightly about the names on the certificate:

> "With such names on his certificate Bayes was certain of election."

It is then a useful exercise to examine Bayes's sponsors more closely since there are some close and some tenuous connections.

At the top of the list is Philip Stanhope (1713 – 1786), 2nd Earl Stanhope. See *Public Characters* for a biography. As noted in §7 Stanhope was keenly interested in mathematics, even after his uncle had denied him the opportunity to study the subject in his youth. It was probably Stanhope who read Bayes's defense of Newton's calculus or doctrine of fluxions ([Bayes], 1736) and decided that Bayes would be a good candidate for fellowship. Stanhope was both a promoter of mathematics and mathematicians. For example, on the death of Robert Smith (1687 – 1768), a mathematics professor at the University of Glasgow, Stanhope paid for the publication of Smith's posthumous works and sent copies of these works to every learned society in Europe and every prominent mathematician that he knew. Further, the Centre for Kentish studies holds Stanhope's mathematical papers, which contain his correspondence with several leading mathematicians of the day. Stanhope was also a patron of known Nonconformists. Joseph Priestley (1733 – 1804), who held Arian views from about 1750 to 1765 until he became a Unitarian (Wiles, 1996, p. 148), dedicated the third volume of one his books related to experiments on air to Stanhope. It is then not surprising that Stanhope would not only support, but also initiate, Bayes's nomination to the Royal Society.

Martin Folkes (1690 – 1754), the next on the list, is known in history as an antiquary. In his earlier years, as a student at Cambridge, Folkes excelled in mathematics and philosophy. His first publication was in astronomy. Folkes became a friend of Newton who nominated Folkes for the vice-presidency of the Society. He was also a friend of Robert Simson, Plumian Professor of Mathematics at Cambridge. When Simson was writing his book *A Complete System of Optics*,

Folkes provided Simson with several comments on his work so that Folkes's contributions were acknowledged in the preface of the published book. Stanhope was also aware of Folkes's mathematical abilities and corresponded with him on mathematical questions.

The connections of James Burrow (1701 – 1782) and Cromwell Mortimer (d. 1752) to mathematics or to nonconformity are both tenuous. Burrow was a lawyer with no apparent connection to either. Mortimer's connections are only slightly better than Burrow's. He was a physician, taking his doctorate in medicine in 1724 at the University of Leiden, one of the locations of study for sons of Nonconformist families.

John Eames (d. 1744), last on the list, shared some of Bayes's interests, both theological and scientific. Eames had trained for the ministry as a Nonconformist, but because of a speech defect gave it up to teach classics and science, which included mathematics, in one of the dissenting academies. This was the Fund Academy in Tenter Alley in London founded by the Congregational Fund Board in 1695. Eames was active in the Royal Society and was both friend and colleague to Isaac Newton. He also participated in experiments with John Ellicott, the watchmaker (Royal Society, Journal Books). In his youth Bayes may have met Eames when he was studying at Ward's school, which was also in Tenter Alley.

The most likely scenario for Bayes's election is that Stanhope, hearing of Bayes's interest in mathematics, met Bayes in the 1730s in Tunbridge Wells, which was near his family estate. Stanhope obtained a copy of [Bayes] (1736), either prior to their first meeting, which perhaps prompted it, or after their meeting. Whichever is the case, Stanhope contacted Folkes, who was also interested in mathematics. Initially they were responsible for bringing forward Bayes's nomination. They then pressed Burrow and Mortimer into service to assure the success of the nomination. At the meeting of April 8 when the nomination was made, Eames, knowing Bayes, joined in.

9. Scientific Work and Interests

Thomas Bayes was a strong Newtonian in his scientific outlook. The first indication is that as a subscriber he supported the publication of Pemberton's (1728) *A View of Sir Isaac Newton's Philosophy*. Henry Pemberton (1694 – 1771) was one of the great popularizers of Newton's work. He had been employed by Newton to oversee the production of the third edition of Newton's *Principia* (*Dictionary of National Biography*). Bayes may have first come across Newtonian philosophy as a student at Edinburgh. David Gregory, who had been Professor of Mathematics at Edinburgh until 1691, was the first to publicly lecture on Newtonian philosophy at Edinburgh. His brother James, who succeeded him as Professor of Mathematics and who taught Bayes mathematics, would likely have lectured on Newtonian philosophy as well, especially considering that his brother's lecture notes remained at Edinburgh (*Dictionary of National Biography*).

In 1734 George Berkeley published an attack on the logical foundations of Newton's doctrine of fluxions or differential calculus (Berkeley, 1734). It was described by Cajori (1919) as "the most spectacular event of the century in the history of British mathematics." Berkeley's argument was based on the derivative of x^n. The ratio of the increments of x^n to x is given by

$$\frac{(x+h)^n - x}{(x+h) - x} \doteq nx^{n-1} + h\frac{n(n-1)}{2}x^{n-2},$$

upon expanding the term $(x+h)^n$ and dropping higher powers of *h*. The limit as *h* goes to 0 yields the derivative nx^{n-1}. The jargon of the time was to let *h* vanish. Berkeley's concern was that if the increment vanished, then one did not really have an increment in the first place. The expansion of $(x+h)^n$ is based on having an increment so that there is a contradiction and hence the whole doctrine falls apart. Smith (1980) explained the problem simply as,

George Berkeley
(1685 – 1753)

> "The attack rested mainly on the assertion that Newton has assumed a quantity to be simultaneously zero and non-zero, and that no valid deductions could be based on such contradictory assumptions."

According to Smith, the real problem is that Newton had not expressed his ideas on fluxions rigorously enough. Several mathematicians rose to Newton's defense including Thomas Bayes. What Bayes did ([Bayes], 1736) was to provide the necessary rigour. Smith (1980), who has provided a detailed analysis of Bayes's treatise, sums up Bayes's work as:

> "Bayes began with a careful discussion of the meaning of fluxions and prime and ultimate ratios. He proceeded to develop the properties of prime and ultimate ratios in a way not unlike Cauchy's treatment of limits, using these results to prove some basic theorems concerning the calculation of fluxions."

On the other hand Jesseph (1993) was much more negative in his assessment of Bayes's work. While acknowledging that Bayes's work foreshadows later rigorous work on the calculus, Jesseph found Bayes's discussion of ultimate ratios obscure and that Bayes failed to address Berkeley's main criticisms.

Thomas Bayes's earliest known mathematical work after his anonymous publication ([Bayes], 1736) is a result related to infinite series and numerical analysis. The result according to Stanhope, already mentioned already in §7, is once again,

> "Theorem mentioned to me at Tunbridge Wells by M^{r} Bayes Aug. 12. 1747. $\dot{y} = \underset{\cdot}{y} - \frac{1}{2}\underset{\cdot\cdot}{y} + \frac{1}{3}\underset{\cdot\cdot\cdot}{y} - \frac{1}{4}\underset{::}{y} + \frac{1}{5}\underset{:\cdot}{y} - \frac{1}{6}\underset{:::}{y} + \&c$",

where the dot over the letter is the differential $y/\ t$ and the dots under the letter refer to the order of finite differencing. This result and a related one,

$$\underset{\cdot}{y} = \dot{y} + \frac{1}{2}\ddot{y} + \frac{1}{2.3}\dddot{y} + \frac{1}{2.3.4}\ddot{\dot{y}}\ \&\ c,$$

which together provide the relationship between derivatives and finite differences, are the very first results that appear in Bayes's undated notebook. Bayes did not provide a proof of these re-

sults but instead used them in the notebook to provide a derivation of "what is essentially the Euler-Maclaurin sum formula" (Dale, 1991). Bayes never published the theorems relating differences and derivatives. The first publication that I can find related to these results is due to Lagrange in 1772 and again in 1792 (Lagrange, 1869-70); see also Goldstine (1977, pp. 164 – 165) for a discussion. Lagrange's result is more general, giving the left hand side of either equation as a general order of derivative or difference. Bayes claimed to have obtained the general result, stating in his notebook that

> "y^{e} relation between $\ddot{x}$ & $\underset{\cdot\cdot}{x}$ & so on may be found".

A detailed discussion of the contents of Bayes's work as it appears in the Stanhope papers is given in Bellhouse (2001). Of consequence here is that it may be safely assumed that Bayes started this notebook in 1747.

As shown in Dale (1991) the infinite series relating derivatives and finite differences are connected to Bayes (1763b) in which he shows that a particular series is divergent. The series had been used to obtain an approximation to log(*z*!) or equivalently Stirling's approximation to factorials. The divergent series appears in two places in the Stanhope collection among a set of papers labeled, "Mathematical papers of Mr. Bayes's communicated Sept^{r}. 1st. 1747". One of the manuscripts opens with:

> "It has been asserted by several eminent Mathematicians that the sum of the Logarithms of the numbers 1. 2. 3. 4. 5 &c to z is equal to $\frac{1}{2}\log, c + \overline{z + \frac{1}{2}} \times \log, z$ lessened by the series $z - \frac{1}{12z} + \frac{1}{360z^3} - \frac{1}{1260z^5} + \frac{1}{1680z^7} - \frac{1}{1188z^9} + \&c$ if c denote the circumference of a circle whose radius is unity."

This is the second paragraph verbatim of the letter from Bayes to Canton on the divergent infinite series that was published posthumously (Bayes, 1763b). Another manuscript within the same group is a derivation by Bayes of an approximation to *z*!, given by $\sqrt{2p\,z}\,\mathrm{z}^{z}e^{-z}$, which is Maclaurin's (1742) form of the Stirling approximation to *z*!. Maclaurin had obtained his version of the approximation using the divergent series, while Bayes's approach to the approximation does not rely on the divergent series. On examining Bayes's notebook in which there are results related to the divergent series as well as notes, or partial transcriptions, (see Dale, 1991) from articles 827, 839, 842 and 847 of Maclaurin (1742), it is apparent that Bayes was motivated to look at this divergent series after seeing Maclaurin's incorrect derivation of the approximation to *z*!. It may also be noted that Bayes had obtained the posthumously published result of infinite series at least 15 years prior to its publication. He never published the correct derivation of $z! \sim \sqrt{2p\,z}\,\mathrm{z}^{z}e^{-z}$.

Bayes's early work appears to have been mainly related to infinite series. There has been much speculation as to when Bayes first became interested in probability theory, or in how he learned probability. For example Barnard (1958) suggested that Bayes could have learned mathematics, and implicitly probability, from de Moivre. Stigler (1986) has more reasonably suggested that Bayes became interested in probability after reviewing a publication of Thomas Simpson. Essentially, what Simpson (1755) had proved was a special case of the law of large

numbers: the mean of a set of observations is a better estimate of a location parameter than a single observation. In a letter to John Canton, Bayes pointed out what in modern parlance is that this may not be true in the presence of measurement bias. In Bayes's words:

> "Now that the errors arising from the imperfection of the instruments & the organs of sense shou'd be reduced to nothing or next to nothing only by multiplying the number of observations seems to me extremely incredible. On the contrary the more observations you make with an imperfect instrument the more certain it seems to be that the error in your conclusion will be proportional to the imperfection of the instrument made use of. For were it otherwise there would be little or no advantage in making your observations with a very accurate instrument rather than with a more ordinary one, in those cases where the observation cou'd be very often repeated: & yet this I think is what no one will pretend to say."

Thomas Simpson
(1710 – 1761)

Stigler (1986, pp. 92 – 95) has given a full description of Simpson's result as well as the effect that Bayes's comments had on a later publication by Simpson.

Stigler's view of the origin of Bayes's interest in probability is supported by two letters involving Stanhope. The first is a letter from Stanhope to Martin Folkes, which is preserved in the Royal Society Library. Though undated, the letter is in a collection containing correspondence mainly from the late 1730s to the early 1740s. In this letter Stanhope wrote to Folkes posing a problem in probability:

> "It is disputed at White's, whether it be an equal wager to lay that the Dealer at whist will have four Trumps. Some think it disadvantageous to lay on the Dealer's side, because he has but 12 cards left wherein to find Trumps, when all the others have 13 apiece for them. Others say, but I don't understand how they can prove it that the advantage to lay on the Dealers side amounts to 25 per cent. If you are at leisure, I should be glad to know your opinion, but if otherwise employ'd perhaps Mr. Daval at your request might take the trouble to consider it."

White's Coffee House, or later White's Club had gained a reputation for betting and gambling as early as 1739 (Lillywhite, 1963, p. 642). What is significant here is that Stanhope asked Folkes for help, not Bayes, whom he probably knew at the time the letter was written. Further, failing Folkes, Stanhope wanted Peter Daval and not Bayes to help out. Daval was a barrister as well as a Fellow of the Royal Society and an able mathematician (Chalmers, 1812-17). A second letter is from Patrick Murdoch to Stanhope and is dated March 18, 1755. Murdoch was a clergyman in the Church of England; he had studied mathematics under Maclaurin in Edinburgh (*Dictionary of National Biography*). The letter, which is part of the Stanhope papers, points to wider group of mathematicians who were unaware of any interests in probability that Bayes might have had. After acknowledging comments made by Bayes on a paper that Murdoch had written, Murdoch made some proposals regarding the publication of de Moivre's (1756) *Doctrine of Chances*:

"The edition which Mr de Moivre desired me to make of his Chances is now almost printed; and a few things, taken from other parts of his works, are to be subjoined in an Appendix. To which Mr Stevens and some other Gentlemen, propose to add some things relating to the same subject, but without naming any author: and he thought, if your Lordship was pleased to communicate any thing of yours, it would be a favour done the publick. Mr Scott likewise tells me, there are in your Lordship's hands two Copy Books containing some propositions in Chances, which de Moivre allowed him to copy. If your Lordship would be pleased to transmit these (to Millar's) with your judgement of them, it might be a great advantage to the Edition."

Abraham de Moivre
(1667 – 1754)

There is a request to Stanhope to submit his work in probability, but no mention of Bayes who figures centrally at the beginning of the letter. An interesting sidelight is that, on examining de Moivre (1756), there seems to be no addition to the publication beyond what appears to be de Moivre's own work.

Bayes had several areas of scientific interest beyond infinite series and probability. Dale (n.d.) in a discussion and partial transcription of Bayes's notebook points to four broad areas: mathematics, natural philosophy, celestial mechanics and a miscellaneous category. Within mathematics, the notebook contains additional material related to trigonometry, geometry, solutions of equations and differentials. The material on natural philosophy relates to electricity, weights of bodies, optics and harmony in music. Related to material in the notebook on electricity is a letter to John Canton preserved in the Royal Society Library written partially in longhand and partially in shorthand. The letter contains notes on a work on electricity by Hoadly and Wilson (1756). In the part written in longhand are critical comments on the work. Home (1974-75) has provided a discussion of Bayes's electrical work. In the miscellaneous category in Bayes's notebook are extracts from works of others on a variety of topics ranging from the measurement of the pyramids to Pascal's *Lettres provinciales*.

Bayes's general scientific interests fit in with an unsubstantiated story reported in Phippen (1840).

"During the life of Mr. Bayes, an occurrence took place which is worthy of record. Three natives of the East Indies, persons of rank and distinction, came to England for the purpose of obtaining instruction in English literature. Amongst other places, they visited Tunbridge Wells, and were introduced to Mr. Bayes, who felt great pleasure in furnishing them with much useful and valuable information. In the course of his instructions, he endeavoured to explain to them the severity of our winters, the falls of snow, and the intensity of the frosts, which they did not appear to comprehend. To illustrate in part what he had stated, Mr. Bayes procured a piece of ice from an ice-house, and shewed them into what a solid mass water could be condensed by the frost – adding that such was the intense cold of some winters, that carriages might pass over ponds and even rivers of water thus frozen, without danger. To substantiate his assertion, he melted a piece of ice by the fire, proving that is was only water congealed. 'No,' said the eldest of them, 'It is the work of Art! – we cannot believe it to be anything else, but we will write it down, and name it when we get home.'"

While the story is also in line with the variety of nationalities that came to Tunbridge Wells, as described by Elizabeth Montagu in §7, it may very well be apocryphal. Dale (1991, p. 13) has noted that similar stories of people from warm climates encountering ice are to be found in the works of John Locke and David Hume. Locke's *An Essay Concerning Human Understanding*, which went through five editions between 1690 and 1706 (Locke, 1975), contains a story of an interaction between a Dutch ambassador and the King of Siam in which the ambassador describes the ability to walk on ice during cold weather (Bk IV, Ch. 15, §5). Later in 1750 Hume turned the King of Siam into an Indian prince and focused on the effect that encountering ice for the first time might have on the prince. The story given by Hume and a discussion of various versions of the story by others is found in Hume (2000, pp. 86 and 172).

Within five years of his election to the Royal Society in 1742, Bayes was known, at least to Stanhope, for his work in infinite series. His reputation grew beyond Stanhope. Bayes's letter to John Canton on the paper by Thomas Simpson, probably written in 1755, shows that Bayes was initially looking at the correctness of Simpson's mathematics, for he says,

> "Hence therefore as I see no mistakes in Mr. Simpsons calculations I will venture to say that there is one in the hypothesis upon which he proceeds."

It appears that Bayes played the role of critic or commentator for a network of mathematicians that initially centered on Stanhope and/or John Canton. Just as Bayes was providing comments to Canton on Simpson's work he was also commenting to Stanhope on a paper by Patrick Murdoch. Initially, it appears that Stanhope had sent Bayes a copy of Murdoch's paper to look at. Then, after Stanhope had received Bayes's comments, he forwarded them to Murdoch. Here are excerpts in an exchange of correspondence involving Stanhope, Murdoch and Bayes. The first is from Murdoch to Stanhope dated March 18, 1755.

> "I am ashamed not to have sooner acknowledged your Lordship's goodness in communicating to me Mr Bayes' paper, which I received from Dr Pringle. But during my short stay in town I as much hurried; and since my return to the Country have had as little time to think of those subjects. I have now returned it inclosed, with my answer on the blank page: which I wish our Lordship and Mr Bayes may find satisfactory."

After the opening sentence Bayes wrote on April 25,

> "I am much obliged to your Lordship for the communication of them [Murdoch's answers] as well as the kind promise to transmit to him any thing farther I might have to say on the subject. It wou'd be a greater pleasure to go on, where there hopes of soon coming to an agreement, or of seeing difficulty removed without giving too much trouble to Mr. M. But for fear this shou'd not be, I don't at present think of entering upon any new point & that which is now upon the carpet will I hope be brought pretty near to a conclusion by the adjoining paper.

Murdoch replied on May 11,

> "I received the honour of your Lordship's letter of April 27th, with Mr Bayes's paper: to which I do not think any answer necessary, seeing we seem to be agreed on that point. That ever Mr B. misunderstood me was certainly my own fault, in not explaining more particularly the sense in which I took Sr Isaac's Corollary… His 44 Proposition, your Lordship knows is general and holds good in finite cases: but to apply it to the uses he had in view, needed the masterly artifice he uses in the 45th, and its Corollaries: which consists in reducing every disturbing force that is expressible by the distance, to the denomination 1/43; and this could not be done but in the case of near coincidence with a Circle, when the higher Terms of the series vanish. So that the Canon which he deduces in this manner is really the result of a fluxionary Equation; and consequently has a form that does not suit finite cases. When Mr B. considers it in this light he can have no further difficulty: and instead of taking any thing amiss on this occasion, I reckon myself very much indebted to him: as the kindest thing one man can do by another is correcting his mistakes. I shall take particular care that the copy books be returned to your Lordship."

Bayes's notebook gives some additional evidence for the existence of this network. The notebook shows that Bayes was probably corresponding with Robert Smith of the University of Glasgow some time after 1749. Smith's connection to Stanhope has already been noted in §8.

Despite the fact that his only publication in mathematics during his lifetime was anonymous and relatively early in his career, Bayes was well regarded by the mathematical community of his day. One indication is the wording of Bayes's certificate for election to the Royal Society in which he is described as "well skilled in Geometry and all parts of Mathematical and Philosophical Learning." This is echoed by some of Bayes's friends. Price (1948) described Bayes as "one of the most ingenious men I ever knew" and Whiston (1749) noted that Bayes was "a very good mathematician."

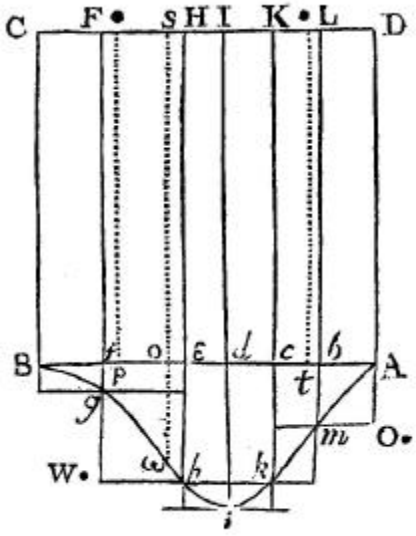


Figure 1: Bayes's Model Table

Richard Price
(1723 – 1791)

Bayes's fame rests on the result in probability that was published posthumously (Bayes, 1763a). The problem that Bayes considered was stated simply in his paper, which was communicated to the Royal Society by Richard Price. It reads,

> "Given the number of times in which an unknown event has happened and failed: Required the chance that the probability of its happening in a single trial lies somewhere between any two degrees of probability that can be named."

Bayes solved this problem by considering the model table shown in Figure 1. A ball labeled *W* is thrown across the table in such a way that it is equally likely to come to rest anywhere on the table. Through that point draw the line *os*. Then throw the ball labeled *O n* times and count the number of times it falls on either side of the line. These are the successes and failures. Under this physical model one can now find the chance that the probability of success q is between two given numbers f and b. On using Stigler's (1986) notation this is given by

$$P(f < q < b \mid X = x) = \frac{\int_f^b \binom{n}{x} q^x (1-q)^{n-x}\, dx}{\int_0^1 \binom{n}{x} q^x (1-q)^{n-x}\, dx}.$$

Many have written about the results in Bayes (1763a). Excellent treatments are in Stigler (1986) and Dale (1991) so that no attempt will be made here to repeat their efforts. Instead, I will focus on the model table. Stigler (1986) has rightly pointed out that Bayes never specified what type of table he had in mind, although many, including Fisher and Pearson, "have promoted it to a billiard table". At first glance a billiard table makes sense because of the side cushions; balls rolled across the table would come to rest somewhere on the table rather than falling off. The major problem with a billiard table as the model is that it has pockets, which do not appear in Figure 1. However, billiard tables from the early 17th Century, which did have side cushions, did not have pockets. One such billiard table is at the stately home Knole in Sevenoaks near Tunbridge Wells. Knole appears in various Tunbridge Wells guides as a recommended place to visit. It is possible that Bayes visited Knole; it would be almost certain that Stanhope would have visited there. The major problem with the conjecture that Bayes's model table was the billiard table at Knole is that the table has been upgraded to have pockets at some time, which is presently unknown. Sackville West (1906, p. 41), who was resident at Knole, has briefly described the Billiard Room and its contents:

An early billiard table
without pockets

> "This room, which is really part of the Leicester Gallery, contains a billiard table, the lower structures of which are evidently of the time of Charles I, while the top or bed, with cushions and pockets are of a later date."

10. Decline and Death

I have speculated that Bayes's decision over the years 1749 to 1752 to leave the pulpit at Mount Sion Chapel in Tunbridge Wells may have stemmed from his Arian theology. It may also have been due to ill health. An entry near the end of Bayes's notebook is for a prescription. The entry occurs several pages after a transcription of an article from *London Magazine* written in 1750 so that the prescription was probably obtained after that date. The prescription has been transcribed by Dale (n.d.) and was interpreted as follows:

> "… take two drachms of the powder seed of cumin and chamomile (both carminative); ½ drachm of a solution of calcium carbonate; 1 scruple of camphor, in a solution of 2 drachms of spirits of turpentine (turpentine oil is a rubefacient used in liniments for rheumatic pain and stiffness); mix together, to one fluid ounce, an unguent of 3 fluid ounces of sambucus (the elder flower – has an astringent action on the skin) with 1 fluid ounce of saponis nigra (liquid drawn from lye soap – an emulsifying agent). Mix and use as a liniment. This is probably a prescription for stiffness of the joints or rheumatism."

The prescription could have been used for other purposes; liniments were used in the 18th century for a variety of ailments. The ailment could also have been arthritis or gout. However, Dale's interpretation does have support in the 18th century medical literature. On checking many of the ingredients of the prescription in James (1743-5) there are several uses for each ingredient. What seems common to the ingredients taken together is pain relief, relief of inflammation and alleviation of rheumatism or gout. Used externally cumin was recommended for pains in the chest or side. Likewise chamomile. When used in a plaster or liniment, chamomile was also recommended to relieve inflammation, as was camphor. In a liniment or unguent, sambucus was used to treat rheumatism or pain from gout. One only hopes that Bayes did not receive the full treatment for rheumatism. The treatment, described by James (1746, p. 188), involves blood letting, blistering of the skin and laxatives in addition to the more reasonable regimen of tepid baths, rest in a warm bed and the application of liniments.

In 1755 Bayes was definitely ill, perhaps seriously. After Stanhope had asked him to look over a paper by Murdoch, Bayes wrote back on April 25,

> "Mr. Murdockes observations coming to hand when I was not well has been one reason, that they have been so long detained here."

Bayes's illness may have been periodic. He signed his will December 12, 1760 and died less than four months later on April 7, 1761. He was probably in ill health at the time he signed his will. From newspaper reports about his death that appear in *The Public Advertiser* and *Whitehall Evening Post*, the only information about his death is that he died suddenly. Although, as in the rheumatism, there may be several explanations, a likely cause of death was heart attack. The heart attack would be consistent with rheumatism, especially acute rheumatism (Copeman, 1964, p. 126). Rheumatism may also have been the reason he stayed in Tunbridge Wells after his retirement from the ministry rather than move to London where his siblings were situated. Although many came to Tunbridge Wells for social reasons, some came there at least partially for their health, including Elizabeth Montagu and Philip Dormer Stanhope, Earl Chesterfield.

After his death in Tunbridge Wells, Bayes's body was taken to Founder's Hall in London, which Nonconformists had used as a meetinghouse for Scots Presbyterians since 1700 Wilson (vol. 2, p, 293). Bayes had requested in his will that his funeral expenses be as frugal as possible. In a typical Nonconformist funeral (David, 1961, pp. 47 and 136) there would be a funeral

procession from the place where the body had been kept, normally the deceased's home, to the cemetery. The Bunhill Fields registers show, for example, that John Bayes was brought from his brother Samuel's home in Cheapside in 1743, that Joshua Bayes was brought from the same place in 1746 and that Nathaniel Bayes was brought from his home in Snow Hill in 1764. Though Nonconformists objected to it for Sunday services, the *Book of Common Prayer* might be used for the burial service at the grave; there was no burial service in the chapel. Boys might sing at the graveyard or perhaps during the funeral procession. How the chapel came to play a part in the funeral was that a funeral sermon might be preached on the Sunday following the burial. The pulpit and clerk's desk would be hung with black cloth and the galleries would be hung with black baize. The preacher would not wear his hat during the funeral sermon; but the hat would be adorned with a silken token of mourning. Bayes's desire for frugality meant that there was no funeral sermon. Presumably, the preacher was given a fee for the funeral sermon and there was also the cost of publication of the sermon. That the funeral was, however, not as frugal as possible comes from Nathaniel Bayes's 1764 will in which he wrote,

The Bayes family vault, Bunhill Fields

> "I desire to be interred in the same decent manner as my Brothers were but not to have any Boys to sing at my funeral."

Bayes was buried in the family vault along with his parents and siblings in Bunhill Fields Cemetery in London. The only recorded expense for his funeral was 14 shillings to open the vault. This was the same expense incurred at the funerals of his father and brothers.

11. Postscript

There are comments that can be made on two outstanding questions regarding Thomas Bayes: What was he like as a person? And what did he look like?

On the first question, Holland (1962) concluded, based on his own research, that Bayes was a

> "quiet man, of earnest thought and abiding faith and of immense intellectual stature…"

My own assessment differs somewhat from Holland. Based on the fact that he denied the pulpit to other Nonconformists, especially on Easter Day, says something of his strength of resolve rather than his quietness. His work as a referee or critic of other mathematical research, which was not done anonymously, at least in the case of Patrick Murdoch, shows a certain confidence in his own abilities and work. As a critic of others, he was very insightful. His intellectual stature may not have been immense, but he was recognized as an excellent mathematician. Finally, his faith may not have been wholly abiding if he drifted from orthodox Presbyterianism to Arianism. If indeed he took on Arian beliefs it shows a willingness to question his faith seriously despite the fact that his father, and probably his siblings, remained orthodox.

The only know portrait that is possibly of Bayes appears in O'Donnell (1936, p. 335). Unfortunately, it is probably not of Bayes; there are too many possible anachronisms in the picture that would lead one to decide against it as a true portrait. Let me repeat, with some additions, what I once wrote in *The IMS Bulletin* in response to a contest to identify the person in the picture. Note in the picture the apparent absence of a wig; or if a wig is present it is the wrong style for the period. The formal portraits of Joshua Bayes, Philip Doddridge and Richard Price all have their subjects in wigs. Bayes most likely would have worn a wig in the style of his contemporary, Philip Doddridge. In the portraits of Whiston and Simpson, the subjects are not wearing wigs. However, Simpson was not a clergyman and Whiston is also not wearing his ecclesiastical garments (instead it appears to be a frock coat), which might be expected in a formal portrait. The gown, or possibly a frock coat, worn in the picture of Bayes appears to have a high collar, which is anachronistic. Doddridge, in his portrait, appears to be wearing a gown; however, the style is different from that worn by Bayes. If Bayes's accoutrement is a frock coat, then it should be tightly fitting as in the portraits of Price and Whiston. Finally, Bayes appears to be wearing a clerical collar with bands. Note that the bands seem to come out at the bottom of the collar; while in the portraits of Berkeley, Doddridge, Price, Whiston and Bayes's father Joshua the bands come over the top of the collar. For a general discussion of the costume of the 18th Century, see Cunnington and Cunnington (1964). Beyond the problems of possible anachronistic style, there is the question of the origin of this portrait. O'Donnell (1936) provides no clue. It is known that the portrait of Joshua Bayes was donated to Dr. Williams Library in 1799 by Joshua's grandson, Bayes Cotton (Jeremy, 1885, p. 124). As noted in §3 the major beneficiary of the various estates of the Bayes family turned out, in the end, to be Bayes Cotton. Since he possessed the portrait of his grandfather Joshua, he would be the likely possessor of any portrait of his uncle Thomas. In view of the fact that in 1799 no donation was made of Thomas Bayes's portrait, it is likely that no portrait existed within the family.

Thomas Bayes?

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