Vincenzo Viviani

Quick Info

Born
5 April 1622
Florence (now Italy)

Died
22 September 1703
Florence (now Italy)

Summary
Vincenzo Viviani was an Italian engineer who worked on the geometry of the cycloid.


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Biography

Vincenzo Viviani's father was Jacopo di Michelangelo Viviani and his mother was Maria Alamanno del Nente; both were members of a noble families. Vincenzo studied at a Jesuit school where he learnt the humanities. He was taught mathematics by Clemente Settimi, a Scolopian friar and a friend of Galileo. Settimi quickly saw Viviani's exceptional intelligence and, in 1638, presented him at court to Ferdinando II de' Medici, Grand Duke of Tuscany. The court was in Livorno, so Viviani had to make the long journey from Florence. While on the road he did not waste his time but spent the many hours studying the first three books of Euclid's *Elements*. He made a presentation to the Tuscan Court explaining the first sixteen propositions in the first book of the *Elements*. Famiano Michelini, Ferdinando's Court mathematician, then set him a problem to which he responded confidently. Ferdinando was greatly impressed and provided a monthly salary for Viviani that enabled him to purchase mathematical books. He also arranged for Viviani to meet Galileo, who was living in his villa in Arcetri, near Florence, where he had been put under house arrest by the Catholic Church. Despite the house arrest, Galileo was still Ferdinando's Tuscan Court Mathematician.

Galileo, who by this time was totally blind, was very impressed by Viviani's knowledge and abilities. In 1639, he took Viviani into his home as a companion, student and collaborator, and Viviani continued in this role until Galileo died in January 1642. Viviani learnt much from Galileo over this period, working with him on physics and geometry. However, as Viviani relates himself, their relationship went well beyond that of scientist and assistant, becoming much more like that of a father and son. He wrote (see for example [4]):-

> *Soon after the unexpected publication of 'Discourses and mathematical demonstrations concerning the two new sciences', Signor Galileo allowed me into his villa in Arcetri where he was staying. I was able to benefit from our intelligent conversations and his precious teachings and he was content that in the study of mathematics, which I had only recently begun, I could turn to his own voice for the solution of those doubts and difficulties that I often found through the natural weakness of my intellect.*

In October 1641, Galileo and Viviani were joined in the villa at Arcetri by Evangelista Torricelli when he moved from Rome. After Galileo's death, Torricelli was appointed to fill Galileo's post as Ferdinando II de' Medici's Tuscan Court Mathematician and Viviani continued his collaboration with him. Torricelli is most famed as the first person to create a sustained vacuum and to discover the principle of a barometer. In 1643 Torricelli proposed an experiment which would demonstrate that atmospheric pressure determines the height to which a fluid will rise in a tube filled with a liquid, then inverted over the same liquid. In 1644 Viviani, as Torricelli's collaborator, carried out the experiment which proved a major scientific advance and led to the development of the barometer. When Torricelli died in 1647, Viviani was appointed to fill the lectureship at the Accademia del Disegno in Florence, holding this post for two years. The Grand Duke also appointed Viviani as mathematics teacher to the Medici family at Court, and as engineer with the Uffiziali dei Fiumi, a position he held for the rest of his life [4]:-

> *While his responsibilities as a Court Mathematician often varied according to the desires of the Grand Duke, the travels of the Tuscan Court, and the arrival on the scene of other thinkers, all his life he was kept busy by his duties to the Medici Court. Particularly exhausting for him was his role of engineer, which required substantial travel on horseback and led to illness on more than one occasion.*

The main thrust of Viviani's life, however, was to keep Galileo's memory alive and he wanted to do so by publishing his collected works. Michael Segre writes [15]:-

> *Viviani had in mind a grand edition of Galileo's works, in which the Latin works would be translated into Italian and vice versa, and throughout his life he collected an enormous quantity of material related to Galileo .... But he never brought this ambitious project to completion, mainly because he was too much of a perfectionist, never entirely satisfied with the material he had amassed and reluctant to stop collecting and begin publishing. For much the same reason, most of Viviani's own scientific work remained unpublished, and an edition of Galileo's works, as Viviani would have liked to see it, only appeared two centuries after his death, under Favaro's supervision. Favaro, however, could hardly have published his National Edition without the materials collected by Viviani.*

In [1] Natucci suggests that it was the Church that prevented the publication of Galileo's works and caused a serious blow to science in Italy. Segre, however, counters that view when he writes [15]:-

> *... the role of the church in Italy's scientific decline during this period, though no doubt major, has sometimes been exaggerated. In Viviani's case I found little evidence of interference. As early as 1656 he had at his disposal enough material to publish an outstanding edition of Galileo's works, even within the limitations set by the Inquisition; his papers testify that primarily his own hesitations prevented him from completing the work.*

Throughout his life, one of Viviani's main interests was in ancient Greek mathematics. As early as 1646, while collaborating with Torricelli, he was also working on a project to restore the work of Aristaeus the Elder. Pappus gave Aristaeus great credit for a work entitled *Five Books concerning Solid Loci* which had been lost. (Solid Loci is the Greek term for conic sections.) Pappus, however, indicated propositions from the work and Viviani reconstructed the original from these references by Pappus. It was a project that Viviani worked on for most of his life. In 1673 he published a first edition of his restoration but he continued to work on it and his final effort *De locis solidis secunda divinatio geometrica in quinque libros iniuria temporum amissos tristaei senioris geometrae* Ⓣ was only published in 1701, two years before his death.

Another restoration of a Greek text by Viviani is interesting for a number of reasons. This was his restoration of the fifth book of Apollonius's *Conics*. At the time he began the restoration only the first four books of this eight-book work had been found and Viviani set about reconstructing the fifth. By 1656 Viviani's work was quite close to completion when Giovanni Alfonso Borelli (a fellow Tuscan Court mathematician) discovered an Arabic version of the first seven books of Apollonius's *Conics* in the Laurentian Library in Florence. Borelli took the manuscript to Rome where it was translated into Latin by Abrahamus Ecchellensis. In 1659 both the translation from the Arabic and Viviani's restoration were published. Viviani's work was entitled *De maximis et minimis geometrica Divinatio* Ⓣ and was certainly written by him without any knowledge of the translation of Apollonius's work. It is interesting, of course, to see how faithfully Viviani was able to reconstruct Apollonius's book since now both the reconstruction and the original had become available. Viviani had done an excellent job, his biggest 'error' being that he had been able to penetrate deeper than Apollonius himself. The realisation that Viviani was, in some sense, a better geometer than the revered Apollonius, gave him instant fame throughout the centres of learning in Europe. His reputation as a mathematician was high throughout Europe. Louis XIV of France offered him a position at the Académie Royale in 1666, John II Casimir of Poland offered Viviani a post as his astronomer, also in 1666. The Grand Duke, not wishing to lose Viviani, appointed him as his mathematician. Viviani accepted this post and turned down the offers from Louis XIV and John II Casimir.

In 1657 Viviani became one of the first members of the Grand Duke's new academy, the Accademia del Cimento, which was formally founded in June of that year. However, the Academy had informally existed for some time before that with Viviani organising a group of natural philosophers to carry out a variety of scientific experiments. One such experiment, carried out before the formal founding of the Accademia del Cimento, related to the speed and propagation of sound. On 10 October 1656, together with Giovanni Borelli, Viviani used a pendulum as a timing device to show that sound travels twice a fixed distance in twice the time taken to travel the original distance. In other words, its velocity is uniform. Two days later, at the palace in Florence, he measured the velocity of sound by timing, again using a pendulum, the difference between the flash and the sound of a cannon fired at the villa of Petraia. They obtained the value of 350 metres per second, which is considerably better than the previous value of 478 metres per second obtained by Gassendi (the currently accepted value is 331.29 metres per second at 0°C. After the Academy was formally founded, Viviani was involved in most of the experimental work they carried out, such as experiments with Torricelli's barometer and experiments relating to properties of freezing water.

Another important work by Viviani is *Quinto libro degli Elementi d'Euclide: ovvero Scienza universale delle proporzioni spiegata colla dottrina del Galileo, con nuov'ordine distesa* Ⓣ. This was another restoration, this time of Euclid's fifth book, building on work already carried out with Torricelli and Galileo in 1641. In the Preface he acknowledges his great debt to Galileo, calling himself 'Galileo's last disciple' (see [4]):-

> *The fact is that through my good fortune, I am his last disciple, because he was my teacher continually during the last three years of his life, and from all of us who were present while he took his last breath (who apart from two priests, included Torricelli, his son Vincenzio Galilei, and others from his home), I alone have survived them all.*

The first edition was published in a short form in 1674, then in an enlarged second edition was printed in 15 April 1676. Natucci writes [1]:-

> *With the rigour and prolixity of the ancients, Viviani devoted an appendix to geometric problems, among which was one on the trisection of an angle, solved by the use of the cylindrical spiral or of a cycloid; another was the problem of duplicating the cube, solved by means of conics or of the cubic* $xy^2 = k$.

He also published *Diporto Geometrico* Ⓣ (1676) and *Enodatio problematum universis geometris propositorum* Ⓣ (1677). The first of these contained solutions to twelve geometrical problems which had been published as challenges by Cristoforo Sadler. It appears that Viviani found these easy and did not consider it worthwhile to publish his solutions but Prince Leopoldo, brother of the Grand Duke, had strongly encouraged him to do so. As he was an engineer all his life Viviani also published on engineering. In particular he published *Discorso intorno al difendersi da' riempimenti e dalle corrosione de' fiumi* Ⓣ (1687).

We have not yet commented on the thing for which Viviani is best known, namely his *Racconto istorico della vita di Galileo Galilei* Ⓣ. Soon after 1650, Carlo Manolessi began preparing an edition of Galileo's writings. It could never have contained all the writings since publication of *Dialogue on the Great World Systems* was banned by the Catholic Church, but the project tp publish the rest had widespread support. Prince Leopoldo asked Viviani to write a sketch of Galileo's life for inclusion in Manolessi's edition of his works. However, things did not go as planned for although Viviani wrote his *Life of Galileo* it did not appear in the edition of Galileo's *Collected Works* published by Manolessi in Bologna 1655-56. It would appear that Viviani, and the Medici family, felt that Manolessi's edition was not grand enough to honour Galileo. Viviani wanted to publish his own edition of Galileo's *Collected Works* so he kept the *Life of Galileo* which he had written intending to include it in a publication of Galileo's *Collected Works* which he hoped to edit. In 1659 Viviani wrote a second essay on Galileo's work *Lettera di Vincenzio Viviani al Principe Leopoldo de' Medici intorno all'applicazione del pendolo all'orologio*. Neither essay was published in Viviani's lifetime, but his *Racconto istorico* was published in 1717. It became the main source of material for Galileo's later biographers. However, in the 20th century historians began to argue that certain details in the essay had been invented by Viviani, particularly those relating to the experiments carried out by Galileo. Viviani was certainly very careful and put in a great amount of effort collecting information about Galileo's life. If he did invent certain incidents, such as Galileo dropping weights from the leaning tower of Pisa, then they were done to illustrate Galileo's approach to science. See [15] for an interesting detailed discussion.

Despite his great expertise in geometry, Viviani seems to have done little original in this area, He did determine the tangent to the cycloid but he was not the first to succeed in this. He believed passionately in the value of geometry, however, writing:-

> *Speculative geometry is the unique teacher of the honest acquisition of what is useful, delightful, beautiful and good. Geometry is the only true science because it produces knowledge from itself without mediation of causes. Geometry alone teaches how to achieve knowledge and even reminds the human intellect - which is a spark of the divine one - that as a knower through the principles most known with the light of nature it can, if it so wishes, without deceiving itself or others, know the existence and properties of all things concerning the created universe and the order disposed by God, in number, weight, and measure.*

However, he lived at a time when the calculus was beginning to be used to prove geometric results. Leibniz was interested in the papers left by Galileo and met Viviani in Florence in late November 1689. The two got on well during this meeting but after Leibniz published *Solutio problematis a Galilaeo propositi de linea catenaria* Ⓣ in 1692, Viviani became unhappy about the use of the differential and integral calculus which he believed to be nothing but a kind of game that could only solve its own problems. For this reason, in 1692, he challenged European mathematicians to solve a problem of the quadrature of a part of the surface of a sphere. In *Aenigma geometricum de miro opificio testudinis quadrabilis hemisphaericae* Ⓣ he asked how four equal windows could be cut from a hemisphere so that the remaining surface can be exactly squared. His solution involved using the intersection of four right cylinders, the bases of which are tangent to the base of the hemisphere. See [12] for a discussion of this problem.

We note also that Viviani published an Italian version of Euclid's *Elements* in 1690. This was reprinted in 1867 by Enrico Betti and Francesco Brioschi who, at that time, were trying to improve the teaching of geometry in Italy. On his death Viviani left an almost completed work on the resistance of solids which was completed and published by Guido Grandi.

Bernard de Fontenelle [7] says that Viviani had an innocence and simplicity of manners which persons commonly preserve who have less commerce with men than with books. He was affable, modest, grateful in the highest degree, and a fast and faithful friend.

Viviani built a handsome house in Florence, and placed the bust of Galileo over the door, with inscriptions on each side of it, to honour his name. This house was commonly called 'Galileo's house' although this is incorrect. The inscriptions are given in the article [16].

Other Mathematicians born in Italy
A Poster of Vincenzo Viviani

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