Maria Gaetana Agnesi

Italian mathematician, linguist and philosopher **Maria Gaetana Agnesi (**May 16, 1718 – January 9, 1799) is regarded as the first female mathematician of the Western world. She was born and died in Milan one of 21 children of the three wives of Pietro Agnesi, a wealthy silk merchant. Maria Gaetana's father employed excellent tutors for his child prodigy daughter. At the age of five, she was fluent in French and at nine she delivered a long speech, which she had translated into Latin, "Oratio qua ostenditur artium liberalium studia femineo sexu necitiquam abhorre," advocating higher education for women. By the time she was 11; she spoke seven languages and earned the designations, "Walking Polyglot" and the "Seven Tongued Orator." By 14, she was solving problems in ballistics and geometry.

At age 20, Agnesi published *Propositiones Philosophicae*, a series of essays on philosophy and natural science, but regrettably, none of her thoughts on mathematics. Her father established a "cultural salon" in their home where his daughter displayed her intellectual talents by defending one or more of her 191 theses in debates with national and international visitors. Her subjects included logic, philosophy, mechanics, chemistry, botany, zoology and mineralogy. Between "performances" Agnesi's sister Maria Teresa, who became a noted composer, singer and harpsichordist, entertained the assemblage with her music. It might seem that Pietro was a barker in a sideshow, exhibiting his small, rather shy young daughter as something of an intellectual freak before audiences eager for entertainment at her expense. But such exhibitions of childish talents were common in the homes of the wealthy of the time. A notable example was Leopold Mozart parading his young son Amadeus' musical talents before the well-to-do in the salons of Salzburg.

Throughout this period Maria Gaetana Agnesi suffered a recurring illness in which convulsions and headaches were the prime symptoms. Her father was horrified when she asked his permission to become a nun. She agreed to continue living with him under the condition that in the future she could live a quiet life free from intellectual performances. Thereafter she devoted herself to the study of religious books and mathematics. She wrote a commentary on Guillaume de l'Hôpital's *Traité analytique des sections coniques*. This was highly praised by those who read it, but it was never published. The monk, Ramiro Rampinelli, a frequent visitor to her home, assisted her in her study of calculus. He had been a mathematics professor at both Rome and Bologna. He encouraged Agnesi to write a book on differential calculus. Her treatise *Instituzioni analitiche ad uso della gioventi italiana* (Analytic Institutions for the Use of Young Italians), which was to be used as a teaching text and a guide for students, is a major work in the development of calculus. It consisted of two large quarto volumes of over a thousand pages. The first volume, which dealt with analysis of finite quantities was published in 1748 and the second, dealing with the analysis of infinitesimals, was published the following year. It was written in Italian, at a time when most mathematical treatises were written in Latin, the scholarly language of the day.

Agnesi's work contained no original ideas, but it provided many examples, carefully selected to illustrate the concepts and techniques of calculus. The work brought her immediate fame and was praised by the Académie des Sciences in Paris. The president of the Academy of Bologna invited her to accept the chair of mathematics there. Shortly thereafter she received a letter from Benedict XIV formally offering her the position. Apparently she neither accepted nor rejected the Pope's offer, having no desire to depart her holy, retired life. Although her name appeared on the faculty roles of the University for forty-five years, she never went to Bologna. It may be that the appointment was more like an honorary degree, not an actual appointment to a chair, as it is difficult to believe that this very

religious woman would ignore the Pope.

If her contribution doesn't seem on a par with those of her male mathematical contemporaries, it would be a mistake to underestimate the importance of her work. The calculus had not been around for very long. Leibniz died in 1716 and Newton in 1727. Calculus wasn't accessible to many, partly because it desperately needed clarifying and because it was written in the language of scholars. Agnesi deserves credit for writing her calculus in the vernacular to make it accessible to as many "young Italians" as possible. She clarified this new and enormously important mathematical field. It was the most complete work on differential and integral calculus up to that point and one of the first calculus texts published after that of L'Hôpital in 1696.

Agnesi devoted only about 20 years of her life to mathematics. In 1771 she declined a request from the University of Turin to referee one of Lagrange's first papers on the calculus of variations. Her *Instituzioni* is the first mathematical work written by a European woman that has survived. After her father's death, she devoted herself entirely to charitable work, spending all of her inheritance to establish the *Pio Instituto Trivulzio,* a hospice for old infirm women. By divesting herself of her worldly goods, she died in poverty in the very poorhouse where she had been the director and was regarded "an angel of consolation to the sick and dying women."

Today Agnesi is mainly remembered in the English-speaking world for a misnamed curve, the so-called "witch of Agnesi." Although Agnesi investigated its properties, Pierre de Fermat and others knew of it earlier. The curve (Figure 5.6) is formed by drawing a circle of diameter $2a$, centered at the point $(0, a)$ on the y-axis. Choose a point A on the line $y = 2a$ and connect it to the origin with a line segment. Name the point where the segment intersects the circle B. Let P be the point where the vertical line through A crosses the horizontal line through B. The "witch" is the curve traced by P as A moves along

the line $y = 2a$. The algebraic equation that generates this curve is $y = 8a^3/(x^2 + 4a^2)$ and the parametric equations are: $x = 2a \cot \theta$ and $y = 2a \sin^2 \theta$.

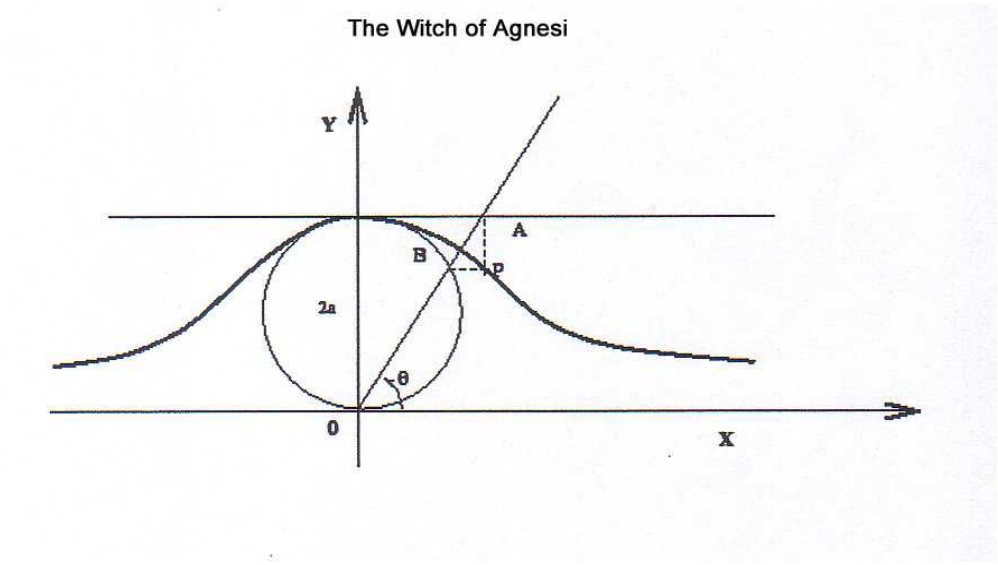

Figure 5.6

Agnesi gave an algebraic method for finding the curve's point of inflection, that is, where it changes from concave upward to concave downward. Guido Grandi provided the curve's construction in 1718, and because of its shape gave it the Latin name "versoria" which means "rope that turns a sail." Agnesi substituted the Italian "versiera" for "versoria" in her book. John Colson, who had translated Newton's *De Methodis Serierum et Fluxionum* from Latin into English, was so impressed with her book that late in his life he learned Italian so he could translate it into English. He hoped that her excellent book would attract more students to the study of mathematics, especially women students. He completed the translation the year of his death, but mistook "la versiera" for 'l'aversiers" which means "the witch" or the "she-devil," and thus the expression "witch of Agnesi" was born. The curve is also referred to as "Agnesi's cubic" and in French, "agnésienne." In fairness to Colson, the editor of the 1801 translation in which the name "witch" first appeared, reported:

> "But besides correcting the errors of the press, it was necessary to correct many little slips of the pen, and inaccuracies, which I found in the copy. For, notwithstanding it (the *Instituzioni*)

was fairly translated for the press in Mr. Colson's own handwriting, it had evidently been written in haste, and wanted revisions; and undoubtedly would have received it from him, if he had lived to superintend the printing of it himself."

Quotation of the Day: "I do not know of any work of this kind which is clearer, more methodic or more comprehensive than your Analytical Institutions. There is none in any language which can guide more surely, lead more quickly, and conduct further those who wish to advance in the mathematical sciences. I admire particularly the art with which you bring under uniform methods the divers conclusions scattered among the works of geometers and reached by methods entirely different." – Pope Benedict XIV in a letter to Maria Gaetana Agnesi.