Marin Mersenne

Our person of the day was a man who knew everyone and read everything. Well, let's amend that slightly, the Minimite friar **Marin Mersenne** (September 8, 1588 – September 1, 1648) made it his business to be in constant correspondence with the greatest mathematicians of his day. He was something of a clearinghouse for mathematical ideas at a time before academies and journals existed to serve such a purpose. From 1623, his regular visitors or correspondents included John Pell, Pierre Gassendi, René Descartes, Girard Desargues, Christiaan Huygens, Galileo Galilei, Evangelista Torricelli, Gilles Persone de Roberval, Pierre de Fermat, Thomas Hobbes, and the Pascals, Étienne and Blaise. Mersenne put these *savants* in contact with each other, and promoted debate and scientific cooperation among them. In his informal role as secretary and facilitator of the group he laid the foundations for the establishment of the first European scientific academy.

Mersenne was born in Oize, in the French region of Maine, but little is known of his early life, other than his father was a laborer, meaning the family was probably poor. Marin attended school at the College of Mans, and then, beginning in 1604 he spent five years at the Jesuit College at La Flèche, where Descartes was his classmate and his close friend. Mersenne studied theology at the Sorbonne from 1609 to 1611 before joining the Minims religious order. The order's name derives from their belief that they were the least (minimi) of all the religious. They devoted themselves to prayer, study and scholarship. Ordained in 1613, Mersenne taught philosophy and theology at Nevers from 1614 to 1618. He then settled in the Parisian convent of the Annunciation, where he remained until his death just before his sixtieth birthday. In his cell were found 78 letters from his famous correspondents.

Mersenne's first publications were theological and polemical studies. In 1625 he composed *La Vérité des sciences contre les sceptiques ou pyrrhoniens* ("The Truth of Science against the Skeptics or Pyrrhonians"), a reply to the threat of skepticism and atheism. Pyrrhonism is the doctrine taught by the Greek skeptic Pyrrho in the 4th century BCE that all knowledge, including the testimony of the senses, is uncertain. In response to the work of Galileo, Mersenne wrote *Traité des mouvements* (1633) and *Les mécaniques de Galilée* (1634), a version of Galileo's lectures on mechanics. *Traité de l'harmonie universelle* (1627) was a work on music, acoustics and instruments, which he continued to revise throughout his life. His two important works on physics were *L'Harmonie Universelle* (1636) and *Cogitata Physico-Mathematica* (1644).

Mersenne formulated the physical laws governing the vibration of strings, and was the first European to accurately describe and mathematically define the six harmonies – 1: 1, 2: 1, 3: 1, 4: 1, 5: 1, 6: 1 – of vibrating strings. He observed, "… all the vibrations of air which the consonances and dissonances make are commensurable [i.e. rational]." This caused scientists and musicians to realize that the rational ratios of just intonation not only constituted a human convention, but also reflected a phenomenon of nature! Mersenne is generally credited with the invention of equal temperament, which was not adopted by musicians until significantly later. Many musicologists refer to Mersenne as the "father of acoustics." In other investigations, he experimented with the pendulum and found the law relating its length and period of oscillation. He proposed the use of a pendulum as a timing device to Huygens, which led to the construction of the first pendulum clock. Mersenne published several designs of reflecting telescopes and was the first to propose the afocal reflecting telescope with a parallel beam entering and leaving the mirror system, but as a theoretician he made no attempt to construct the instruments, which would have been very difficult to do anyway.

In mathematics Mersenne studied prime numbers seeking a formula that would represent them all. Naturally he failed, but his work with numbers of the form $M_p = 2^p - 1$, with p a prime, guarantees he will always be remembered. In *Cogitata Physico-Mathematica*, Mersenne stated without proof that the only primes for which M_p is a prime are 2, 3, 5, 7, 13, 17, 19, 31, 67, 127, and 257. It took until 1947 to completely check Mersenne's list. It was determined that his list was both incorrect and incomplete. M_{67} and M_{257} are not primes, although showing that without mechanical or electronic means is no walk in the park. In 1876 Édouard Lucas developed a method for testing the primality of numbers of the form $2^n - 1$ and proved $2^{127} - 1$ was prime. In 1883 it was shown that M_{61} belonged on the list. In 1911, it was demonstrated that M_p is a prime when p is 89 and in 1914, M_{107} was shown to be prime. Since Mersenne's time, mathematicians, both professional and amateur, have contributed to expanding the list of what are known as "Mersenne primes." In the 1930s, D.H. Lehmer improved on the Lucas method to establish the basis for the test still used today. Mersenne erred in a third way; there are prime numbers greater than 257 for which M_p are prime. Some of these are those with p equal to 521, 607, 1279, 2203, 2281, 3217, … 216091, 756839, and 859433. It wasn't until 1984 that researchers using a supercomputer were able to verify another Mersenne claim. He stated without proof that M_{251} is composite. He was correct. Its factorization is:

$$2^{251} - 1 = 503 \times 54{,}217 \times 178{,}230{,}287{,}214{,}063{,}289{,}511 \times 61{,}676{,}882{,}198{,}695{,}257{,}501{,}367 \times 12{,}070{,}396{,}178{,}249{,}893{,}039{,}969{,}681$$

Finding new Mersenne primes would be a prohibitive task were it not for the use of multiple new supercomputers and software. In 1963 when investigators at the University of Illinois found the 23rd Mersenne prime the institution was so proud it had its postage meter changed to imprint "$2^{11213} - 1$ is prime" on each envelope leaving the school. The best known and most successful of the numerous groups working to find more Mersenne primes is the GIMPS project, where the acronym stands for "Great Internet Mersenne Prime Search." They are responsible for finding the 35th (p = 1398269), 36th (p = 2976221), 37th (p = 3021377), 38th (p = 6972593) 39th (p = 13466917) Mersenne primes. The 39th Mersenne prime consists of 4,053,946 digits. In 2003 GIMPS announced the discovery of the 40th Mersenne prime (p = 20,996,011), which has 6,320,430 decimal digits by 26-year-old Michael Shafer of Michigan State University. To put the size of these numbers in perspective, the relatively small 36th Mersenne prime, which consists of only 895,932 digits, would fill a 450 page paperback book, run to 1.4 miles if written out, and take 28 days to state, speaking for 8 hours a day.

But one might ask, "Why would anyone care about Mersenne primes?" We're getting closer (dangerously or beautifully, depending on one's point of view) to, "Why would anyone care about mathematics?" George Mallory gave one answer when he was asked why he wanted to climb Mount Everest: "Because it is there." [This answer is often incorrectly attributed to Sir Edmund Hillary, who reached the summit of Everest with Tenzing Norgay on May 29, 1953. What Hillary said on returning from the summit is another good answer: "Well, we knocked the bastard off!"] People who do little frequently ask people who do something, "Why?" For those who must have a practical use for things, it is believed that Mersenne primes may help in developing unbreakable codes and message encryptions.

Quotation of the Day: "This problem is extremely difficult, for one can find geometers who claim that it is not possible to find a square whose surface is equal to that of the circle, and others who claim the opposite."– Marin Mersenne