GODFREY HAROLD HARDY

Godfrey Harold Hardy (February 7, 1877 – December 1, 1947) is noted almost as much for his charm and colorful eccentricities as for the power of his remarkable mind. He is sort of a patron saint for those who consider themselves pure mathematicians. He was among the purest of pure and was quite proud of the fact. Most pure mathematicians pursue their investigations for the sake of mathematics alone, unconcerned whether their work will ever have any practical applications. Hardy, who considered mathematics an art, similar to that of painters and poets, went further, insisting that practicality be divorced from his mathematics. He described applied mathematics as "repulsive, ugly and interminably dull" and maintained:

> "I have never done anything 'useful'. No discovery of mine has made, or is likely to make, directly or indirectly, for good or ill, the least difference to the amenity of the world…. Judged by all practical standards, the value of my mathematical life is nil; and outside mathematics it is trivial anyhow. I have just one chance of escaping a verdict of complete triviality, that I may be judged to have created something is undeniable; the question is about its value."

Yet in 1908, Hardy developed, concurrently with the German physician Wilhelm Weinberg, what is now known as the Hardy-Weinberg Law. It describes how the proportions of dominant and recessive genetic traits are propagated in a large mixed population. Hardy dismissed this as unimportant but it has proved of major importance in blood group distribution.

Hardy was born in Cranleigh, Surrey, England. His father was bursar and art master at Cranleigh

School and his mother was a teacher at Lincoln's Teacher's Training School. Hardy attended Cranleigh School up to the age of twelve at which time he won a scholarship to Winchester College, known as the best school in the country for mathematical training. Although Hardy was an exceptionally fine student, he did not care for the school, which was a rough place for a quiet and delicate youngster. Hardy won a scholarship to Trinity College, Cambridge in 1896. He was shocked to discover that the subject of his mathematical training was not mathematics per se but rather the mastering tricks that would allow him to achieve the best possible marks on examinations. Fortunately for Hardy and mathematics he came under the influence of Augustus Edward Hough Love, who held the Sedleian chair of natural philosophy. In 1900, Hardy was elected a fellow at Trinity and began his long productive career. He disliked teaching but enjoyed lecturing to students bright enough to learn on their own. In 1919, Hardy, who was quite unhappy at Cambridge, left to accept the Savilian professorship at Oxford. But in 1931, for purely practical reasons, he returned to Cambridge to accept the Sadlerian chair. Hardy was getting older and at Cambridge he would be allowed to keep his rooms when he retired, whereas this was not possible at Oxford.

For those who think that mathematicians are strange, Hardy will reinforce their conviction. He despised mirrors and the first thing he did when entering a hotel room was to cover all mirrors with towels. In teaching, Hardy did not believe in reviewing what had gone before, no matter how long the interval between lectures. Students were expected to retain what he had shared with them. Once his series of lectures was interrupted by a rather long vacation. At the first class meeting after the recess, he began his address with "It thus follows that."

Hardy had three pictures on his mantelpiece in his rooms at Trinity College, Cambridge. One was of Lenin, one of Jesus Christ and one of a man named Sir John Berry Hobbs, at that time the star cricketer

of England. Hardy believed that these three were the only substantial personalities who had accomplished a hundred percent of what they set out to achieve. Hardy, who considered God his personal enemy, once listed the four things he most wished to achieve in his lifetime: 1. to prove the Riemann hypothesis, 2. to make a brilliant play in a critical cricket match, 3. to prove the nonexistence of God, and 4. to assassinate Benito Mussolini. Unfortunately for Hardy he did not accomplish any of his cherished goals.

The Riemann hypothesis is a celebrated unproved conjecture important to number theory. Leonhard Euler pointed out connections between the theory of prime numbers and the series

$$1/1^s + 1/2^s + 1/3^s + \ldots + 1/n^s + \ldots$$

where s is an integer. Georg Friedrich Bernhard Riemann studied the same series for s a complex number $a + bi$. The sum of the series defines a function $\zeta(s)$, which has come to be known as Riemann's zeta function. Around 1859, Riemann conjectured that all the imaginary zeros of the zeta function have the real part $a = 1/2$. In 1914, Hardy succeeded in proving that $\zeta(s)$ had an infinity of zeros with $a = 1/2$, but the original Riemann conjecture is still unresolved. According to George Pólya, someone once asked David Hilbert what he would do if, like Barbarossa, the Emperor Frederick I, he could revive in 500 years. "I would ask," said Hilbert, "Has somebody proved the Riemann hypothesis?"

Mathematically, Hardy is best known for his collaborations with John E. Littlewood and the self-taught Tamilian genius Srinivasa Ramanujan. Hardy suffered a heart attack in 1939, which seemed to sap not only his remarkably youthful body but his mental powers as well. By the end of WWII, Hardy's health was failing rapidly. He longed to be creative again, for that was all in life that really mattered to him.

According to J.J. O'Connor and E.F. Robertson, realizing his productivity was gone he once tried to commit suicide by swallowing a large dose of barbiturates but took too many, became ill, and survived. He died December 1, 1947.

Hardy once described himself modestly as "for a time the fifth best mathematician in the world." His marvelous little book *A Mathematician's Apology* (1940) was an elaboration of his inaugural lecture at Oxford, which he had delivered in 1920. In it Hardy wanted to proclaim to those anti-war non-scientists at Oxford and Cambridge that "mathematics [is] harmless, in the sense in which, for example, chemistry plainly is not." Anyone interested in mathematics will find it a fascinating read.

In "Some Mathematicians I Have Known", *The American Mathematical Monthly*, September 1969, Pólya, an associate of Hardy's, tells of the time when Hardy spent one summer in Denmark visiting Harald Bohr. When he was obliged to return to England for the new term, there was only one small boat to take him across the channel and the seas appeared particularly rough. Hardy was concerned the boat might capsize and he would drown. Then a brilliant plan occurred to him. He sent messages to Bohr and colleagues back at Cambridge that he had proved the Riemann hypothesis. This done, Hardy hopped on the boat, found a comfortable spot, and promptly fell asleep until they reached England. Why was Hardy so confident he would arrive safely back on English soil? First, God hated Hardy. Secondly, Hardy was one of the world's most respected mathematicians. Had he drowned the mathematical world would believe that he had died taking with him the secret of the proof of the Riemann hypothesis. Hardy was certain that God would never allow him such an honor. Thus He would not let the boat sink.

Quotation of the Day: "The mathematician's patterns, like the painter's or the poet's must be

beautiful; the ideas, like the colors or the words must fit together in a harmonious way. Beauty is the first test: there is no permanent place in the world for ugly mathematics." – G.H. Hardy