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# Bernhard Riemann

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Bernhard Riemann

Andrew Crook

History of Mathematics

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## Abstract

Georg Friedrich Bernhard Riemann, or Bernhard Riemann as he is commonly known, was a devout Lutheran and brilliant mathematician, and was both for all his life. His results are indispensable, providing us with a non-Euclidean geometry, the path to general relativity, and perhaps in time, the key to the problem of the distribution of primes. His faith in God was exemplified both through his mathematics and his home life for as long as he lived, and his example is one to which we may aspire as both mathematicians and simply as Christians.

“...[I]f God does exist and really created the world, as we well know, he created it according to the principles of Euclidean geometry and made the human brain capable of grasping only three dimensions of space.” Had Bernhard Riemann been alive to read those words from Dostoevsky’s 1880 novel *The Brothers Karamazov*, he certainly would have chuckled, if not written a direct rebuttal. A German mathematician born in 1826, Riemann held fast to his Lutheran faith all his life, even (though it may surprise Dostoevsky) while proving near endless results in multiple dimensions and strange geometries. The son of a pastor, Riemann studied theology for a time. It is said that when he was young, he even attempted to prove the book of Genesis mathematically, a venture which was without notable mathematical fruit (Mastin). Before his university days, young Riemann had a habit of devouring mathematical texts far advanced for his age, which included collegiate-level works by Euler and Legendre (“Famous Scientists”). When he began attending Göttingen University in 1846, however, it was to obtain a degree in Theology and Philology to become a functioning member of the clergy. Regardless, it was not long before his love for mathematics prompted him to change courses. While at Göttingen, he fell in with the equally notable Carl Friedrich Gauss, who became a mathematical mentor of sorts. Eventually, Riemann secured a position as the head of the mathematics department at Göttingen. His devout faith remained with him all his life. He passed away in 1866, it is said while reciting the Lord’s Prayer with his wife.

Riemann’s mathematical results defy description. From non-Euclidean geometry to the distribution of primes, he proved theorems and posited hypotheses that mathematicians obsess over to this day. Though his writing and lecturing were less than ideal and difficult to follow, the intellectual depth of his ideas was recognized by the other prominent mathematicians of the day (Gray). One of his notable contributions was his expedition in the realm of non-Euclidean

geometry. Unlike his predecessors Bolyai and Lobachevski, who developed geometry from the assumption that triangles contained fewer than 180 degrees, Riemann worked from the idea that they contained more than 180 degrees, pioneering elliptical geometry. He eventually combined all three forms (Euclidean, hyperbolic, and elliptical), generalizing them into what is now known as Riemannian geometry (Mastin). This was not, however, his greatest departure from traditional Euclidean geometry. He developed the idea of multi-dimensional space (meaning greater than three dimensions). This idea certainly seems like one which would have no possible application, even deserving some derision (or perhaps Dostoevsky's treatment), but the applications are astounding. It was Riemann's multi-dimensional geometry which allowed for the possibility of Einstein's famous theory of general relativity and the concept of space-time ("Famous Scientists"). The concept of multi-dimensional space, strangely enough, lays bare the Biblical truth of the limitations of humanity. There is the possibility that our universe is currently one of infinite dimension that we can only experience in three, a thought only slightly less humbling than God's rebuke of Job in the eponymous book of the Bible. One can also consider God's sovereignty and infinity as being analogous to space of infinite dimensions. While it is unknown whether Riemann held these ideas, the devout Lutheran must have applied his beliefs to mathematics in some manner, and it is not a stretch to suppose he contemplated God's infinity. While these achievements are of immense mathematical and practical importance, Riemann is perhaps most famous for one of those oft-encountered mathematical beasts, an unsolved problem.

The zeta function was an eighteenth-century discovery by the eminent Leonhard Euler. Riemann took the function and from it derived the now-infamous Riemann zeta function, an infinite series denoted by  $\zeta(s) = 1 + \frac{1}{2^s} + \frac{1}{3^s} + \frac{1}{4^s} + \dots$ . Riemann observed that it seemed as if all

the zeroes of the function (the places where the value of the series is zero) when considering complex numbers occurred when the real part of  $s$  was equal to  $\frac{1}{2}$ . He never proved the conjecture, abandoning it after a couple of unsuccessful attempts in favor of his other mathematical pursuits (“Famous Scientists”). Still unproven, the Riemann Hypothesis remains one of the most important problems in mathematics, for if it were proven, it may provide the key to solving the distribution of prime numbers, the holy grail of number theory and perhaps all of mathematics. The hypothesis was one of the twenty-three unsolved problems David Hilbert discussed in his famous 1900 address (all but three of which are now solved), and there is a reward of one million dollars for its successful proof or disproof (“Famous Scientists”).

As a Christian, and lover of mathematics, I believe that math, along with every other true science and art, is nothing less than a reflection of God’s mind and character. If reality conforms to certain rules, and if God created reality, it follows that God created the rules that underlie reality. This the way I think of it: God does not conform to a human idea of “justice,” but rather our human idea of “justice” is derived from the character of God. In the same way, God is not bound by mathematical laws, but those mathematical laws that humans are lucky enough to discover are reflections of God’s mind, of logic. I interpret my duty, therefore, as exploring mathematics to know more about God, about Who He is. This is, of course, not limited to mathematics. God blessed me with a wide range of interests, something I hope never to take for granted. Just as I can follow God by discovering more about mathematics, I can mimic his role of Creator by writing. I can explore language, the thing which God used to create the world (“Let there be light”). All these are optional, however. Not everybody has an inclination toward mathematics. What is not optional for the Christian is exemplifying the Fruit of the Spirit. It was Paul who, writing to the church at Corinth, said that no talent, gift, or power is worth anything

without the love from God (KJV I Cor. 13:1). Therefore, even if I use mathematics not once in my professional or family life, I can serve God by doing whatever it is I do with love for others as the endgame. “Let us hear the conclusion of the whole matter. Fear God, and keep His commandments, for this is the whole duty of man” (KJV Ecc. 12:13). Everything else, even mathematics, is secondary.

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