Impact of Riemann's Work on Physics

Bernhard Riemann, who died young at the age of forty, left behind him a rich legacy of mathematical ideas. Like his teacher Gauss, Riemann had an interest in the physics of his day. Riemann was greatly influenced in physics by Weber (a friend and collaborator of Gauss) who studied electromagnetic theory and terrestrial magnetism. Riemann worked in Weber's laboratory as an assistant for a year and a half. He was interested in electromagnetic theory, mechanics and fluid dynamics. Riemann has written on shock waves, electrodynamics and even on the mechanics of the ear! But the main impact of Riemann's work on the physical sciences came from his *mathematical* legacy. It took nearly a century for the full force of this impact to be realised. Modern physics uses several mathematical disciplines on which Riemann left his mark. Examples are differential geometry, topology, complex analysis and of course, Riemannian geometry.

The first application of Riemann's mathematical ideas in physics was in Einstein's General Theory of Relativity. When Einstein was thinking deeply about the gravitational force and how to fit it into the special theory of relativity, he arrived at an insight which he called the principle of equivalence. This insight was of a physical nature: that the gravitational field can be eliminated locally by going to a suitable frame of reference. This physical insight led him to the idea that the gravitational field can be described by geometry. Luckily for Einstein, the necessary mathematics had already been developed some years earlier by Riemann. With help from a mathematical friend Marcel Grossmann, Einstein used Riemannian geometry to express the physical ideas he had arrived at. More details of Riemann's contributions to physics are discussed in the article 'Riemann and Theoretical Physics' in this issue.

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