Gravitational breakdown

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The Rise and Fall of the Fifth Force: Discovery, Pursuit, and Justification in Modern Physics. By Allan Franklin. *American Institute of Physics: 1993. Pp. 141. $29.95, £21. (Distributed in the United Kingdom by Oxford University Press.)*

HOW do scientists come to formulate new scientific hypotheses and in what context? How do these hypotheses get rejected or, in some rare instances, canonized as new laws of nature? What is the driving force behind scientific endeavour? Allan Franklin attempts to answer these questions by examining the suggestion made by Ephraim Fischbach and colleagues in 1986 of a possible extra component to gravity.

Whereas conventional gravity generates the same acceleration on all bodies, irrespective of their composition, this new force would distinguish between different substances and cause them to move at different speeds. Moreover, unlike gravitation, which is a long-range force whose strength decreases in proportion to the inverse square of distance, the new force was proposed to decrease exponentially with distance (similar to the decrease in nuclear forces as suggested by Yukawa, albeit with a typical range of 10–100 metres).

Fischbach and colleagues based their suggestion on several apparently disjointed clues: in 1955, Lee and Yang had discussed the possibility of a long-range force that couples baryons akin to the electrostatic coulomb force that couples electric charges. Some ten years later, Lee, who with Yang had pioneered the discovery that parity was not a universal symmetry in nature but was maximally violated in weak interactions, attempted to save the combined symmetry of charge conjugation (particle-to-antiparticle interchange) and parity in the decay of the K_L^0 meson. Violation of this combined symmetry — which is equivalent to the violation of time-reversal invariance — was, according to Lee and others, only seemingly so; the real cause of the apparent CP-violation was a long-range force that couples hypercharge. Other clues came from experiments on gravitation, notably those of Eötvös; his results had so impressed Einstein that they led him to formulate the principle of equivalence on which, indeed, all metric theories of gravitation are based.

Yet despite these exciting beginnings, and probably because of them, within about five years many new experiments were done that led to the firm conclusion that such a new force was not there in nature, at least not at strengths greater than one part in ten thousand of gravity.

This brief interlude in the contemporary history of science is well documented by Franklin, and should be of much interest to those concerned with the philosophy of science and epistemology. Classical epistemology based on complementary and often confrontational ideas of empiricism and rationalism similarly underwent a huge change in the post-newtonian period and indeed had to be modified substantially to accommodate Einstein's idea of relativity, spacetime and gravitation. With such an evocative title, however, one expects to find a book of more majestic dimensions with a detailed analysis of the episode in terms of the competing ideas in the field of philosophy of science and epistemology. Instead, the author provides a detailed review not merely of the scientific papers and conference discussions, but also of the informal electronic-mail exchanges of the original collaborating workers. This meticulous chronicle, with its comments on the basic questions of scientific methodology and verification of scientific truth, should therefore constitute an important reference for more extensive studies. □

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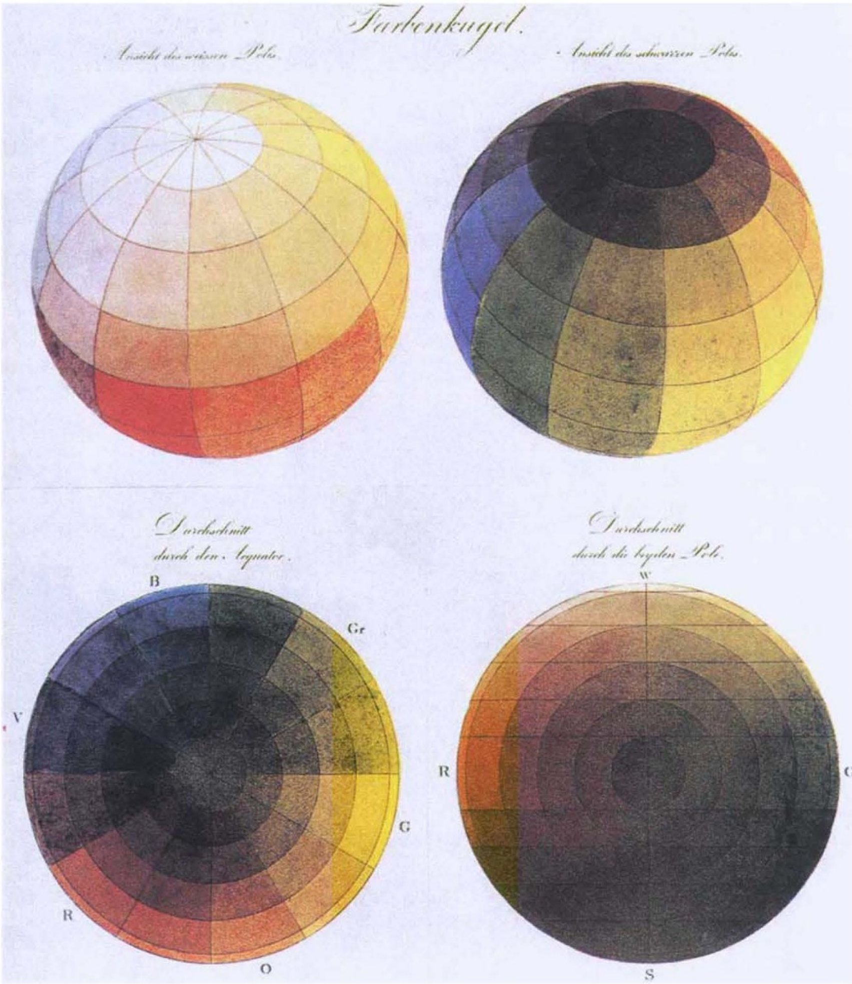

NEWTON'S *Opticks* sought to put the study of light and colour on an objective, quantitative basis. But it was increasingly the subjective colour phenomena, such as colour contrasts and the Purkinje shift, that occupied the attention of scientists who developed the modern study of colour vision. In particular, Goethe's *Theory of Colours* (1810), a polemic against Newton, made an important contribution to the developing science of the physiology and psychology of perception in the nineteenth and twentieth centuries. The poet's influence also extended to the Romantic artists who sought to extract new meanings for colours from their positions in space. Runge's *Colour Sphere* (1810), shown here, was one of the earliest attempts by a painter to coordinate hues and values (light–dark content) into a coherent whole. This picture appears in John Gage's *Colour and Culture*, an immensely detailed and sweeping analysis of colour in Western culture from the ancient Greeks to the present. Copiously illustrated, it will prove irresistible to artists and scientists alike. Thames and Hudson, £38.