A Most Appetizing First Course

A First Course in String Theory

Barton Zwiebach
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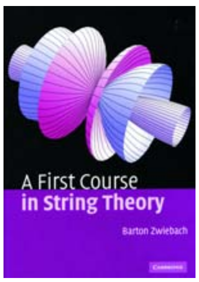
Reviewed by Marcelo Gleiser

String theory is one of those topics that invoke both awe and controversy.



The awe comes from its elegant mathematical formulation, the symmetries explicitly used, and the promise of a well-behaved quantum theory of gravity that also unifies all fundamental interactions of nature—the final theory that seekers of the hidden unity-in-all-that-is aim to find. One is reminded of the remark Einstein made when he was confronted with the possibility that general relativity—in this case, the calculation of the precession of Mercury's perihelion—might be wrong: "The result could not be otherwise than correct. . . . I did not for one second doubt that it would agree with observation." Indeed, general relativity did not have to wait long for its telltale if then somewhat arguable confirmation—the 1919 observations of the sun's bending of starlight during a total solar eclipse.

The controversy over string theory comes from the paucity of experimental evidence supporting the theory and its twin cornerstones: supersymmetry and extra spatial dimensions. String theorists have struggled to come up with testable predictions that could vindicate their ideas. Periods of great excitement have been followed by quiet disappointment. The current dilemma relates to the theory's energy landscape and the search for a selective principle that will single out the one vacuum from a ridiculously large number of possibilities. Strings are not alone in generating such vast landscapes of choices: Protein folding shares somewhat similar challenges. The advantage for biophysicists is that proteins are known to exist and their properties can be studied in the lab.

I was a graduate student in England during the mid-1980s when Michael Green and John Schwarz reenergized the whole field by showing that supersymmetry tamed the infinities of the theory; as a bonus, they predicted the dimensionality of spacetime to be 10. My graduate thesis explored byproducts of their result, the cosmology of a 10-dimensional spacetime and the so-called spontaneous compactification problem, or how three spatial dimensions became large while the other six remained small, possibly as small as 10^{-33} cm. I also remember how hard it was as a young student to make sense of everything; the material was technically difficult, and the lack of accessible review papers and books on the subject was appalling. How wonderful Barton Zwiebach's *A First Course in String Theory* would have been during my graduate years! (Of course, it would have been much slimmer, but still—.)

Zwiebach, a respected researcher in the field and a much beloved teacher at MIT, is truly faithful to his goal of making string theory accessible to advanced undergraduates. I can see his book being adopted at Dartmouth for a joint graduate and advanced undergraduate course. The author is honest about the promises and serious challenges the theory still faces, a trait for which he should be commended. String theory is not all roses, and students learn that from the start. Zwiebach presents the topics with the clarity and contagious enthusiasm of an outstanding expositor and pedagogue who knows what sorts of difficulties students face when tackling theories in higher dimensions: comprehending the quantization of point particles and strings; calculating in the light-cone gauge; understanding D-branes, Dp-branes, and the T-duality of closed and open strings; figuring out how strings interact or how 11D M-theory relates to 10D string theories, and so forth.

The text develops intuition before formalism, usually through simplified and illustrative examples, such as quantum mechanics with a compact dimension or analogies with musical strings and their vibrational modes. In keeping with the doctrine that you only learn by doing, the exercise problems are an integral part of the text. Solutions are provided for instructors via a specified website; however, a supplemental volume would have been more convenient. Zwiebach avoids the temptation of including topics that would weigh the book down and make many students rush it back to the shelf and quit the course. He presents suggestions for further reading once the topics are mastered by students. I suggest starting with Zwiebach's book and then moving on to Joseph Polchinski's two-volume *String Theory* (Cambridge U. Press, 1998).

Even if string theory doesn't pan out as a theory of all interactions, it will remain a key chapter in the history of physics, contributing deeply to our understanding of field theories. We will all have to wait and see. I, for one, stand in awe of string theory's elegance but am painfully aware that Nature doesn't always share our longing for harmony.

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Blackett: Physics, War, and Politics in the Twentieth Century

Mary Jo Nye
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Patrick M. S. Blackett (1897–1974) was among a generation of outstanding British physicists, five of whom won Nobel prizes in physics in the 1940s and early 1950s. Blackett won his in 1948 for improving the Wilson cloud chamber and for the discoveries he made with the improved device in the 1930s. In 1947 he announced, and then retracted, a new universal law uniting gravity with magnetism. He developed new magnetometers that would be important in establishing the geological theory of continental drift and was a key figure in British wartime operational research. He was also interested in what were considered to be old-fashioned problems,