Lessons from strings

We've come a long way, from the Planck realm to the multiverse. What are the grand lessons? How do strings tidy up our understanding? What are the loose ends? Here are a few observations to summarize the current state of our stringy world.

1. We can't pin down any fundamental scale in strings, nor can we define "fundamental" particles. When we try to probe the string scale, dualities modify the particle zoo.
    a. T-duality interchanges the Kaluza-Klein description with the physics of winding number.
    b. S-duality interchanges "fundamental" particles, e.g. electrons and magnetic monopoles, fundamental strings and D1 branes.

2. T-duality requires existence of other topological structures, e.g. branes.

3. Dualities allow us to model the same physics in different dimensions. This is the holographic principle.

4. String theory requires gravity.
    a. Closed strings, and therefore gravitons, exist in any string theory (because even open string ends can join).
    b. The theory includes Einstein's field equations at its core.

5. String theory is not one theory; it is many theories. Strings live on Ricci-flat space, and there are many such topologies.

6. The plethora of topologies predicts a cosmic landscape of allowable universes. Such conjecture is compatible with observation; it appears plausible that ours is just one universe in a multiverse.

7. We have not yet found a string theory that reproduces the Standard Model of particle physics. On the other hand, tools of string theory have helped solve many practical problems in nuclear physics, condensed matter physics, black holes, and cosmology.

There's lots yet to be done. I hope you would like to join the endeavor.

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