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Michael Duff: Einstein didn't explain everything. We need a scientific revolution

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The central quandary facing 21st-century physics is that the two main pillars of 20th-century physics – quantum mechanics and Einstein's general theory of relativity, are mutually incompatible. Quantum theory deals with the very small: atoms, subatomic particles and the forces between them. General relativity deals with the very large: stars, galaxies and gravity, the driving force of the cosmos as a whole. The dilemma is that on the microscopic scale, Einstein's theory fails to comply with the quantum rules that govern the behaviour of the elementary particles. On the macroscopic scale, black holes are threatening the very foundations of quantum mechanics. Something big has to give. This augurs a new scientific revolution.

Some believe that this revolution is already under way because of "superstrings". As their name suggests, superstrings are one-dimensional string-like objects. Just like violin strings, they can vibrate, and each mode of vibration, each note if you like, corresponds to a different elementary particle. This note is an electron, that one a quark, a Higgs boson, and so on. The strange feature of superstrings is that they live in a universe with nine space dimensions and one time dimension. Since the world around us seems to have three space dimensions, the extra six

would have to be curled up to an unobservably small size if the theory is to be at all realistic. Fortunately, in the equations this actually happens. Unfortunately, there are not one but five mathematically consistent superstring theories, each competing for the title "Theory of Everything" – an embarrassment of riches.

This problem is cured by M-theory, a unique all-embracing theory which subsumes the five superstring theories by requiring 11 space-time dimensions and incorporating higher-dimensional extended objects called branes. M stands for "Magic, Mystery or Membrane", according to taste.

Theorists are so excited about string theory and M-theory because they seem at last to provide the long-dreamed-of consistent quantum theory of gravity and hold promise of incorporating and extending standard models of particle physics and cosmology.

Michael Duff is Abdus Salam Professor of Theoretical Physics at Imperial College London, where he was speaking on Wednesday

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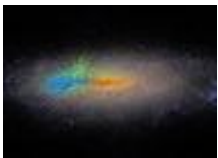
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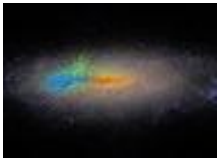
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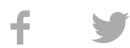


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