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Theories beyond the standard model, one year before the LHC[1]

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Next year the Large Hadron Collider at CERN will begin what may well be a new golden era of particle physics. I will discuss three theories that will be tested at the LHC. I will begin with the supersymmetric standard model, proposed with Howard Georgi in 1981. This theory made a precise quantitative prediction, the unification of couplings, that has been experimentally confirmed in 1991 by experiments at CERN and SLAC. This established it as the leading theory for physics beyond the standard model. Its main prediction, the existence of supersymmetric particles, will be tested at the large hadron collider. I will next overview theories with large new dimensions, proposed with Nima Arkani-Hamed and Gia Dvali in 1998. This links the weakness of gravity to the presence of sub-millimeter size dimensions, that are presently searched for in experiments looking for deviations from Newton's law at short distances. In this framework quantum gravity, string theory, and black holes may be experimentally investigated at the large hadron collider. I will end with the recent proposal of split supersymmetry with Nima Arkani-Hamed. This theory is motivated by the possible existence of an enormous number of ground states in the fundamental theory, as suggested by the cosmological constant problem and recent developments in string theory and cosmology. It can be tested at the large hadron collider and, if confirmed, it will lend support to the idea that our universe and its laws are not unique and that there is an enormous variety of universes each with its own distinct physical laws.

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