

Proposal for a Galileo Galilei Institute Workshop in Spring 2006

*New Directions Beyond the Standard Model
in Field and String Theory*

Dear Members of the Advisory and Scientific Committees,

In recent years, we have witnessed a vast amount of activity in particle physics beyond the Standard Model, both within field theory and in string theory. New approaches to the hierarchy problem have been proposed based on large or small extra dimensions, and considerable progress, both theoretical and phenomenological, has been made on the problem of supersymmetry breaking via compactification, non-BPS systems and via the addition of fluxes in internal spaces. New models of electroweak symmetry breaking based on the properties of extra dimensions have been proposed and new ways of breaking grand unified gauge groups that avoid some of the problems of traditional GUT models have been explored.

The gauge-string duality conjecture has led to new computational methods in strongly-coupled regimes of gauge theories and to new views on composite models. Moreover, warped spaces naturally arising in this context have also led to a new explanation of large hierarchies and to the novel possibility of localising gravity even in the case of infinitely large extra dimensions.

New mechanisms for breaking gauge symmetries and supersymmetries have been successfully introduced in string theory, and have been explored in some detail in new phenomenological models that are testable at the next generation of colliders.

Recent results on the compactifications of string theory have also showed the possibility of stabilising all moduli fields, which determines the string coupling constant and the geometry of the internal space. This progress opens the way to a thorough phenomenological analysis of low-energy string models. The large number of string theory vacua and their multifaceted intrinsic properties can also suggest radically new views on string phenomenology, with possible impact on low-energy model building and experimental signatures.

The beginning of the LHC experimental program in 2007, with its high priority to determine the origin of the electroweak scale, makes it compelling to analyse the different mechanisms of electroweak (and possibly supersymmetry) breaking, and to undertake a detailed analysis of their phenomenological consequences. Despite the tremendous theoretical progress summarised thus far, extensions of the Standard Model have to successfully pass the new broad range of experimental tests including electroweak, flavor, proton decay and neutrino physics, as well as tests in cosmology and astrophysics. In view of the important theoretical tasks and experimental difficulties in interpreting LHC data without clear theoretical predictions for the expected new physics, we believe that a collective effort of both the phenomenological and string communities in approaching these problems is welcome and urgent.

The purpose of our workshop proposal would then be to bring together leading string and field theory experts with a key interest in low-energy supersymmetry, supergravity, extra dimensions and nonperturbative methods in gauge theories. This would help to stimulate an intense and fruitful interaction between these communities, with the idea of encouraging collaborations that, while clearly of great importance in view of the difficulties presently faced, are still not well widespread. We believe that progress in central problems like, for example, the scale of supersymmetry breaking and the sparticle spectrum, the issue of flavour changing effects, the possible existence of large extra dimensions and the study of strongly-coupled gauge theories based on the AdS/CFT correspondence should come from a combination of top-down (typical of string theorists) and bottom-up (typical of phenomenologists) approaches. We think that this can emerge from a very fruitful interaction and collaboration of the two communities working together in an appropriate environment such as the one provided by the Galileo Galilei Institute.

Our proposal is to have a two month workshop in May and June 2006. A preliminary organisational schedule includes two advanced seminars every week, tentatively on Monday and on Wednesday, and one seminar of general interest for the participants on Friday. The expected participants are world leading experts, confirmed researchers and postdoctoral fellows in the fields of physics beyond the Standard Model and of string theory and phenomenology, while the participation of advanced PhD students will also be considered

in special cases and typically for short periods. A three-day conference devoted to the exposition of the most recent results in the field would take place in early June. During the conference we also intend to have intense discussions on the possibility of testing new models and methods at forthcoming particle physics colliders, in particular at the LHC and at a linear collider, and on their possible microscopic (string) realisation. Particular attention should also be devoted to the possible cosmological signatures induced by new particle physics scenarios and by the more popular low-energy supersymmetric models. The main topics we intend to discuss during the workshop include:

1. Electroweak symmetry breaking.
2. Supersymmetric models and supersymmetry breaking.
3. Warped compactifications and holography.
4. String vacua and model building.
5. Modification of gravity and cosmological implications.

The proposed organisers are Carlo Angelantonj from the University of Torino, Emiliano Dudas from the Ecole Polytechnique, Paris and the LPT-Orsay, Tony Gherghetta from the University of Minnesota and Alex Pomarol from the University Autònoma of Barcelona.

Yours Sincerely,

Carlo Angelantonj
Emiliano Dudas
Tony Gherghetta
Alex Pomarol