Wave-function localization and flavor structure in supergravity

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Wave-function localization in extra dimensions is one of a few dynamical sources of hierarchical structures in four-dimensional (4D) spacetime, e.g. among observed quark/lepton masses/mixings. For example a realistic pattern of fermion masses/mixings results from a wave-function localization of matter fields in five-dimensional (5D) spacetime with a single extra dimension. This can be embedded into supergravity models with a low scale supersymmetry (SUSY) breaking. In this case, the localized wave-function is a consequence of gauging the matter hypermultiplets by the graviphoton vector multiplet.

In supergravity models, on the other hand, there generically exists SUSY flavor problem. The flavor structure of superpartners is severely restricted by suppressed flavor changing processes. However if the fermion mass hierarchy is a consequence of localized wave-functions, quarks and leptons couple to moduli fields and SUSY breaking sectors in flavor dependent ways. Moduli fields govern the size and the shape of extra dimensions and mediate sizable SUSY breaking effects under basic moduli stabilization mechanisms. Then, soft SUSY breaking parameters become flavor dependent correlated with the fermion mass structure. Such flavor violations cause dangerous flavor changing neutral currents. Furthermore, some superpartner scalars get tachyonic masses because either heavy or light flavors are forced to localize toward the SUSY breaking sector in a single extra dimension, and then sizable direct couplings always yields a tachyonic structure in a minimal 5D supergravity model with quasi-localized matter fields [1].

In order to construct realistic supergravity models, we have to solve such problems. One way is to consider nonminimal models with multiple moduli originating from 5D Z_2-odd vector multiplets. We have shown that these problems can be solved at the same time with at least one modulus in addition to the radion originated from the graviphoton multiplet, if we assume a certain prepotential, certain gaugings of matter multiplets and appropriate moduli stabilization mechanisms for them. The tachyonic problem can be solved by choosing suitable prepotential which determines the structure of (direct) couplings between localized fields including the SUSY breaking sector in the 4D effective theory. On the other hand, the SUSY flavor problem can be avoided by suitably gauging matter multiplets by moduli vector multiplets [2]. The low energy feature of soft SUSY breaking parameters are summarized as follows. The gaugino masses are typically smaller than the scalar masses. The scalar masses of the first and the second generation degenerate at the leading order with a class of realistic fermion masses/mixings, and the magnitude of top squark and Higgs scalar masses are larger than the other scalar masses [3].

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References

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