Activity Report, Summer Institute 2000 at Fuji-Yoshida, Japan

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As my main contribution to the Summer Institute 2000, I delivered a lecture on "Brane-World Models from M-Theory". This lecture presented an overview of the theoretical foundations and the recent developments of this topic. After a pedagogical introduction into heterotic M-theory, the version of M-theory relevant to brane-world models, I described the vacuum solutions of this theory based on Calabi-Yau three-folds. I explained how these vacua can be used to derive five-dimensional brane-world theories from M-theory and presented the simplest example of such a theory. These theories are characterized by a bulk with gravitational and gravity-like interactions and three-branes localized in this bulk carrying either the standard model of particle physics or hidden sectors.

I went on to discuss several particle physics properties of such brane-world models. First, I explained how unification of coupling constants is achieved in a quite generic way. Furthermore, I reviewed some of the attempts to construct models with a realistic particle content, such as three generations of quarks and leptons, on the observable brane. Focusing on a more recent development, I showed how Green-Schwarz anomaly cancellation and the structure of anomalies in five-dimensional brane-world models from M-theory can be understood in terms of the anomaly-inflow mechanism.

In addition to this lecture, I presented a related talk on the early universe cosmology of five-dimensional brane-world models. I reviewed the attempts to find promising models of brane-world inflation in the context of rolling-radii solutions as well as potential-driven inflation. Finally, I introduced a formalism to deal with cosmological perturbations in brane-world theories. This formalism allows one, for example, to deal with fluctuations generated during an early phase of brane-world inflation.

Apart from giving these seminar, I had a number of very interesting

and fruitful discussions on topics such as five-dimensional supergravity and its off-shell formulation, brane-world neutrinos physics and the domain-wall vacuum structure of heterotic M-theory.