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Physics and Modularity of Calabi-Yau Manifolds

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One of the most fascinating and important topics in contemporary mathematics is the study of modularity. This is a phenomenon where it is possible to associate a modular form to a manifold by using its number theoretic properties. Surprisingly, this deep correspondence has concrete implications for the physics of Calabi-Yau compactifications of string theory; the modular form turns out to encode physical information. For instance, it appears in the Bekenstein-Hawking entropy of BPS black holes. Another central example is given by IIB flux compactifications, where the modular form specifies the axiodilaton, or equivalently F-theory fibre in the F-theory uplift.

In this talk, I give a concise overview of the geometry and number theory behind modularity, as well as various instances in physics where modularity appears. I will then explain in concrete terms, how modular Calabi-Yau manifolds can be found in practice, and how their modular properties can be studied by using numerical methods. Additionally, I will present some examples where results and conjectures from number theory give novel approaches to solving significant problems in physics.

This talk is based on several joint works with Candelas, de la Ossa, Jockers, Kotlewski, and McGovern.

Summary

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