As I learned from my own thesis at Harvey Mudd College, participation in research is the is the best way to learn to think like a physicist. Students who are passionate about theoretical physics deserve the chance to pursue it, and I believe that I can successfully collaborate with them on cutting edge projects. My interests in string theory are well suited for student participation: they can contribute calculations in geometry or other accessible topics while I handle the more sophisticated parts of each project. Here, I outline a few explicit examples of how I plan to put that into practice. Some of these would contribute to my main research programs, while others are side projects interesting in their own right.

- String theory suggests that our universe may have more than three dimensions of space, and extra dimensions can give rise to a form of electromagnetism. These models include magnetic monopoles, and studying them can give new insight into the theory. There are two ways to describe these monopoles in terms of a Lagrangian: a well-known form valid only at low energies, and a high energy form that is less understood.

  A student could participate in my study of these monopoles by investigating the connection between these high and low energy forms. We would begin by building experience applying the Euler-Lagrange equations to similar systems, and we would then apply those skills to demonstrate the connection between high and low energies for the case of a magnetic monopole. Once that was established, we could attempt a more challenging task: to determine the high energy Lagrangian that describes *two* monopoles by working backward from the known low energy expression.

  Several followup projects are possible, whether with the same student or with others. Generalizing from two monopoles to arbitrarily many could be important and should not require too much additional insight. Also, the initial phase of this project would focus on ordinary Lagrangians but most applications would require a generalization using "supersymmetry" (which relates bosons and fermions). Learning the appropriate rules for such a generalization would be another substantial but achievable goal.

- A fascinating property of string theory in a universe with an extra dimension is the phenomenon of "T-duality", which implies that many objects in the theory that appear entirely distinct are in fact completely equivalent in a subtle way. The rules relating the different objects consist of straightforward algebra applied to the fields and functions that describe them. I am interested in exploring T-duality for a class of objects where these rules have not previously been thought to apply. The math is not difficult, but understanding the results will require a good understanding of the underlying physics.

  A student interested in learning about T-duality and participating in this research would first need to learn a little bit of general relativity, just enough to recognize key features of its description of black holes. (These essentials could be learned from a thirty page "General relativity primer" by Richard Price.) We would begin our work by applying the T-duality rules to some well-known systems and learning to interpret the results physically. Coming to understand T-duality at this level is already a respectable accomplishment, but we should be able to go on to find what the rules imply for the new systems that I hope to study. Those new results could have interesting implications for the recently developed "doubled geometry" formalism for T-duality.

- Recent observations in cosmology have revealed that the expansion of the universe is speeding up, contrary to the expectation that gravity should be slowing it down. The most common explanation for this is a "cosmological constant", a form of energy intrinsically associated with the vacuum of empty space, but another possible model is a "quintessence" field in which the dark energy is related to a new type of particle. I have studied a model related to string theory which included both of these features, but only the cosmological constant aspect of it was discussed in the literature, so the possibilities of the quintessence aspect of the model remain unexplored.

  A student interested in this topic could begin by studying published descriptions of quintessence to learn how such models studying the literature on quintessence to learn how such models work and how details of a particular model affect observable data. After learning how these ideas play out for several well-understood models, I would then provide the features of the quintessence field extracted from my earlier work and we could determine its implications. The key questions are whether it is compatible with current observations and whether it makes any testable predictions.

- We have recently learned that some of the mathematics of string theory can be applied to studies of the strong nuclear force, which could give new tools and insight into observable phenomena (possibly even at the Large Hadron Collider). A recent paper has shown how to use computational techniques developed for simulations of the strong nuclear force to explore some of these ideas and applied them to a system that I know well. Although I have not previously worked in this computational field, its recent successes are exciting and students interested in computational physics could play a part in developing this work.

  Early student projects in this direction would most likely focus on simply establishing the basic code needed to model the system and testing that we could reproduce known results. The prospect of computational tests of string-inspired models is exciting, but I have only recently begun to consider it: it would be premature for me to make specific plans for student projects before I learn more about the field myself. I would make this research direction a priority if a substantial number of students were interested in computational physics.