**Research Statement**

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Cosmology has become a particularity exciting field in recent years, driven by observational discoveries as well as new theoretical models. Measures of the CMB power spectrum and distance measurements give strong evidence for cosmic inflation and acceleration, two phenomena often described by scalar fields, while new work on string theory and holography have expanded the theoretical framework. I have been involved with research in **Cosmic Acceleration, CMB power spectrum calculations, cosmic inflation, and singularity theorems in General Relativity.**

# Dark Energy

My current project it to determine how effective future experiments might be at differentiating between specific scalar field models of dark energy. This starts with the data models used by the Dark Energy Task Force (DETF). Besides answering the question of what the DETF figure of merit means in terms of actual dark energy models, the use of Monte-Carlo Markov chains also allows exploration of the non-Gaussianity of the parameter spaces, something missed by the DETF's Fisher matrix approach. I am now exploring how future observations may be able to distinguish between different quintessence models of dark energy.

A future direction I might take with this is to project these models onto a space of best measured modes of the equation of state $w(a)$, and then use the power in those modes as parameters. This may give interesting insight, but can also solve various problems, such as the large volumes in the parameter space of some models that are indistinguishable from a model with a cosmological constant, but are unattractive theoretically. Further improvements can be made using the cross calibration of data sets, and the field of models can be expanded to include altered General Relativity models that mimic dark energy.

The techniques used in this research can be applied to evaluate new observation strategies, as well as new combinations of data. This will be useful for planning new, high impact experiments in the field of cosmology.

# Cosmic Inflation

I have looked into the implications of some open inflation models, exploring their effect on the Cosmic Microwave background using the CMBfast algorithm. I also have some experience with the calculation of the primordial power spectrum of density perturbations from inflation, including its derivation from a slowly rolling scalar field during inflation. I am particularly interested in the beginning of cosmic inflation, and the idea that it may arise naturally or statistically from a more general state.

# General Relativity and Singularity Theorems

In my research into cosmic inflation, I have become familiar with the basics of singularity theorems, and have looked into their implications for the energy condition violations. This stemmed from a search for a way around the singularity theorems in the case of inflation starting as a random fluctuation in a space dominated by a cosmological constant, which drew heavily on the holographic principle concept of a horizon with a temperature. These

problems are generic to scenarios involving a beginning to inflation. Further research into this area might involve quantifying the energy condition violations in these scenarios.

I am interested in solving problems in all areas in the field of cosmology. My Ph.D. work gives me a sound foundation, and look forward to branching out with new directions and collaborations as a postdoc.