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Statement of Research Goals & Interests
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My primary research interest lies in the field broadly referred to as *quantum gravity.* I did my graduate training at Pennsylvania State University, under Prof. Stephon Alexander and Prof. Martin Bojowald. My graduate work involved applying ideas from many-body phenomena to cosmology. In particular we explored whether a four-fermion attraction between fermions mediated by the gravitational connection could lead to the formation of a cosmological fermionic condensate. This work further led us to propose a possible resolution to the cosmological constant problem. With my advisor and co-workers I also explored the possibility that the acceleration of the universe as induced from measuring supernovae redshifts and fitting with CMB data from the WMAP satellite could in fact be attributed to the possibility that our solar system is located in the interior of a cosmological void spanning $\sim$ 100-150 mega parsecs.

While at Penn State I was also able to learn about *Loop Quantum Gravity*, which is considered the main competetitor to String Theory as a candidate theory of quantum gravity. With my collaborator Sundance Bilson-Thompson, I have written an introductory text on LQG, titled *LQG for the Bewildered*, published in 2017 by Springer Nature.

There is a common thread which runs through all my work - *the desire to understand how best to formulate a complete, consistent theory of quantum gravity.* For this purpose I have employed various tools from quantum information, many body physics and canonical quantum gravity. The shared motivation behind all of my work has been to understand how our smooth, classical spacetime arises from an underlying quantum substrate which might take the form of a tensor network or a Hubbard model on an abstract lattice. Of course, no theory of quantum gravity can be considered complete if it does not incorporate the particles of the standard model and their associated interactions. Therefore my work has also focused on trying to understand how elementary particles can be embedded within loop quantum gravity, a possible relationship between elementary particles and quantum computation, the emergence of non-abelian gauge fields from defects in spin-networks and, more recently, a possible relationship between scattering of elementary particles and semiclassical states of geometry.

Over the years I have realised that *the insights we have obtained from research in String Theory, such as the fundamental significance of conformal field theories, the AdS/CFT correspondence and the existence of various dualities (T, S and R dualities for example) will ultimately be core ingredients of any theory of quantum gravity.* Therefore I have undertaken self study of this subject and even attempted to draw connections between String Theory and LQG. At the same time I firmly believe that the insights gained from LQG, such as importance of viewing gravity as a theory of connections rather than a metric, the quantization of area and volume operators and the description of the LQG state space in terms of *spin networks* will also be essential ingredients of any ultimate theory of quantum gravity. The large volume of work coming from the Strings community on tensor networks and quantum information over the past decade only serves to support this perspective. In the future I intend to continue to pursue the various threads coming from these fields in an attempt to find reconciliation between the two.