Statement of Purpose
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Fascinated by the idea that the laws of nature are discovered by people, as a child I wanted to become a scientist. Upon growing up, my interest shifted to building simple robots that can help do everyday chores. The construction involved programming, electronics and assembling mechanical parts. Upon learning physics and doing questions from books like Irodov, I became interested in physics again. It was however only after coming to IISER, my second home, that I took seriously the idea of becoming a scientist.

Initially we're taught all the basic sciences plus pure math. I developed a taste for abstract mathematics during that time. My first subject for exploration was group theory and symmetry. I also looked at knot theory at the time and was surprised to learn its relation to quantum computation and elementary physics. I learnt eventually that while mathematics was fascinating in its own right, I missed physics, the connection to reality. That *my equations describe nature*, I realised was rather important for me.

I spent the following summer constructing an experiment whose objective was to study the dynamics of spins on a lattice. Having enough experience with robotics, this project wasn't all that challenging in terms of novelty and learning, even though it took a lot of effort. By the end of it, I was convinced that while constructing physics experiments, there's not too much focus on physics itself. I learnt that I really *wish to explore theoretical physics* in my future projects.

By this time, I had chosen physics as my major. Physics had never ceased to surprise me, but with solid state physics, fluid mechanics, quantum computation, quantum field theory (QFT) and gauge theories, the standard model & beyond, the excitement pinnacled.

In my major years, I spent the first summer exploring the simulation of quantum physics on a quantum computer. This was fascinating for I had independently discovered a small simulation protocol, that extended the pure state simulation to that of a mixed state. That for me, was the first novel construction of its type. However towards the end of it, I felt that I wasn't doing physics. I wanted to work on *finding new laws of nature.*

In the next summer, I was awarded the DAAD-WISE scholarship to work in Germany. While applying, I was confused between quantum gravity and quantum optics & foundations. I chose the latter for I felt it is experimentally more accessible, that our results could at least be verified within our lifetime. I was able to make some progress and construct a new extension of the Bell test[1]. In addition to this, I learnt about Bohmian Mechanics (BM) which is a deterministic theory that describes the same phenomena that Quantum Mechanics does. While I was not disappointed with my progress and had learnt about exciting research directions such as the No-Signalling principle/PR-box and information causality, I somehow *missed the richness of the remaining physics.*

For my master's thesis, I decided to explore BM, a theory in which observers play no fundamental role. This I felt might eventually make interpretation of 'quantum spacetime' more meaningful as a concept. For the thesis though, I'm focusing on a more specific problem, viz. seeing how BM could be consistent with contextuality; more precisely, I want to see how a theory deterministic in position & momentum (q,p) can be consistent with a quantum mechanics' test that says (q,p) must be contextual, if at all they're deterministic. This would show the relation between non-locality and contextuality in the continuous variable regime, which isn't yet properly understood and is of considerable interest. The larger goal is to see how spin like discrete degrees of freedom are fundamentally different from (q,p). Perhaps this would suggest an appropriate understanding of it's extension to QFTs and quantum gravity (QG).

While I haven't had any formal courses in QG, of the two popular approaches, Loop Quantum Gravity (LQG) and String theory, Louisina State University (LSU) is among the few places where both are explored. Perhaps naïvely so, but I am more inclined towards LQG. LSU not only has a core relativity group, which includes Prof. Parampreet Singh who is actively exploring LQG and cosmology, a strong connection with experimental gravity (LIGO) but also has a strong computational facility that catalyzes research in such directions of fundamental importance. With mavericks working in important and diverse fields, I believe, LSU will be an ideal place to pursue my interests; additionally, the course work in the initial years would be conducive to learning the bakcground for the research. A possible project topic could be to attempt applying these principles to cosmology, however, for my lack of knowledge about the area, a definite research problem can't be formulated at the moment. I hope however that my past work sufficiently supports my application to a PhD in this exciting field.

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[1]A. S. Arora, A. Asadian. *Proposal for a macroscopic test of local realism with phase-space measurements.* Phys. Rev. A **92**, 062107.