# Statement of Purpose

# Diksha Jain

Nature has its own secrets and unraveling them has always fascinated **the** human mind. Being able to describe almost everything from atoms to galaxies, motion of cars to planets, working of rockets to light bulbs [**comment**: the rocket and bulb analogy sounds naive] is something that propelled me towards **learning** physics. The craving for finding an explanation behind everything **has been growing** in me since childhood. I have spent many nights gazing at the sky and wondering how every star knew what **it** had to do, which path **it should** follow. I still remember the sense of accomplishment I felt when I first **learnt** about planetary motion in school and was able to find answers to many of **my childhood curiosities**.

This love for planets, stars and galaxies accompanied me to college. I chose to join **the** Indian Institute for Science Education and Research (IISER) for my undergraduate studies due to my developing interest in **the** basic sciences and also due to its well setup curriculum. **Of** the five years of dual degree program, the first two are spent in studying all the four major fields of the basic sciences (Physics, Chemistry, Biology and Mathematics) followed by **the freedom of maturely choosing a major**. Although from the very beginning I knew that it was physics that excited me the most, but I wanted to explore other fields also and IISER gave me good opportunity to do that.

**At IISER**, I pursued my interest in Astronomy and worked on radio astronomy in my first summer project. I studied the working principle behind the Giant Microwave Radio Telescope (GMRT) which is setup near Pune, India. In December of the same year I participated in **the** “Astronomy Nurture Camp” where I worked **as a team** with three fellow students on a small project. Our project was entitled “Constraining Dark energy parameters using Supernova Type 1A data”. We used the available **values** of Luminosity and compared it with the theoretical **values**, **which were** obtained using different cosmological models. I **particularly** enjoyed this experience, **for not only were we** working with real experimental data and testing different **models, but** also because I learnt basics of Cosmology and General Relativity (GR). I got answers to many questions that I **occupied me** as a child and **simultaneously**, **formulated** new ones.

**I spent the following summer (2014), developing** the mathematical background **necessary for comprehending** **GR**. Working with tensors seemed difficult at first but once I got used to it, I started appreciating the beauty of GR. I also read about black holes and **scratched the surface of** black hole thermodynamics from the book “Gravitation: Foundations and Frontiers” by Prof. T. Padmanabhan. In the end, **I was able to** **solve** **the** wave equation in **a** black hole background.

After choosing **Physics as my major**, I got introduced to the bizarre new world of Quantum Mechanics. It challenged the basic notion of how I perceived the world [**comment**: the remaining part of this sentence can be ommited] and is still the best non-relativistic theory **known**. **Quantum Computation, a fascinating topic, was offered as an elective course, which ultimately became the topic I explored in my next summers.** I worked on a **recently invented technique, “One way Quantum Computation”, designed as a possible implementation** **Universal** Quantum Computation. In the following semester, I chose Quantum Field Theory (QFT) as one of the elective. Although the mathematical structure seemed arduous at first, but given the accuracy of with which Quantum Electrodynamics, a QFT, predicts **basic** experimentally **observable** parameters, **I knew it was worth the struggle**. In one of the lecture our instructor**,** Prof. Sudipta Sarkar**,** mentioned the problems that arise when **attempts are made to quantize gravity**. It was then that I decided to work on this mysterious, long standing open problem.

In December 2014, IISER hosted a conference on "Field theoretical approach to quantum gravity" which was a boon for my growing interest in quantum gravity. However, being *relatively* new to the field, I was not able to follow certain arguments. **Determined** to learn more, **I requested our department, along with my other batchmates, to offer a follow up course to QFT, which came to be known** as "Radiative corrections and renormalization group in relativistic QFT". By that time I was **convinced** that I wanted to work in the field of quantum gravity but before choosing this purely theoretical **direction**, I wanted to explore experimental physics (which I had not explored **until then**). **Ambitiously**, I applied for a summer project on experimental quantum optics in one of the finest labs in Germany and was subsequently offered the DAAD-WISE fellowship to work with Prof. Juergen Eschner at University of Saarland. My project involved designing a filtering cavity for a single photon experiment. This experience was very crucial for me**;** it made **me** appreciate the effort and time experimentalists put in to prove an **apparently** simple theoretical result. **More importantly, I concluded that experiments are not my cup of tea; I am a theoretician at heart.**

Currently, in my MS thesis, I am working on a five dimensional gravity model called the "Randall- Sundrum model" [**incomplete?: suggestions:** written [or] defined] in **a** cosmological background. We are looking at the dynamical stability of branes in the presence of [**comment**: define FRW]FRW metric. We are able to find a potential which we hope will result in stabilization [**incomplete?:** of what?]. **Further details of the potential are under analysis**.

IISER is currently hosting "National String Meeting" and "International Conference on Gravitation and Cosmology"**. It** is a perfect time for me to explore various approaches to **Quantum Gravity (QG)**. I attended the introductory lecture on String Theory by Prof. Ashoke Sen. Since string theory tries to addresses the problem of unification, quantum gravity, dark energy etc. **in a single framework**, I found it very compelling **as a candidate for QG**.

~~Although I do not predict what course my interests will take in graduate school, I expect to work on quantum gravity.~~ I wish to explore various approaches that are being used to **address QG** and work on Black holes because they can offer **more insight into the said problem**. I think **that**, with a **rich** background in Physics and rigorous Mathematical training I received at IISER, I am well prepared for a PhD at the University of Chicago (UC). ~~Apart from having the requisite knowledge, I have the ability to work hard. I am pretty conﬁdent that my dedication and strong perseverance to achieve success will help me create a niche for myself in the area of my interest.~~ I intend to use my educational experience and **scientific supervision** to emerge as a competent researcher and contribute to the institute by teaching, if accepted. The diverse and vibrant research environment at UC would be, undoubtedly, the best place to begin my research career.