Personal Statement for QFFF

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My fascination with theoretical physics comes from abstracting mathematical structures that describe the universe. Algebra in particular allowed me to explore ideas like generalising structures, recognising patterns or invariants, and classifying objects axiomatically which are the generalisation of the recurring themes like prime factorisation, Jordan canonical forms, the Jordan–Hölder theorem, root systems of Lie algebras etc. These connections showed me how symmetries and dualities emerge from isomorphisms and structure classification. I realised that investigating these could be key to understanding the laws of nature, which is why I am keen to pursue a career in high-energy theoretical physics.

In the summer after my 1st year, I did a UROP with Prof. F. H. Berkshire on the brachistochrone curve for a tunnel through Earth, where I proposed applying the concept of "discomfort" as integrated acceleration squared over time. This gave me my first taste of real research and the challenge of tackling problems with no established answers. In my 2nd year, I self-studied topics like linear algebra, GR, group theory, and QFT, and later convinced Prof. Hee-Cheol Kim to lead a CFT study group. Presenting weekly on topics such as the Virasoro algebra, dualities between conformal blocks taught me to explain complex ideas clearly and gave me the confidence to present at the Warwick Imperial Mathematics Conference.

For my BSc project in 3rd year, I worked with Prof. Amihay Hanany on quiver gauge theory, computing Hilbert series to study moduli spaces. We used techniques like the monopole formula and the Molien-Weyl integral, and I had to learn ring theory, classification of semisimple Lie algebras, supersymmetry, and brane systems. It was overwhelming at first, but I enjoyed the challenge and the satisfaction of applying dualities and symmetries to computation. This experience showed me how much I thrive when learning difficult concepts independently and applying them to problems.

The most unforgettable experiences during my studies are when discovering patterns and generalising ideas. For example, when studying harmonic oscillators, I noticed the proportionality of the ladder operators and the commutator of the ladder and number operator and then proved this algebraic structure is defining property of general ladder operators which later turned out to be useful ubiquitously such as root systems. Similar moments, like deriving the Clebsch–Gordan coefficients, the gamma factor in special relativity etc, are what keep me hooked on physics — they are my "indirect eureka moments".

The QFFF course is perfect for me because of its strong emphasis on high-energy physics and summer research opportunities to work closely with experts in the field. I am excited to deepen my understanding. With my background, research experience, and curiosity, I believe I am well-prepared to take on the challenges of the course and grow as a theoretical physicist.