

CDT Placement Personal Profile

Alan-Francis Kirby
Swansea University
Lattice Quantum Chromodynamics

Project Title

Exploring QCD under extreme conditions

Research Area

My area of research is within the domain of theoretical particle physics and more specifically focusing on one of the four fundamental forces known as the strong force which holds atoms together. The theory which describes this force is called Quantum Chromodynamics (QCD). In order to understand the force entirely we must understand how it behaves under different conditions, which we can then somewhat visually summarize using what is known as a phase diagram.

Most studies explore only a small region of the phase diagram where the force is acting in an environment which is at zero temperature. My research focuses on how the force behaves when in an environment of high temperature, such as that which was present at the beginning of the universe.

Furthermore many studies use a calculational tool called perturbation theory which essentially provides a good approximation. I'm using a different calculation tool called lattice gauge theory which offers an exact result rather than an approximation. In this way we can free ourselves of many results which are not physical but rather a consequence of our approximation. With that said, lattice gauge theory is itself very complicated and when we're not careful we can still fall victim to nonsense results.

One of the issues within lattice gauge theory is the presence of noise within our measurements. This is where a tool known as Wilson flow is put into use, which then enables us to perform our exact calculations with greater ease and higher confidence due to the reduced influence of the noise. Wilson flow is what I'm currently using in order to answer various research questions in high temperature QCD.

About Me

I enjoy personal development in general and trying to keep a balanced life. I enjoy working out at the gym and running, reading non-physics educational books including those written by business people or about general productivity skills such as speed writing (I'm weird like that). I often find that I work best when I understand the wider context of what I'm working on as it helps me to orientate myself and focus better.

Data Intensive Research Skills and Interests

I've received training in;

- Data analysis i.e. Bayesian model testing etc
- Data visualization i.e. big data visualization
- High performance computing - CPU based
- Machine learning