

**ASPIRE League Partnership Seed Fund
2nd (2020) Round - Project 4
Research Project Summary**

Q1. Title of Research Project

Lattice simulation for axion dark matter abundance from cosmic string

Q2. Timeframe

Project Start: 01/09/20

Project Completion: 28/02/22

Q3. Project Synopsis

Recent cosmological observations revealed that the energy density of our Universe is dominated by unknown matters called dark matter/energy. While underlying physics of all known particles of our Universe are successfully described by the Standard Model which has been firmly tested, there is no candidate for the dark matter in the Standard Model. Dark matter is a key-ingredient toward the complete understanding of our Universe.

Axion as dark matter has been increasingly attractive, although it was originally introduced in some extensions of the Standard Model to resolve a mysterious fine-tuning in quantum chromodynamics. Whether axion can be dark matter or not requires precise estimate of its present abundance. Cosmic strings, topological line objects formed in the early Universe, are of particular interest as the source of axions. Despite the recent progresses, the box size of the latest lattice simulations is still far smaller than the realistic case by more than 20 digits. One has to rely on more than 20 digits extrapolation in time scale, and it leads to large uncertainties. This calls for a paradigm-shifting-idea in numerical simulations as the improvement by 20 digits will be difficult with existing techniques.

We explore a drastically new idea with an adaptive size mesh. We expect it to cover much bigger dynamics range than what one has ever imagined to be possible. We will address many previously challenging issues through the long-term collaboration with our new technique.

