**Optimizing Hydrodynamic Simulations of Quantum Fluids**

CSCI 4576/5576 Project Proposal

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**Introduction**

The lattice Boltzmann method, first popularized by its success in mainstream computational fluid dynamics, has received interest in recent years as a method for simulating strongly-interacting quantum fluids. The proposed project

**Problem**

The naïve implementation of the lattice Boltzmann method which has been previously implemented is overly restrictive on the simulation sizes we are able to achieve with available resources, due at least in part to lack of parallelism and inefficient memory handling. We propose to remedy these problems by implementing following methods:

1. **Single-Core Optimization** by vectorizing computations and adopt blocking wherever possible and reevaluating data structures to improve memory-usage.
2. **OpenMP** implementation for parallelizing data independent sections of the single-core optimized code.
3. **MPI** implementation for running OpenMP implemented functions in parallel and intercommunication.
4. **HDF5** application to improve data processing and visualization by porting IO to

**Simple explanation of the problem you want to solve, what techniques and methods you plan to implement. What input data you plan to use and what kind of output data you intend to produce.**

**Analysis**

Performance improvement will be gauged by running the code on INTEL Phi, and doing benchmarking as well as detailed profiling at the beginning of the project and after each of the above proposed implementations. Profiling will include MFLOPS, time taken per function and total execution time, and will be done using PerfSuite and Tau.