Research Statement

Weiyao Ke
Email: wk42@phy.duke.edu
Advisor: Steffen A. Bass
Duke University, Durham NC

1 Introduction

My current research interest is the development of a tunable Monte-Carlo model that accurately reflects perturbative calculation, targeting the examination of theory assumptions using future precision measurement.

2 Project description

The understanding of jet and heavy-flavors in heavy-ion collisions requires good uncertainty control on both experimental and theory sides. With measurements gaining precision, a reduction of prediction uncertainty is necessary. The current situation is that theory calculations are often performed in idealized scenarios while phenomenology jet Monte-Carlo models, though include important qualitative features such as the Landau-Pomeranchunk-Midgal effect in different ways, lack quantitative comparison with known theory calculations. This gap between the theory and Monte-Carlo tools can obscure the interpretation and understanding of the data.

This problem needs to be solved by designing a jet Monte-Carlo that quantitative agrees with theory calculations in idealized limits and then apply to jets in heavy-ion collisions. I have made such an attempt in a recent paper []. The Monte-Carlo simulated radiative energy loss and especially the radiation spectrum agrees with leading order calculation within $\pm 20\%$. This is very promising and it means that we can make leading order calculations in event-by-event evolving medium with a quantification of uncertainty. Of course, this is only a first step towards precision prediction. Other effects such as the interplay between the vacuum and the medium induced shower and possibly higher order corrections should also be implemented in a Monte-Carlo simulation to help understand the full picture of jets in heavy-ion collision. Eventually, the predictions will be made by coupling the jet Monte-Carlo to a state-of-the-art medium evolution model which I have been familiarized with during my graduated study.

3 Future plan

To push this effort, we will certainly benefit from a close connection with the jet theory community to discuss how to implement the jet physics more accurately in a Monte Carlo model and what novel effects can be studied in such a way. I have summarized my responsibility as follows,

- Study jet theory and familiarize with novel observables.
- Improve the leading order implementation as it is the baseline for studying new effects.
- Try to interface vacuum and medium induced shower.
- Benchmark the model predictions with uncertainties.