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Keywords: **Quantum Mechanics, Quantum Information Theory, Machine Learning, C++, CUDA, Rust, Git, CMake, Docker**

Visa Status: **H1B** (cap) kicks in on 10/01/2024. Sponsored by **JASR** systems with anticipated start date 10/01/2024, for the role of ML Research Engineer.

Experience

- Postdoctoral Research Scholar in EE, UC San Diego, 04/22 - Present
- Collaborated informally with Prof. Bharadia's group, 10/21 - 04/22
- Preparation for career in ML and software development 03/20 - 09/21
- Postdoctoral Research Associate in Physics, UIUC, 09/19 - 03/20

Education

- PhD in Physics, **MIT, Cambridge, MA** 07/13 - 08/19
- BTech in Engineering Physics, **IIT Delhi** 08/09 - 06/13

Press Coverage

- Wireless anomaly characterization research covered in press

Awards

- Institute Silver Medal, 44th convocation of IIT Delhi for Academic Performance

Completed Projects

- **Wireless anomaly characterization using Machine Learning**
  - Combined Transformers and 1D CNNs with soft triplet loss
    - for improved model robustness and
    - explainable performance

    in order to classify anomalous over the air wireless signals.
  - Delivered a model with **85%** classification accuracy on unseen data.

- **Polyphase filter bank implementation on GPU**
  - Implemented a high-performance polyphase channelizer in CUDA C++, optimizing direct GPU core utilization, complete with bindings to the Rust programming language.
  - Attained a throughput of **763** Megasamples per second on a single GPU device.
  - For comparison, typical software implementations on GPU Matlab provide a throughput of 500 Megasamples per second on a single GPU core.
  - Code resides in the **rustypfb repository** in my github profile.

- **Strip spectral correlation analyzer implementation on GPU**
  - Developed a high-performance version of the strip spectral correlation analyzer in CUDA C++, enabling real-time estimation of the cyclostationary spectral correlation function, complete with bindings to Rust,

- Realized a throughput of **40** Megasamples per second on a single GPU core, scaling to achieve cyclostationary estimates at the rate of 100 Megasamples per second with just three GPUs, which is the maximum input sampling rate of software defined radios used in the project.
- Code resides in the **rustycyclo repository** in my github profile.

- **Effective Actions for Anomalous Hydrodynamics**
  - Construction of hydrodynamic effective actions is useful among other things, to study the quantization of vortices, and also potentially in the study of the onset of turbulence.
  - Prior to this project, parity breaking hydrodynamics with anomalous global charges had **non-local** effective actions in the literature which made computations difficult.
  - I constructed for the first time the effective action for anomalous hydrodynamics that is purely **local**, thereby opening the door for better understanding of the off-shell dynamics of parity breaking fluids.

- **Generalized Perturbation Theory**
  - Constructed a new perturbative expansion for the logarithm of unbounded operators.
  - The novelty of this expansion is that it was arranged in terms of modular/time evolution with the unperturbed operators (inspired by the interaction picture of quantum theory), with care taken for the finiteness of each term in the expansion in the strong operator topology.
  - Uncovered novel commutator structures in the expansion.

- **Modular flow of excited states**
  - Quantities relevant to quantum information theory like relative entropy, in continuum systems, are computed in terms of so-called modular operators and modular automorphisms/modular flows.
  - Before this work, modular flows were known explicitly only for specific geometries and quantum states in the literature.
  - I constructed modular flows in quantum field theories (QFTs) for excited states for the very first time.

Publications

- Blind Signal Characterization: Transformers, Triplet Losses and Beyond. R.Mathuria, S. Rajagopal, D. Bharadia *, IEEE Dyspan, 2024 Washington D.C.*
- Fourier meets Gardner: Robust Blind Waveform Characterization, R. Mathuria, S. Rajagopal, D. Bharadia *IEEE Dyspan, 2024 Washington D.C.*
- Multirate signal processing for software radio architectures, F Harris, E Venosa, X Chen, R Bell, S Rajagopal, R Mathuria, D Bharadia, *Signal Processing and ML Theory, 403-494*
- Perturbation Theory for the logarithm of a positive operator**,** N. Lashkari, H. Liu and S.Rajagopal, *JHEP 2023, 97 (2023)*
- Modular Flow of Excited States, N. Lashkari, H. Liu, S. Rajagopal, *JHEP 2021, 166 (2021)*
- Global Anomalies, Discrete Symmetries and Hydrodynamic Effective Actions, P. Glorioso, H. Liu, S. Rajagopal, *JHEP 2019, 43 (2019)*
- Holographic Trace Anomaly and Local Renormalization Group, S. Rajagopal, A. Stergiou and Y. Zhu, *JHEP 2015, 216(2015)*