PRANAV SAMPATHKUMAR

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RESEARCH INTERESTS

- High Energy Physics and Cosmology with emphasis on numerical computations and interpretable machine learning.
- Model independent analysis of data, and systematic deviations in data using anomaly detection techniques.

EMPLOYMENT

Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany ***Jan 2021 - Present***
Doctoral researcher at CORSIKA on a third party funded project (BMBF)

Tata Institute of Fundamental Research (TIFR), Mumbai, India ***Jan 2020 - Mar 2020***
Visiting Researcher at Department of Theoretical Physics

EDUCATION

Tata Institute of Fundamental Research (TIFR), Mumbai, India ***Aug 2016 - Sep 2019***
M.Sc, Physics (Department of Theoretical Physics)
CPI: 73.2/100

SASTRA University, Thanjavur, India ***Jul 2011 - Jun 2016***
M.Tech (int), Advanced Manufacturing (Mechanical Engineering)
CGPA: 7.4/10

ONGOING RESEARCH PROJECTS

- **Using generative neural networks for efficient EAS Simulations in CORSIKA8**
  KIT, Karlsruhe ***Jan 2021 - Present***
  The work involves developing a generative neural network model which can help us accelerate simulation by directly generating the final distributions, bypassing certain computationally intensive phases in the simulation. Initial protyping is done with PyTorch.
- **Efficient multi-threading in CORSIKA8**
  KIT, Karlsruhe ***Aug 2021 - Present***
  The work involves developing threadsafe memory efficient data structures to facilitate better multi-threading in CORSIKA8. The project involves implementing these in `c++`.

PAST RESEARCH PROJECTS

(Part of Master's Thesis, defended on 24/09/2019)

- **Cross correlation between GL and SZ maps to constraint cosmological parameters**
  Supervisor: Prof. Subhabrata Majumdar
  TIFR, Mumbai ***Aug 2018 - Mar 2020***
  The work involves using the independently generated tSZ maps from the other ongoing project to cross correlate with weak-lensing maps from various sky surveys like KiDs and RCSLens to impose constraints on cosmology and halo astrophysics. The project involves building k-D trees for fast computation of correlation function and gain an understanding of Halo models.

- **Using neural networks to cluster the CMB Sky Maps based on foreground contamination**
  Along with: Prof. Rishi Khatri
  TIFR, Mumbai ***Dec 2018 - Mar 2020***
  This work involves trying to create tSZ maps from Planck data, by using unsupervised machine learning techniques. The work involved building neural networks and machine learning frameworks using various libraries and gain an understanding of using component seperation methods such as GILC to seperate the signal from the foregrounds.

(During Visitorship at TIFR)

- **Studying turbulence in inter-galactic medium**
  Along with: Prof. Rishi Khatri
  TIFR, Mumbai ***Jan 2020 - Mar 2020***
  This work involves trying to create tSZ maps from Planck data, by using unsupervised machine learning techniques in a localised region of the sky around galactic clusters such as COMA and VIRGO. We then use this to study turbulence in Inter Cluster Medium by looking at fluctuations in tSZ maps.

- **X-Ray - Galaxy cross-correlation and Halo models**
  Along with: Prof. Subhabrata Majumdar
  TIFR, Mumbai ***Jan 2020 - Mar 2020***
  This work involves find the halo-gas and AGN contribution to X-ray sky and it's cross-correlation with the distribution of galactic halos using the ROAST All-Sky survey along with Yang's catalogue.

- **Estimation of the mass gap in modified SYK hamiltonians**
  Supervisor: Prof. Gautam Mandal
  TIFR, Mumbai ***Aug 2018 - Jan 2019***
  Worked on numerically estimating the massgap in Modified SYK hamiltonians. The work involved understanding the conformal limit in the SYK model and analytically computing the massgap in the conformal limit and numerically trying to compute the eigenvalues of large dimensional matrices to get as close to the conformal limit as possible.

- **Quark gluon discrimination using deep neural networks**
  Supervisor: Prof. Tuhin S Roy
  TIFR, Mumbai ***Aug 2017 - Jan 2018***
  Worked on building a convolutional neural network classifier to classify the quark jets from the gluon jets in particle accelerators. The work involved understanding the basics of neural networks and machine learning, build it using TensorFlow, make simulations of particle accelerators using Pythia, jet clustering using FastJet and understanding certain physics observables to classify jets.

- **Rigidity percolation in wet granular systems**
  Supervisor: Prof. Purusattam Ray
  Institute of Mathematical Sciences (IMSc), Chennai ***Jun 2015 - Aug 2015***
  Jan 2016 - May 2016

  Worked on understanding rigidity transition by using percolation theory and modelling it similar to jamming transition in granular systems.

CONFERENCES & WORKSHOPS

- Cosmology - The Next Decade (School) ***Jan 2019***
  International Centre for Theoretical Sciences (ICTS) , Bangalore
- Nvidea Hands-on Workshop on GPU Programming, ***Dec 2018***
  TIFR, Mumbai
- Mumbai Pune Collider Meet ***Oct 2017***
  Indian Institute of Technology (IIT) Bombay, Mumbai

TALKS & TEACHING

- **Neural Networks and Deep learning for Particle Physicists** (Talk) ***Oct 2017***
  Mumbai Pune Collider Meet, IIT Bombay, Mumbai
  A talk introducing neural networks to particle physicists in the Mumbai-Pune area.
- **Teaching Assistant for Classical Mechanics (P-103)** ***Aug 2018 - Dec 2018***
  TIFR, Mumbai
  Grading assignments and conducting tutorials for first year Physics master's students at TIFR
- **A series on "Physics for undergrad engineers"**(Series of talks) ***Aug 2014 - Mar 2015***
  Celeritas (Physics Forum), SASTRA University, Thanjavur
- **Organizing "Open-days" in TIFR**
  Teaching school children around Mumbai area about ongoing research projects in TIFR with lecture demonstrations

TECHNICAL SKILLS

Programming Languages	C, C++, Python, Bash Script
Softwares	Mathematica
Cpp-Libraries	ROOT, Pythia, FastJet, CUDA, OpenACC(Directives), OpenMPI
Python-Libraries	PyTorch, TensorFlow, Scikit-Learn, HealPy, Matplotlib, NumPy

AWARDS AND SCHOLARSHIPS

- Visitor Fellowship at TIFR ***Jan 2020 - Mar 2020***
- Research Scholar fellowship at TIFR ***Aug 2016 - Sep 2019***
- Summer fellowship at IMSc ***Jun 2015 - Aug 2015***

EXTRA-CURRICULAR

- Courses audited at TIFR: General Relativity, String Theory, Fluid Dynamics, Cosmology, Machine Learning
- Represented SASTRA University in **SAE BAJA 2012 & 2013**
- Writing - penning poetry and stories for TIFR magazine *Cresendo*