

# Nikhil Tilak, Ph.D.

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## SUMMARY

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Postdoc in Physics with 8+ years of research experience. Expert at device fabrication using e-beam lithography and characterization via tunneling and transport measurements. Highly skilled at analyzing data and summarizing findings. Experienced in numerical and machine learning techniques using Python and always working to expand my skill set. Open to process/yield engineering roles in the semiconductor industry as well as data scientist positions.

## PROFESSIONAL EXPERIENCE

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**Postdoctoral Associate, Rutgers University, New Jersey, USA.**

**07/2023 - present**

My research focuses on correlated phases in two-dimensional heterostructures and moire materials.

**Physics Faculty, Bakliwal Tutorials, Pune, India.**

**06/2014 - 05/2015**

Taught calculus-based physics for the highly selective Indian institutes of technology joint entrance exam (IIT-JEE). 1200+ hours of teaching experience to over 550 high school juniors and seniors.

## EDUCATION

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**Ph.D. in Physics, Rutgers University, New Jersey, USA.**

**09/2015 - 06/2023**

**B.Tech. in Engineering Physics, I.I.T. Guwahati, Assam, India.**

**08/2010 - 05/2014**

## RESEARCH PROJECTS

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**Structure and electronic properties of marginally twisted MoS<sub>2</sub>.**

Studied lattice-relaxation, moire potentials and interfacial ferroelectricity in marginally twisted MoS<sub>2</sub> bilayers using scanning tunneling microscopy (STM) and piezoresponse force microscopy (PFM).

**Carrier confinement in magic-angle twisted bilayer graphene.**

Investigated the effects of substrate potential disorder on magic-angle twisted bilayer graphene using STM/STS.

**Proximity-induced charge density wave in graphene/1T-TaS<sub>2</sub>.**

Investigated the incommensurate and commensurate CDW phases in 1T-TaS<sub>2</sub>. Used graphene as a cover to protect TaS<sub>2</sub> surface from degradation.

**Design and construction of a low temperature scanning tunneling microscope.**

Designed and constructed a dip-stick style STM and a scanner head capable of operating from 300 K to 4.2 K. System was optimized to reduce heat-load to reduce cryogen consumption.

**Effect of strain on CVD graphene microdrums.**

Optimized the growth of monolayer graphene on copper foils. Transferred the graphene to holey silicon nitride substrates to make suspended graphene devices for strain measurements.

## DATA PROJECTS

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**Bookend : predict author from text snippet**

[repo](#), [video](#)

Trained an ensemble classifier model on books scraped from project Gutenberg to predict the authorship of a snippet of text with 93% accuracy.

Led a team of four and was responsible for dividing tasks and establishing a GitHub-based workflow to maximize productivity. Implemented a bag-of-words model which gave the highest prediction accuracy score (85%) among the models in the ensemble.

**Project placed first** in the final project competition of Erdos data bootcamp 2020.

## Sudoku-Solver: solve a Sudoku puzzle given its picture

[repo](#), [webapp](#)

Wrote a custom pipeline which processes the image, identifies the filled digits and produces a solution.  
Deployed a Docker containerized Dash/Plotly app to Google Cloud (GCP).

## BreweryXplorer: explore 3000+ breweries in the US

[repo](#), [webapp](#)

Scraped and cleaned unstructured brewery data from Wikipedia and other open sources.  
Designed an interactive Dashboard using Dash/Plotly which was deployed to Heroku.

## IMDB Movie review sentiment analysis

[Kaggle kernel](#)

Used a word2vec model trained on movie reviews to generate semantic word embeddings.  
Trained a neural network to predict if a given movie review is “positive” or “negative”.

## SKILLS

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**Device fabrication:** Expertise in making van der Waals heterostructures. Electrical contact fabrication using e-beam lithography and photolithography, thermal metal deposition, reactive ion etching, wet etching etc. Experienced in working with air-sensitive materials inside an inert gas filled glovebox.

**Characterization techniques:** Scanning tunneling microscopy (STM), scanning probe microscopy (AFM, KPFM, EFM, PFM, force-distance spectroscopy), electronic transport, Raman spectroscopy, optical microscopy.

**Vacuum and cryogenic techniques:** Expert at design, construction and maintenance of ultra/high vacuum chambers and cryogenic temperature measurement apparatus. Highly experienced in helium leak detection.

**Mechanical and electronics:** Soldering, Brazing, CAD, Machining (Drilling, Lathe, Milling), Arduino based circuits.

**Data analysis and programming:**

**Languages & platforms:** Python, C, SQL, HTML, CSS, Git/Github.

**Python packages:** NumPy, SciPy, Pandas, Scikit-Learn, OpenCV, NLTK, TensorFlow.

**Machine learning:** Linear/Logistic regression, KNN, SVM, PCA, Random Forests, XGBoost, NLP.

## SELECTED PUBLICATIONS ([google scholar](#))

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<sup>1</sup>N. Tilak, M. A. Altwater, S.-H. Hung, C.-J. Won, T. Kaleem, G. Li, S.-W. Cheong, C.-H. Chung, H.-T. Jeng, and E. Y. Andrei, “Revealing the charge density wave proximity effect in graphene 1t-TaS<sub>2</sub>”, (under review at Nature materials) (2023).

<sup>2</sup>N. Tilak, G. Li, T. Taniguchi, K. Watanabe, and E. Y. Andrei, “Moiré potential, lattice relaxation, and layer polarization in marginally twisted MoS<sub>2</sub> bilayers”, Nano Letters (2022).

<sup>3</sup>N. Tilak, X. Lai, S. Wu, Z. Zhang, M. Xu, R. d. A. Ribeiro, P. C. Canfield, and E. Y. Andrei, “Flat band carrier confinement in magic-angle twisted bilayer graphene”, Nature communications **12**, 4180 (2021).

<sup>4</sup>M. A. Altwater, N. Tilak, S. Rao, G. Li, C.-J. Won, S.-W. Cheong, and E. Y. Andrei, “Observation of a topological defect lattice in the charge density wave of 1t-tas<sub>2</sub>”, Applied Physics Letters **119**, 121601 (2021).

<sup>5</sup>R. S. Bisht, J. Park, H. Yu, C. Wu, N. Tilak, S. Rangan, T. J. Park, Y. Yuan, S. Das, U. Goteti, H. T. Yi, H. Hijazi, A. Al-Mahboob, J. T. Sadowski, H. Zhou, S. Oh, E. Y. Andrei, M. T. Allen, D. Kuzum, A. Frano, R. C. Dynes, and S. Ramanathan, “Spatial interactions in hydrogenated perovskite nickelate synaptic networks”, Nano Letters (2023).

<sup>6</sup>R. K. Biroju, N. Tilak, G. Rajender, S. Dhara, and P. Giri, “Catalyst free growth of zno nanowires on graphene and graphene oxide and its enhanced photoluminescence and photoresponse”, Nanotechnology **26**, 145601 (2015).

## CONFERENCE TALKS AND POSTERS

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STM studies of marginally twisted MoS<sub>2</sub> bilayers [poster]

Rutgers Center for Materials Theory symposium, 2022

Moiré bands in twisted MoS<sub>2</sub> homobilayers [talk]

APS March Meeting 2022, Chicago

Observation of charging peaks near the flat band in magic-angle twisted bilayer Graphene [talk] APS March Meeting 2021, Virtual

A method for controllably inducing ultra-high strain in suspended 2D materials [talk] APS March Meeting 2018, Los Angeles

## RECENT HONORS

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### **David C. Langreth Graduate Development Award**

**2017**

“Presented annually to an especially promising early-stage graduate student by the Department of Physics and Astronomy at Rutgers”

### **MITACS Globalink Research Internship**

**Summer 2013**

Was selected for a competitive 12-week research internship at the *Institut national de la recherche scientifique*, Varennes, Quebec, Canada.

## REVIEWER FOR

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ACS Nano, ACS Nano Letters, NPJ Quantum materials

## TEACHING EXPERIENCE

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### **Teaching Assistant, Rutgers University, NJ, USA.**

**Fall 2015 - Spring 2018**

TA for extended analytical physics (115), analytical physics (123 & 124), intro solid state physics (406), graduate quantum mechanics 1 (501), electromagnetism (385) and classical physics lab (276).

## LEADERSHIP AND MENTORSHIP

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Directly mentored five undergraduate students leading to successful transitions to graduate school and industry.

Student representative on the graduate studies and life committee (AY 2018-19)

Vice President of the Physics and Astronomy Graduate Student Organization. (AY 2016-17)