

# Shishir Adhikari

PHD CANDIDATE, PHYSICS, CASE WESTERN RESERVE UNIVERSITY

Department of Physics  
Case Western Reserve University  
Cleveland, USA  
[sra42@case.edu](mailto:sra42@case.edu) | [adhikarisr@my.hiram.edu](mailto:adhikarisr@my.hiram.edu)  
Webpage : [arshishir.github.io](http://arshishir.github.io)  
LinkedIn : [linkedin.com/in/arshishir](https://www.linkedin.com/in/arshishir)  
801-921-2313

EDUCATION	PhD, Physics Case Western Reserve University Area: Biophysics Advisor: Prof. Michael Hinczewski	Aug' 13 - Aug' 19 (Expected)
	MS, Physics Entrepreneurship Case Western Reserve University Thesis: PLEXAR IMAGING: A Startup Determined To Solve Dose Variability Problem	Aug' 11 - Jul' 13
	BA, Physics, Minor: Computer Science, Mathematics magna cum laude Hiram College	Aug' 07 - Jul' 11

RESEARCH INTERESTS	Non-equilibrium Statistical Mechanics, Biophysics, Machine learning
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PUBLICATIONS	Shishir Adhikari, Jacob Moran, Christopher Weddle, Michael Hinczewski, "Unraveling the mechanism of the cadherin-catenin-actin catch bond" <i>PLoS Comput. Biol.</i> 14, e1006399 (2018)
	Mark P. Taylor, Yuting Ye, Shishir R. Adhikari, "Conformation of a flexible polymer in explicit solvent: Accurate solvation potentials for Lennard-Jones chains" <i>J. Chem. Phys.</i> 143, 204901 (2015)
	Mark P. Taylor, Shishir R. Adhikari, "Conformation of a flexible chain in explicit solvent: Exact solvation potentials for short Lennard-Jones chains" <i>J. Chem. Phys.</i> 135, 044903 (2011)

AWARDS & ACHIEVEMENTS	Phi Beta Kappa (2011) Magna Cum Laude (2011) Applied Physics Departmental Honors (2011) Global Trustee Scholarship (2007- 2011) Ranney Webster Grant for Physics Research (Summer 2008) Mahatma Gandhi Scholarship (2003-2005)
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RESEARCH PROJECTS	<b>Physics of Machine Learning</b> <i>Supervisors: Prof. Michael Hinczewski &amp; Prof. Alkan Kabakcioglu</i> Aug '18 - Present <b>Questions:</b> <ul style="list-style-type: none"><li>- Is it possible to map machine learning to stochastic mechanics problem?</li><li>- What kind of mathematical formulation do we need to do so?</li><li>- How does the probability distribution of weights evolve?</li></ul> <b>Progress:</b> <ul style="list-style-type: none"><li>- In the process of writing a paper and submitting to a peer-reviewed journal.</li></ul>
	<b>Heterogeneity</b> <i>Supervisor: Prof. Michael Hinczewski &amp; Colleague: Tenglong Wang</i> May '17 - Present

One of the most intriguing results of single molecule experiments on proteins and nucleic acids is the discovery of functional heterogeneity: the observation that complex cellular machines exhibit multiple, biologically active conformations (states).

**Questions:**

- Given the experimental data, is it possible to figure out the number of states?

**Progress:**

- Using Deep Neural Network, we have been able to figure out number of states in a simple fake systems.
- We are also trying to use Bayesian nonparameteric model like infinite Hidden Markov Model(iHMM) as another method to solve this problem.

### **Modeling Triphasic Bonds**

*Supervisor: Prof. Michael Hinczewski & Colleague: Shamreen Iram* *May '16 - Present*

Under the application of force, the bond lifetime of E-selectin-PSGL-1 behaves as slip-catch-slip. This behavior is termed as triphasic bond.

**Questions:**

- Is it possible to develop a physical model of triphasic bond?

**Progress:**

- We have such a model and we are in a process of fitting experimental data to that model.

### **Modeling Catch Slip bond on Notch-Jag/DLL**

*Supervisor: Prof. Michael Hinczewski & Colleague: Marcus Lapeyrolerie* *May '16 - Present*

In *PLoS Comput. Biol.* 14, e1006399 (2018), we came with a physical model for catch bond. We asked the following question:

**Questions:**

- Is it possible to modify aforementioned work's model to understand catch & slip bond on Notch-Jag/DLL?

**Progress:**

- We found it possible to do so. We are in the process of validating our calculation by fitting the model to the experimental data.

### **Energetic Mechanism Behind Regulation of Catch Bonds Under Time Varying Force**

*Supervisor: Prof. Michael Hinczewski* *Jul '14 - Present*

**Questions:**

- Is it possible to model the regulation of catch bonds under time varying force? - What physics principle can we learn from the model?

**Progress:**

- We have found such a model and physical principle behind it.
- In the process of writing a paper.

### **Persistence Length of Virus**

*Supervisor: Prof. Michael Hinczewski* *May '14 - Aug '14*

Plant based viruses can be used as drug vector of cancer medication. Our job was to figure out stiffness of different plant based viruses.

**Questions:**

- Given TEM images, is it possible to figure out persistence length of viruses?

**Progress:**

- We used ImageJ to collect extract end-to-end distance of viruses.
- By assuming viruses as worm-like chain polymer, we calculated the persistence length of viruses.

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CONFERENCES & Attended Ohio Section of the APS meeting (2008 & 2009)  
TALKS

Poster presentation at Ohio Wesleyan University OSAPS meeting on "Conformation of Lennard Jones chain in explicit solvent: A solvation potential approach" (2010)

Poster presentation at **Hiram College** on “**Conformation of Lennard Jones chain in explicit solvent: A solvation potential approach**” (2009 & 2010)

Talk on “**Computer Threats and Security Measures**” as a Guest speaker at **Hiram College** (2010)

Poster Presentation at **The Ohio Statehouse Atrium** organized by **The Ohio Foundation of Independent Colleges** on “**Conformation of a Polymer Chain in Solvent: Mapping a Many Body onto a Few Body Problem**” (2011)

Poster Presentation at **APS March Meeting** “**Conformation of Lennard Jones chain in explicit solvent: A solvation potential approach**” (2011)

Poster Presentation at **Single Molecule Biophysics Conference** at **Aspen Physics Center** “**Unraveling the Energetic Mechanism of the Cadherin-Catenin/Actin Catch bond**” (2017)

Poster Presentation at **Gordon Research Conference** “**Unraveling the Energetic Mechanism of the Cadherin-Catenin/Actin Catch bond**” (2017)

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## COURSES

**Mathematics:** Calculus, Linear Algebra, Differential Equation, Statistics, Chaos Theory, Stochastic Processes

**Physics:** Classical Mechanics, Quantum Mechanics I & II, Electrodynamics, Statistical Mechanics, Magnetic Resonance Imaging, General Relativity

**Computer Science:** Compiler Design, Database Design, Computer Ethics, Introduction to Java

**Coursera (*Audited*):** Machine Learning by Andrew Ng, Deep Learning Specialization(Neural Networks and Deep Learning, Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization, Structuring Machine Learning Projects, Convolutional Neural Networks)

**Edx:** Quantum Mechanics and Quantum Computing (*BerkeleyX Completed*)

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## STUDENTS

**Supervised in undergraduate research:** Jacob Moran (CWRU), Marcus Lapeyrolerie(CalTech)  
**Mentored in high school project:** Nicholas Kernan

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## COMPUTER SKILLS

**Languages:** C, Python, Julia, L<sup>A</sup>T<sub>E</sub>X, PHP, SQL

**Scientific Software:** Maple, Kaliedagraph, Origin, Mathematica

**Research Tools:** Chimera, PyMol, High Performance Computing

**Simulation Techniques:** Monte Carlo, Brownian Dynamics, Kinetic Monte Carlo

**Image Processing:** Photoshop, InkScape, ImageJ, GIMP

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## EXTRA INTERESTS

**Hobbies:** Photography, Rock climbing, Hiking