September 28, 2015
For Immediate Release

The Origins Project Announces $50,000 Awarded to Outstanding ASU Undergraduates and Faculty Mentors

Tempe, AZ - The Origins Project is pleased to announce the winners of the inaugural Undergraduate Research Scholarship. These scholarship funds for joint research projects between ASU undergraduates and their faculty mentors consist of a $5,000 research fund for both the student and their mentor, for a total of $10,000 awarded per project.

Winners of the $10,000 research project funding include Astrophysics student Michael Busch and mentor Judd Bowman, Economics and Biochemistry student Alexi Choueiri and mentor Jason Newbern, Physics and Mathematics student Aditya Dhumuntarao and mentor Maulik Parikh, Anthropology and Geological Sciences student Alexandra Norwood and mentor Michael Smith, and Biomedical Engineering student Nitish Peela and mentor Mehdi Nikkhah.

“The Origins Project is providing a wonderful opportunity to support aspiring scientists with undergraduate research funding,” said one of the student winners Alexi Choueiri. “My faculty mentor and I are very grateful and excited to pursue our research goal of elucidating the origins of the brain. I strongly believe this award will cultivate me as a scientist and a scholar. It is a privilege to have the Origins Project here at Arizona State University!”

Choueiri’s mentor Jason Newbern agreed, saying “we are extremely honored to have the opportunity to contribute to The Origins Project mission by unraveling the complex origins of neural circuitry. I look forward to the fantastic mentoring opportunity made possible by this award and preparing the next generation of innovative neuroscientists."

“The Origins Project was established at ASU in part to encourage ASU undergraduates to explore foundational questions as they pursue their studies, and to encourage new research opportunities in forefront areas of interest across the full spectrum of scholarly activity associated with origins,” said Origins Project director Lawrence Krauss.

“What better way to support this than to encourage our best students to seek out faculty resources and to be engaged directly in exciting new research projects. I am delighted that we have been able to raise funds to support these projects and am delighted by the quality of the students who applied with their mentors and the proposals we received. It was a difficult decision and these five projects are truly exceptional.”

This scholarship funding has been generously provided by the Epstein VI Foundation. This award is one of many awards and scholarships the Origins Project has available to students, researchers, and scholars. For more information visit origins.asu.edu/prizes-scholarships.

Student Bios

Michael Busch (Mentor Judd Bowman)
BS Earth and Space Exploration (Astrophysics)
Michael Busch is a senior undergraduate with majors in Astrophysics and Physics and a minor in Mathematics. He studies Experimental Cosmology and aids in the creation of the tools and methods to study Cosmic Dawn and the Epoch of Reionization.

Alexi Choueiri (Mentor Jason Newbern)
BS Biocehmistry
BS Economics
Alexi Choueiri is studying Biochemistry and Economics at Arizona State University. He is interested in the molecular mechanisms of neural circuit formation and the genetics of stimulated neurons of the brain. He plans to pursue a PhD in neurobiology to unravel the mysterious origin of the brain and how it processes the world.

Aditya Dhumuntarao (Mentor Maulik Parikh)
BS Physics
BS Mathematics
Aditya Dhumuntarao is a senior honors student at Arizona State University pursuing dual degrees in mathematics and physics. Aditya's research interests primarily reside in theoretical physics with an emphasis in high energy physics and gravity.

Alexandra Norwood (Mentor Michael E. Smith)
BA Anthropology
BS Earth and Space Exploration (Geological Sciences)
Alexandra Norwood is studying archaeology and geology. Her research interests include how people define and adapt to their physical environments and the rise of social complexity. She done archaeological fieldwork where environments required her to adapt: rainy Iceland and sweltering New Mexico.

Nitish Peela (Mentor Mehdi Nikkhah)
BSE Biomedical Engineering
Nitish Peela is an undergraduate student pursuing a degree in Biomedical Engineering. In his research, he works at the intersection of multiple disciplines (mechanical, chemical, and biological) to create three-dimensional disease models that can better elucidate novel mechanisms of disease.

Student

Alexi Choueiri	achoueir@asu.edu	Biochemistry and Economics, May 16

Faculty Mentor

Jason Newbern	Jason.Newbern@asu.edu	Assistant Professor, School of Life Science

Resume

Experience

Arizona State University- Tempe, AZ: Researcher 2015-Present
PI: Dr. Jason Newbern

-Unravel the intricate biochemical mechanisms that orchestrate the formation of the brain and spinal cord
-Analyze the morphology and population number of LKB1 deficient GABAergic inhibitory neurons using immunohistochemistry staining and microscopy

Harvard University- Boston, MA : Researcher 2015 -Present
PI: Chairman Dr. Michael E. Greenberg

-Investigate neuronal activity-dependent gene processes whose dysfunction can lead to neurological diseases
-Performed q-PCR analysis to study BRD4, chromatin binding bromodomain, regulation of Immediate Early Genes in
stimulated and non-stimulated Cortical neurons
-Conducted immunohistochemical staining of BRD4 to investigate localization and expression in the developing mouse brain
-Execute Connectomics work in collaboration with the Lichtman Lab to map the neural circuits of a diseased brain (Working remotely)

The University of Texas [redacted]. Anderson Cancer Center- Houston,TX: Researcher
Summer 2013
PI: Dr. Zhimin Lu

-Explore the role of the metabolic enzyme PGK1 in an attempt to exploit the Warburg effect and improve therapeutic strategies for treating glioblastoma
-Constructed a growth curve and mouse xenograft model to investigate the effects of PGK1 on tumor formation and apoptosis

Barrow Neurological Institute- Phoenix, AZ: Researcher 2011—2015
PI: Dr. Anna Joy

-Investigated the role of PI3K/Akt pathway in tumorigenesis, progression and therapy resistance in glioblastoma multiforme
-Utilized flow cytometry to determine if Akt3 protein kinase affects the rate of transit through the S-Phase in the cell cycle
-Used q-PCR analysis to quantify and find if Akt3 regulates FBL mRNA in glioblastoma cells

Refugee Women's Health Clinic - Phoenix, AZ: Adjunct Research Associate
2013—present

-Assess the risk factors and prevalence of cervical dysplasia among refugee populations by extracting patient information from the Epic electronic chart system

St. Georges Hospital-Beirut, Lebanon: Summer Intern 2011—2012

-Shadow geriatrician in a facility with over 600 elderly patients who were abandoned or mentally ill
-Trained over 50 children in a nursery home concerning the proper care of elders
-Conducted a public health presentation in French and Arabic regarding basic teen health to the Cedar Scouts

Community Involvement

Global Microfinance Brigade- Arizona State University: Co-Founder and President
2012—present

-Direct a group students to Honduras in order to provide rural community members a community banking system, access to loans, financial literacy programs, and education to increase production and foster a culture of savings and growth
- Implemented the first auditing program in Global Brigades and consulted the rural bank of Tomatin
-Allocated 28,406 Lempiras into the Community Investment Fund where we purchased 2 grain storage silos, increased the bank reserve to promote loan distribution and created a scholarship fund for all 50 children in the village
-Started a chicken coop business in El Jute that created jobs for women in the community

Arizona Microcredit Initiative-ASU: Consultant and Loan Distribution Analyst
2013—2014

-Student-led 501(c)3 nonprofit working to benefit low-income entrepreneurs in the greater Phoenix Area.
-Small business consulting and small loans to help people who cannot get capital through traditional methods due to low-income, unemployment, or poor credit history.
-Develop and teach an 8-week Entrepreneurship Cohort Program for low-income adults covering business model generation, lean startup methods, problem solving, finance, product development and marketing.
-Designed metrics analysis to measure the impact of the client loans and helped formulate the loan application to improve the risk assessment of distributing loans to clients.

Biomedical Debate HOSA-ASU: Membership Director 2012—2013

-Organize and register the ASU-Tempe chapter for HOSA competition in the spring
-Plan events for the purpose of membership recruitment
-Compete in health related competitions in the state and national leadership conference

Sun Devils Rising-ASU: Director of Science Outreach and Co-Founder
2012—2014

-Promote the importance of a university education to high school students
-Educate students about the opportunities and excitement in scientific fields
-Proposed this program to the superintendent and panel committee of the Tempe Union High School District in order to implement the program in all high schools within the district

Students Supporting Brain Tumor Research-ASU: Event Chair and Mayo Clinic Officer
2012—2013

-Manage and execute events that raise awareness about brain tumors; invited the Principal Investigator of Neuro-Oncology at Barrow Neurological Institute to present research to students
-Promoted a walk-a-thon held at Saguaro High School which generated over $215,000 towards brain tumor research

Project C.U.R.E- ASU: Program Chair 2012—2013

-Deliver medical supplies and equipment to more than 125 developing countries
-Sort medical devices in the Project C.U.R.E warehouse in preparation for shipment

Awards and Honors

•Obama Scholar- 2012 to Present

•Regent High Honors Scholar-2012 to Present

•Harvard-Amgen Scholarship- 2015
o 1 of 20 students selected for this highly competitive program to conduct research with world-renown faculty at Harvard University.

•Barry M. Goldwater Scholarship Nominee -2015
o The most prestigious undergraduate award given in the sciences is awarded to about 300 college sophomores and juniors nationwide.

•Memorial Sloan Kettering Cancer Center SURP-2015
o 20 outstanding undergraduates selected to conduct research in the No.1 cancer hospital
oTurned down offer for Harvard-Amgen Scholarship

•American Association for the Advancement of Science Travel Grant- 2014
o Awarded $1000 to present my research at the AAAS Annual Meeting |2014, the world's largest general scientific meeting, in Chicago.

•SOLUR Travel Grant-2014
o Awarded an additional $300 to attend the AAAS Meeting, sponsored by the School of Life Sciences.

•Great Lakes National Scholarship-2014
o 750 students out of 20,000 applicants in STEM majors are selected to receive this $2500 award.

•School of Life Sciences Undergraduate Research Scholarship-2014
o 1 undergraduate student is selected for a $2000 highly competitive award.

•Alfred C. Knight Scholarship-2014,2015
o Awarded to students who are majoring in pure or applied Mathematics or Science at ASU.

•School of Life Science Undergraduate Fellowship Award-2014
o 8 of the highest level undergraduate researchers selected to receive wages for engagement in research.

•Mayo Clinic Scholars Program-2014
o 50 Students selected to engage in research and medical related activities.

•Pat Tillman Scholar-Leadership Through Action Program -2013
o 15 distinguished undergraduate students selected for demonstrating academic excellence, leadership and social action.

•CPRIT Scholar at MD Anderson Cancer Center-2013
o 40 individuals in the world selected to engage in research at the top cancer care institute.

•Norm Perrill Origins Project Scholar-2013
o 1 undergraduate student selected for demonstrating interest in the origins of life, the universe, and disease for the development and transformation of science education.

•Sigma Xi: The Scientific Research Society
o Qualified individuals who are interested in science and engineering are inducted into oldest scientific research honor society in the world which was founded in 1886 at Cornell University.

•Cedar Club of Arizona Scholarship- 2013
o $1000 awarded to 2 undergraduate students of Lebanese descent.

•Dean's List –Since Fall 2012

•1st place in state Biomedical Debate Tournament Collegiate Level, HOSA Leadership Conference-2013

•1st place in state Neuroscience Competition-2012

•1st place in state Creative Problem Solving competition, HOSA Leadership Conference-2011

•1st place in state Biomedical Debate Tournament, HOSA Leadership Conference-2012

•4th place in the National HOSA Biomedical Debate competition against 48 states-2011

•1st place in state "We the People" Competition Government-2012

Publications

Choueiri A. Dieting: An Effective Approach for the Complementary Treatment of Neurological Disorders and the Improvement Neuronal Health. Triple Helix: The Science in Society Review, Volume 10– Issue 1, 2013. ISSN: 2164-4314

Fink G, Johnson C, Farley J, Jimenez BJ, Choueiri A, Drachman D. Cervical Cancer Screening and an Assessment of Risk Factors and Prevalence of Cervical Dysplasia Amongst Refugee Populations. (Pending)

Choueiri A. The Implications of Social Media on Physiological and Socio-Behavioral Alterations: Does Social Media Have Positive or Negative Effects on the Well-Being of its Users? Triple Helix: The Science in Society Review, Volume 9 – Issue 1, 2013. ISSN:

2164-4314

•Nominated for the International Journal of Science, Society, and Law

Choueiri A. Spotted Truth. All Poetry, 2012

Posters and Presentations

Alexi Choueiri, Susan Su, Michael E. Greenberg. Neuronal BRD4 regulates activity-dependent gene expression. Harvard- Amgen Scholars Oral Presentations at Harvard University, 2015. Presentation

Alexi Choueiri, Susan Su, Michael E. Greenberg. Neuronal BRD4 regulates activity-dependent gene expression. Affiliated Summer Undergraduate Research Symposium at Harvard University, 2015. Poster

Alexi Choueiri, Burt Feuerstein, and Anna Joy. Akt regulates expression of Fibrillarin mRNA and protein in Glioblastoma Cells. 22nd Annual Undergraduate Research Poster Symposium at Arizona State University, 2015

Alexi Choueiri. The Role of Nuclear Akt3. Barrow Neurological Institute, 2014.Presentation

Alexi Choueiri. FBL Expression and Glioblastoma Multiforme. Barrow Neurological Institute, 2014.Presentation

Alexi Choueiri, Burt Feuerstein, and Anna Joy. Flow Cytometry to Measure the Effects of Akt3 on Glioblastoma Cell Cycle Rate. 21st Annual Undergraduate Research Poster Symposium at Arizona State University, 2014.Poster

Alexi Choueiri. BrdU Pulse–Chase Time Course to Monitor the Effects of Akt3 on Glioblastoma Cell-Cycle AAAS Annual Meeting, 2014.Poster

Alexi Choueiri, Xinjian Li, and Zhimin Lu. Phosphoglycerate Kinase 1 Promotes Proliferation and Suppresses Apoptosis in Glioblastoma Cell Line. MD Anderson Cancer Center Poster Symposium, 2013.Poster

Alexi Choueiri. BrdU Pulse-Chase Time Course to Monitor the Effects of Akt3 protein kinase on the Cell Cycle in Glioblastoma. 20th Annual Undergraduate Research Poster Symposium at Arizona State University, 2013.Poster

Alexi Choueiri. Akt3: Its Effect on the Rate of the Cell Cycle and Proliferation in Glioblastoma Multiforme. Barrow Neurological Institute, 2012.Presentation

Conferences and Symposiums

Affiliated Summer Undergraduate Research Symposium, Harvard University, Cambridge, MA-2015

Amgen Scholars National Symposium, UCLA, CA-2015
Lebanese Collegiate Network Annual Convention, Harvard University, Cambridge, MA-2014

AAAS Annual Meeting, ASU representative, Chicago, IL- 2014
Clinton Global Initiative University, ASU, AZ-2014

CPRIT Poster Symposium, [redacted]. Anderson Cancer Center, Houston TX,-2013

Annual Undergraduate Research Poster Symposium, ASU, AZ- 2013, 2014, 2015

Lebanese Collegiate Network Annual Convention, Purdue University, IN-2013

Global Brigades Student Leadership National Conference, UCLA, CA-2012

National HOSA Leadership Conference, Orlando, FL-2012

"We the People" National Finals, Washington [redacted]. - 2012

National HOSA Leadership Conference, Anaheim, CA-2011

Project Title

The Role of STK11/LKB1 Protein Kinase in the Development of Cortical GABAergic Circuits

Project Narrative

The human brain is considered to be one of the most complex structures in the known universe. Containing approximately a hundred billion neurons with close to a quadrillion connections between them, the vast neural network of this three pound organ is responsible for our ability to perceive, learn, feel, create and also control our very own physiology. The brain and its mysteries require much more exploration if we are to understand the origins of human consciousness and prevent devastating neurological diseases.

The goal of the Newbern Lab is to unravel the intricate biochemical mechanisms that orchestrate the formation of the brain and spinal cord. The lab aims to understand the development of neurons and glia in the brain through the use of a wide range of genetic, cellular, and molecular techniques. Providing insight into the cellular and molecular mechanisms by which complex neural circuits develop has implications for defining the pathogenesis of a variety of neurodevelopmental syndromes and may assist in developing novel therapeutic approaches.

Cell polarity is defined as the asymmetric organization of different aspects of the cell. The molecular control of this polarity is particular vital for neurons. For example, the polarity in the

structure of a neuron facilitates the flow of information by propagation of electrical signals down the axon to the synapse. The molecular mechanisms that translate polarity into highly specific patterns of axon growth and branching in neurons are absolutely crucial in the formation of neuronal circuits.

STK11/LKB1 (Serine Threonine Kinase 11/Liver Kinase B1), is a poorly understood intracellular kinase that has been found to regulate cell polarity in a wide range of cell types and animal models. STK11/LKB1 mutations have been linked to Peutz-Jeghers syndrome (PJS), an autosomal dominant syndrome that is linked primarily to certain forms of cancer. Research has shown that STK11/LKB1 is required for the establishment of polarity and axon branching in specific subsets of neurons in the nervous system. Interestingly, the effects of STK11/LKB1 appear to be selective for certain neuronal subtypes, however, the determinants of this functional selectivity are poorly understood.

A major focus in neuroscience has been made to unravel the cellular mechanisms underlying the regulation of neural plasticity, especially during critical periods of brain formation. Plasticity is the nervous system's ability to rewire its neural connections in order to adapt to environmental experience. A detailed understanding of heightened plasticity and maturity of neural circuits during critical periods could help describe the origins of developmental brain disorders. New evidence has shown that GABAergic inhibitory circuits in the cortex are playing a critical role in regulating plasticity in brain development by sculpting the pattern and timing of electrical activity in neurons. Abnormal balance of synaptic inhibition/excitation leads to defects in brain plasticity and is thought to contribute to the genesis of neurodevelopmental disorders, including Autism, Down syndrome, and Rett syndrome.

Importantly, the role of STK11/LKB1 has not been studied in the differentiation and maturation of GABAergic inhibitory neurons. We hypothesize that STK11/LKB1 is required for the physiological development and differentiation of GABAergic inhibitory neurons. My project is to explore the establishment and maturation of GABAergic inhibitory neurons and whether STK11/LKB1 regulates this process. I will examine the number, differentiation, and dendritic morphology of inhibitory neurons in a genetically modified mouse model with STK11/LKB1 deleted in GABAergic inhibitory neurons in the brain. The brains will be harvested from mice of different ages and sectioned. I will then perform an immunohistochemical experiment using antibodies to specifically stain for GABAergic inhibitory neurons at distinct stages of development. The purpose of this technique is to gain the ability to visualize the antibody when looking through a microscope. It is not possible to see the antibody directly; therefore, we will use a fluorescent dye that is covalently attached to the antibody. When a light excites the fluorescent dye, it emits light at a characteristic wavelength that can be detected. This will allow us to visualize the inhibitory circuits that lack LKB1. Once stained, software will be used to analyze the morphology and number of inhibitory neurons relative to a normal mouse brain.

Understanding pathways that promote differentiation of inhibitory circuits in the brain is critical since they have been found to regulate developmental processes whose impairment is linked to an array of neurodevelopmental disorders. Overall, inhibitory transmission has dramatic effects on brain plasticity and understanding the molecular processes will help explain how complex neural circuits develop. If the causal pathways for dysfunctional inhibitory circuits can be defined, it is possible that modification of this pathway would serve

useful for correcting imbalances in brain activity that are linked to neurodevelopmental syndromes. This project will contribute to the Origins Project mission of defining the biochemical and cellular origins of complex neural systems and possibly neurodevelopmental diseases.

Attempting to determine the origins of the brain and developmental of neural circuits will broaden my horizon in a mosaic of ways by stimulating my intellectual curiosity and by conditioning me into the professional researcher I aspire to be. I hope my passion and perseverance will assist me through our goal in further understanding the molecular underpinnings of neurodevelopment. I possess a strong craving of knowledge, and I believe the Origins Project Undergraduate Research Scholarship will aid me with my mission of investigating the genesis of this complex system we call the brain.

Project Timeline

•September: Initiate breeding to generate transgenic mice

•October: Begin collecting brains for analysis. Start immunohistochemical staining

•November: Continue sample collection and staining. Initiate microscopy and image analysis
.
•December-March: Collect/immunolabel/analyze replicates to complete dataset.

•March-April: Finalize data analysis for GABAergic neuron number and differentiation. Perform viral injections in transgenic mouse brains to analyze 3D neuronal morphology.
o The data up to this point will be used for the poster

•May-June: Initiate confocal 3D imaging of neuronal arbors and perform morphological analysis using Neurolucida software.

•July-August: Finalize experiments; write sections for manuscript/abstract/poster submissions.

Project Budget

•	Mouse housing, breeding, and genotyping costs	$4700
•	Antibodies	$1800
•	Staining/perfusion/microscopy reagents	$1500
•	Confocal Imaging in ASU Keck Bioimaging Core	$2500

Student

Aditya Dhumuntarao	adhumunt@asu.edu	B.S. Physics, B.S. Mathematics, May 16

Faculty Mentor

Maulik Parikh	Maulik.Parikh@asu.edu	Associate Professor, Physics

Resume

Aditya Dhumuntarao
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Research Interests:

Theoretical physics, applied mathematics, and computational sciences. Especially interested in theoretical high energy physics, cosmology, numerical relativity, and turbulence.

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Education:

Arizona State University, College of Liberal Arts & Sciences
Barrett, the Honors College - Cumulative GPA: 4.11

School of Statistical and Mathematical Sciences
Bachelors of Science in Mathematics - Cumulative GPA: 3.93

Department of Physics
Bachelors of Science in Physics - Cumulative GPA: 4.02

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Academic Accolades:

Society of Physics Students National Leadership Scholarship- May 2015
National recognition for outstanding academic performance and high level of SPS activity.
(ASU Physics) Arek Dieterle SPS Service Scholarship - May 2015
Awarded to outstanding undergraduate member of the Society of Physics Students.
(ASU Mathematics) Jack H, Hawes Research Scholarship - May 2015
Awarded to mathematics undergraduates for academic achievement and involvement in undergraduate research.
President's Award - 2011-2015
Recipient of the ASU New American University Merit Scholarship for high academic achievement in high school.
Student of Barrett, the Honors College 2011-Present

Dean's List 2011-Present

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Research Experience:

Coupling of Quantum Matter to Classical Gravity (High Energy Theory)
Dr. Maulik Parikh, Cosmology Initiative, ASU Physics Department
August 2015 − Present
Studying the coupling of quantum matter to classical gravity using techniques from string theory and quantum field theory.

Gauge/Gravity duality to a Pure SU(3) Gauge Theory (High Energy Theory)
Dr. Joseph Kapusta, Graduate Physics Director, University of Minnesota
May 2015 − Present −− REU Opportunity
Selected as one of thirteen in the Physics and Astronomy Research Opportunity for Undergraduates (REU) to conduct theoretical research studying the gauge/gravity duality applied to a pure SU(3) gauge theory as a simplified extension of quantum chromodynamics.

Self Interacting Dark Matter Models of Satellite Galaxies (Cosmology)
Dr. Carl Gardner, Professor & Honors Faculty, ASU Mathematics
May 2014 − Present −− Awarded the Jack H. Hawes
Currently investigating a proposed form of strongly self-interacting dark matter using cosmological codes, such as RAMSES and GADGET2, to study the formation of dwarf satellite galaxies.

Bistable Dynamics of Chaotic Topological Flow Structures (Mathematics)
Dr. Wenbo Tang, Associate Professor, ASU Mathematics
May 2014 − Present −− REU Opportunity
Selected as one of thirteen in the Computational Sciences for Undergraduates in Mathematics Program to characterize the influence of topological fluid structures, such as eddies and hyperbolic flows, in determining the fate of a turbulent chemical mixing process during the summer of 2014. This work has built on the research that Dr. Tang and I started during May 2013, and resulted in a publication.

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Publications:

Tang, W., & Dhumuntarao, A., "Bistability in Inhomogeneity − Effects of Flow Coherent Structures on the Fate of a Bistable Reaction." AIP − Physics of Fluids, 27(7), (2015)
− Published

Dhumuntarao, A., & Kapusta, J., "Gauge/Gravity Duality on a Pure SU(3) Gauge Theory."
Physics Review Letters D. − In Preparation

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Presentations & Conferences:

Bistable Dynamics In Chaotic Flow Structures
Joint Mathematics Meeting, San Antonio, TX, Jan. 2015
APS 2015 March Meeting, San Antonio, TX, Mar. 2015

Building Virtual Universes
Society of Physics Students: Regional Zone Meeting, ASU, Feb. 2015

AdS/CFT on Pure SU(3) Gauge Theory
Summer Undergraduate Research Expo, University of MN, Aug. 2015

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Professional Employment: Teaching Assistant for ASU Physics

Mathematical Methods in Physics I, Dr. Lunardini, Fall 2015
Mathematical Methods in Physics II, Dr. Lunardini, Spring 2015
Statistical and Thermal Physics, Dr. Oskan, Fall 2015

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Clubs & Societies:

Sigma Pi Sigma Fall 2015 - Spring 2016
President
Started the Sigma Pi Sigma community at the Arizona State University to promote excellence and the study of physics

Society of Physics Students:
President Fall 2015 − Spring 2016
Currently working to enact the Sigma Pi Sigma honors society, preserve the SPS outreach and volunteering efforts, and develop PGRE and class review sessions for ASU Physics students.

Vice President Fall 2014 − Spring 2015
Assisted in revitalizing the presence of SPS throughout ASU and the four corners region through volunteering efforts, and public outreach events, such as Night of the Open Door, and Earth and Space Exploration Day. Helped host the ASU Physics Department Picnic, and the Regional Body Meeting, where we invited Dr. Paul Davies and Nobel laureate Frank Wilczek to speak at the event.

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Volunteer Efforts:

Earth & Space Exploration Day Aug. 2014 − Present
Night of the Open Door Aug. 2014 − Present

Mentor for Underrepresented Students Fall 2014 − Present
- Society of Physics Students: (Phil Jang, Roger Bennett)
- SunDial: (Kyle Brown)

I have had the pleasure to work as a physics and mathematics mentor for the above students, while also guiding them through the ASU physics program and beyond.
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Transcripts: (Unofficial Transcript sent by email)

Project Title

Quantum Matter Coupling to Classical Gravity

Project Narrative

It has been 100 years since Einstein's great discovery of General Relativity. No longer was gravity a force, as in Newton's theory, instead gravity was revealed to be the curvature of space-time. Einstein, however, hoped to extend the unifying framework of space-time to connect gravity with the other forces of nature. This unification demands the reconciliation of matter, which is fundamentally quantum, with gravity, a stubbornly classical theory. While Einstein was unsuccessful, developing a quantum theory of gravity remains an active field of research.

A much studied limit of quantum gravity is semi-classical gravity in which quantum matter is coupled to classical gravity. This limit draws inspiration from the inception of quantum mechanics, where the electron, regarded as a quantum point particle, sources a classical electromagnetic field. Indeed, we know that white dwarfs and neutron stars are composed of quantum matter, and they appear to source classical solutions of general relativity. The supposition therefore seems to have experimental evidence and is generally reasonable. Nevertheless, the existence of both the black hole information paradox and the cosmological constant problem suggest that we should perhaps revisit this assumption.

In 1974, Stephen Hawking showed that classical black holes radiate, leading to the black hole information paradox. As a black hole shrinks into oblivion, through Hawking radiation, objects that fell in during the formation of the black hole appear to have evaporated, thereby violating a principle tenet of quantum mechanics − information cannot be lost. Though holography and the anti deSitter Space/Conformal Field Theory Correspondence have furthered the field, a universally accepted solution to this problem remains elusive.

Meanwhile, the cosmological constant, a parameter that defines the vacuum energy density, leads to severe conflicts with predictions from quantum field theory. Known as the cosmological constant problem, the vacuum energy density that one would obtain from quantum calculations when coupled to classical gravity leads to curvatures that are 123 orders of magnitude greater than what are observationally indicated − arguably making it the most incorrect calculation in theoretical physics.

What the cosmological constant problem and the black hole information paradox have in common is that both calculate the expectation value of the energy-momentum tensor − in the absence of gravity − and then forcibly couple it by hand to gravity via semi-classical Einstein equations. With guidance from Dr. Maulik Parikh of ASU's Cosmology Initiative, I would like to

re-examine the validity of this procedure. Specifically, I would like to identify the regime of validity of semi-classical gravity. This project could sharpen the conditions for the underlying assumptions of the black hole information paradox, and the cosmological constant problem, and, ultimately, reveal insights into the theory of quantum gravity.

In detail, the project will approach the assumption from many different angles, primarily using techniques from quantum field theory and string theory. To rigorously understand this coupling, I have enrolled in graduate courses in general relativity and quantum field theory to build on the fundamentals. With respect to the project, the regime in which gravitons can be omitted from Feynman diagrams will be studied. In the same vein, I will inspect whether the path integral formulation of quantum mechanics naturally leads to a limit in which classical gravity couples to quantum matter. I will also attempt to find a limit of the AdS/CFT correspondence in which gravity is treated differently from matter.

Recent developments in string theory, notably the AdS/CFT correspondence, have introduced a mathematical framework which offers valuable insights into this coupling. During the previous summer, I was selected as one of thirteen U.S. students to participate in a Research Experience for Undergraduates program at the University of Minnesota. With Dr. Kapusta, I studied the AdS/CFT correspondence as applied to a pure SU(3) gauge theory, a simplified representation of Quantum Chromodynamics. The pen and paper project, which will result in my second coauthored publication, illustrated the theoretical foundations and techniques of the correspondence.

Developing a quantum theory of gravity by reconciling quantum field theory and general relativity is one of the greatest challenges in modern physics, and the opportunity to study this problem in depth has been my dream since starting my undergraduate degree. In addition to significantly expanding my own knowledge regarding the interplay of quantum mechanics and gravity, I hope to contribute to the growing body of work discussing quantum gravity by embarking on this project as my undergraduate honors thesis.

The Origins Project represents the first step towards galvanizing the public and scientists to reveal the origins of life, the universe, and everything. With the Origins Project's Undergraduate Research Scholarship, I have such an opportunity by pondering issues in quantum gravity. Quantum matter profoundly affected classical gravity during the inflationary period of our universe, and quantum calculations of the vacuum energy are relevant to the current dark energy problem. Thus, understanding the coupling of quantum matter and classical gravity will shed light on both the origin and the fate of our universe.

Project Timeline

Aditya Dhumuntarao
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I plan to adhere to the strict guidelines set by Barrett, the Honors College for the senior honors thesis. The project will be a year long endeavor. The month by month projected breakdown is as follows.
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September - Barrett Thesis Proposal due by Sept 18.

By this deadline, The Barrett Thesis Proposal will put into perspective the requirements and milestones of this project. In addition, I plan to work with Dr. Parikh to determine the exact, mathematical and physical definition of the problem.

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October & November

I aim to study when the conditions for Feynman diagrams, used for quantum field theory calculations, will contain gravitons. These quantum particles are bosons, which are the carriers of force and describe the interactions of gravity.

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December & January

At the end of December, I will complete my course in quantum field theory. In the course, I will learn about the path integral formulation of quantum mechanics. In these months, I aim to study the limits in which quantum matter connects to classical gravity.

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February

From the methods of investigating the principle assumption, Dr. Parikh and I will accumulate our results and compare to other theoretical models, specifically the AdS/CFT Correspondence. In addition, we plan to meet with Dr. Paul Davies since his text on curved spacetimes in the quantum regime will heavily influence this work.

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March

In this month, I project acquiring tangible results that we would then need to interpret and recast to the original motive. The bulk of the honors thesis will be written in this month, and the possibility of a scientific paper will be discussed.

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April

Barrett Honors Thesis Defense will be in this month. In addition to the Origins Symposium, I plan to participate in the Barrett Honors Symposium.

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May - Project is largely, or entirely, completed.

There is a possibility of the project extending into the summer if a scientific paper seems feasible. However, this would be beyond a long term goal beyond the scope of the program.

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Student

Michael Busch	mpbusch@asu.edu	Astrophysics, May 16

Faculty Mentor

Judd Bowman	Judd.Bowman@asu.edu	Associate Professor, School of Earth and Space Exploration

Resume

Michael Busch

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Address: 555 E. Veteran's Way #3017, Tempe, Arizona 85281
Email: mpbusch@asu.edu Mobile: (520)280-7151

EDUCATION: 2012 – Present, Arizona State University
BSc. Physics, BSc. Astrophysics, Minor: Computational Mathematical Sciences
1st Year
§ Calculus I & II
§ Space Science Problem Solving
§ Geology I & II
§ Astronomy Labs
§ Introduction to Earth/Solar System/ Universe
§ Physics I – University Mechanics
§ Mars Exploration: Undergraduate Seminar
2nd Year
§ Differential Equations
§ Vector/Multi-Variable Calculus
§ Mathematical Methods in Physics I
§ Physics III - Optics, Thermodynamics, Waves
§ Galactic and Extragalactic Astrophysics
§ Physics II – Electricity & Magnetism
§ Principles of Programming
3rd Year
§ Mathematical Methods in Physics II
§ Planetary and Stellar Astrophysics
§ Quantum Physics I
§ Object-Oriented Programming
§ Technical and Scientific Reports
§ Astrophysics I
§ Applied Linear Algebra (MATLAB)
§ Numerical Analysis II
§ Quantum Physics II
§ Methods of Teaching Physics

The Individual and Group Projects in the Low-Frequency Cosmology (LoCo) Lab
Analysis of the primary beam of the Murchison Widefield Array (MWA) in Australia and describing quality of the so called Epoch of Reionization (EoR) window in the Fourier space power wedge, led to a discovery that the data pipeline code needed alteration. Findings published in an MWA collaboration memorandum and Beardsley et al 2016 in prep. Current independent project focuses on analysis and simulation of the signal-to-noise ratio of the proposed Hydrogen Epoch of Reionization Array (HERA). I also work with a team of three engineers in constructing antennas tuned to the 21cm hyperfine transition line of hydrogen in order to test the quality of a radio transmitter on a helicopter drone. This utilized independent research skills, computer programming and problem solving skills. Deadlines were very important due to time constraints.

Mathematical Methods Group Projects
I was a member of a four-person group in two semesters of mathematical physics. We were assigned assignments that required ample time to meet outside of class to work on, typical projects required 10+ hours of outside classroom work. One project was assigned for every two weeks, on top of two mathematical physics homework assignments weekly. I learned how to work with a team of physicists to accomplish goals and how to be a part of an effective group. Especially useful was the write up of our work because it had to be as concise as possible. Group members also familiarized themselves with LaTeX in order to write up these projects.

WORK EXPERIENCE:

NASA Space Grant Fellow, Arizona State University, Tempe, Arizona, 85281
August 2013 - Present
Fellow under Dr. Judd Bowman. Work relating to Epoch of Reionization (EoR) including graphical user interfaces to visualize radio data and preforming outreach with grade school/high school students. Aided in creating a data pipeline for the Murchison Widefield Array (MWA). Worked in a group setting on an external calibrator for hydrogen observatories (ECHO), for the MWA and other telescopes.

Resident Assistant, Arizona State University, Tempe, Arizona, 85281
August 2013 - Present
College of Liberal Arts and Sciences Resident Assistant. Facilitated a floor of sixty residents in Manzanita Hall and San Pablo Hall. Crisis management; event planning and execution, leadership abilities, communication skills, mediation. Awarded the Community Builder award at first annual leadership gala.

REU Student, University of Michigan, Ann Arbor, Michigan, 48109-1107 May 2015 – August 2015
Research Experience for Undergraduates (REU) Student through the National Science Foundation at the University of Michigan under the supervision of Professor Eric Bell. Worked with Subaru Telescope and Hubble Space Telescope Data to investigate galaxy formation using observations of M83, the Southern Pinwheel Galaxy.

PUBLICATIONS:

Beardsley, [redacted]., Hazelton, B. J., Sullivan, I. S., Pober, J. C., Carroll, P., Barry, N., Morales, M. F., Jacobs, D. C., Bernardi, G., Bowman, J. D., Busch, M. P., and 54 others. First Season MWA EoR Power Spectrum Results at Redshift 7. In Prep for Collaboration Review.

CONFERENCES:

The 24th Annual Arizona/NASA Undergraduate Research Symposium, April 18th, 2015. Arizona State University. Contributed Talk: The External Calibrator for Hydrogen Observatories

The 23rd Annual Arizona/NASA Undergraduate Research Symposium, April 12th, 2014. University of Arizona. Contributed Talk: Epoch of Reionization: Creating a Data Quality Metric for the MWA

INTERESTS:

§ I co-created a rocketry club on campus called Icarus Rocketry which I helped coordinate outreach for and design rockets for members. This led to me creating my own rocket which I will soon fly for my level 1 national certification in rocketry. This required a great deal of time management, creativity and cooperation.
§ I am a cellist, having played the instrument since the fifth grade; I am sometimes contacted to play for weddings, as a soloist for choirs or in concerts. I was in three local orchestras, as 1st chair, before starting my college career. I now play just to keep up my skill and relieve stress. I plan to find a local orchestra to play in while in graduate school. As 1st chair, I led the cello section in all orchestras and helped the conductor when needed as concertmaster.
§ I am also a writer. While in high school I interned at a local county magazine for eight months where I wrote (ironically) horoscopes, fiction, and copy-edited pieces contributed from the community. After my editor moved jobs, I became de facto editor of the magazine. I then setup interviews, called contributors and setup deadlines. Eventually I guided the content of the magazine overall. Being able to write effectively is a huge part of the science field. I find all of the skills I learned as an editor transferable when writing physics group reports and lab memos.
§ I enjoy giving back to the community when possible by performing outreach for the public. I was inspired at an outreach event to pursue a career in astrophysics so I regularly do these types of activities through my college. Typically, I speak about radio and low-frequency astronomy and present a poster on the Epoch of Reionization at these events.

OUTREACH:

(Select events, not a complete list.)
Future STEM Sun Devil Family Night (10/20/2012): Arizona Science Center. Assisted families in exploring STEM Majors in college. Contact: Nicole Cassis; ncassis@asu.edu

ASU Earth and Space Open House (10/26/2012): ASU Tempe Campus. Operated telescopes for use by the general public. AstroDevils. Contact: Kimberly Ward-Duong; kwardduo@asu.edu

STARLAB Portable Planetarium (11/6/2012, 11/9/2012): Granada East School. STARLAB education and misc. galaxy activities with 7th graders. Contact: Dr. Karen Knierman; [redacted]

Earth and Space Exploration Day x2 (11/20/2012): ISTB-4 open to public, 3000+ participants, assisted in outreach at AstroDevils table. Contact: Kimberly Ward-Duong; kwardduo@asu.edu

Night of the Open Door x2 (3/2/2013): ASU Tempe Campus, ISTB-IV. Represented ASU Astronomy Club, aided in coordination, set-up and tear-down. Contact: Meg Hufford marsmom@asu.edu

STARLAB Portable Planetarium (4/10/2013): Salt River Elementary School. STARLAB education and galaxy activities with K-3rd grade students. Contact: Dr. Karen Knierman [redacted]

Mesa Prep Academy (5/9/2013): 1303 S Lindsay Rd, Mesa AZ 85204, Event Details: STARLAB Planetarium in the Gym operated by Michael and Danny. Approx. 200 students.

Earth and Space Open House (5/24/2013): 781 E Terrace Rd, ISTB 4Tempe AZ 85287, Event Details: LoCo table with Octocopter and Dipole antenna, etc. Approx. 150 students.

Night of the Open Door (6/1/2013): 781 E Terrace Rd, ISTB 4 Tempe AZ 85287, Event Details: LoCo table with Octocopter and Dipole antenna, etc. Approx. 3000+

Gallery Tours: 9am – Noon, December 15th and December 16th 781 E Terrace Rd, ISTB 4 Tempe AZ 85287, Event Details: Michael gave tours of the GSE (1st and 2nd floor of ISTB 4)Approx. 150 First and Third Graders

Earth and Space Exploration Day (ESE Day): 9am – 3pm, November 2nd 781 E Terrace Rd, ISTB 4 Tempe AZ 85287, Event Details: LoCo table with Octocopter and Dipole antenna, etc. Approx. 3000+ general public.

CLAS Homecoming Block Party: 9am – 5pm, October 19th Old Main, ASU Tempe AZ 85287 Event Details: Space Grant table, Michael talked about LoCo with the public. Approx. 100

Arizona Museum of Natural History: "A Night with the Stars": 6pm – 9pm, October 4th 53 N MacDonald Mesa, AZ 85201, Event Details: AstroDevils table and STARLAB Planetarium with Jackie M. Approx. 300

Incoming Freshman Tour of GSE: Noon – 3pm, August 9th 781 E Terrace Rd, ISTB 4 Tempe AZ 85287, Event Details: Michael helped with tours of the Gallery of Scientific Exploration with incoming freshmen. Approx. 200

Project Title

Enabling a New Window on the Earliest Astrophysical Structures from the Dark Ages, First Light, and Reionization

Project Narrative

Introduction

One of the most compelling questions remaining in astrophysics today is the origin of structure in the Universe. How did the massively complex cosmic web—with sheets, filaments and halos that we see today—form from a smooth and simple intergalactic medium (IGM) that emerged in the aftermath of the Big Bang? Research in recent decades have seen tremendous progress in answering many of the questions in this story and has established the foundational theory that is now in place. In this theory, the Cosmic Microwave Background—the afterglow of the Big Bang—contains tiny density fluctuations caused by gravitational instabilities. Eventually, these instabilities grew and collapsed hierarchically into the complex cosmic web (Furlanetto et al 2006).

This paradigm has been incredibly successful in explaining both observations of the early Universe and local structures. However there are gaps remaining in explaining the origin of these structures. We have yet to observe directly the cosmic 'Dark Ages', the time between the surface of last scattering and the emergence of everything we see today: galaxy clusters, stars, planets—everything. Additionally, we are only now beginning to observe the era known as 'First Light' (about a billion years after the Big Bang); when the first luminous objects in the Universe formed and ionized the IGM in a period known as the Epoch of Reionization (EoR). In order to directly investigate these epochs, new radio array interferometers are coming online to observe this mysterious time in our Universe's history. The Murchison Widefield Array (MWA) is a radio telescope in Western Australia that is making strides to observing the formation of the cosmic web, the first luminous sources, and mapping the reionization of the IGM during the EoR.

Research Plan and Expected Impact

ASU is one of four U.S. partners of the MWA, lead locally by Prof. Judd Bowman's Low-frequency Cosmology (LoCo) research group in SESE. The LoCo team has undertaken preliminary analysis of data from the MWA EoR observations in collaboration with colleagues at MIT, Harvard and U. Washington. This type of research is an important step in mapping the reionization of the IGM by the first luminous sources such as stars and galaxies, from which we can infer the properties of the first sources and how they influenced the development of large-scale structure in the Universe.

A pressing concern of these observations is the spectral structure of bright sources in the primary beam sidelobes of the MWA. Sidelobes are lobes in the radiation pattern of the MWA that are not the primary beam, where the field strength is the largest. Radio point sources in the sidelobes of the primary beam are numerous and difficult to deal with: these include active

galactic nuclei, radio galaxies, and local Galactic sources. These foreground contaminants are 5 orders of magnitude brighter than the redshifted 21 cm emission expected from the IGM during the EoR (Bowman et al. 2009). This is one of the major challenges for all of the upcoming radio interferometers that aim to detect the faint hydrogen signal from the EoR. In order to prevent contamination, these foreground signals must be properly subtracted from the MWA observations (Datta et al, 2010).

The Jansky Very Large Array (JVLA) in New Mexico has the most reliable equipment to provide observations of the radio sources in the MWA's sidelobes. We also do not know how sensitive the MWA is to the sky in the sidelobes as well as we do in the primary beam. By creating a foreground model for these contaminations, the MWA will be able to subtract these sources from their future EoR measurements, enabling more sensitive measurements of the origins of cosmic structure.

My research plan is to use the JVLA to characterize 100 bright radio sources to provide a high-quality foreground model to the MWA and potentially other interferometers. Observations of these 100 sources have already been acquired by graduate SESE student Boom Kittiwisit over the last 16 months. As a current third-year member of the ASU MWA team, this project is readily available for me to work on. In the first two months of the project, I will calibrate and image all of the individual observations and from the calibrated data, I will extract spectral fits and fluxes for each source. In December and January, I will compare the data from the JVLA observations to the MWA observations. In February, I will begin to investigate discrepancies between the two data sets, and look for the causes of these. By March I will be able to compute the foreground signature from these radio sources, since JVLA observations are more accurate than the MWA, this foreground model will enable the MWA to overcome its foreground limits and should deliver deeper, more sensitive EoR data.

Conclusion

The compelling story of Cosmic Dawn: the origins of cosmic structure—from the Dark Ages to First Light and the subsequent reionization of the Universe within the first billion years of our history is one of the fundamental frontiers left to explore in the astrophysics community. This proposed research is poised to help the ASU MWA EoR team in answering some of these questions by providing a validated, reliable foreground source model. By comparing JVLA with the MWA, it is expected that this research will further identify calibration errors in the MWA and help transfer the northern hemisphere flux-scale standard to the MWA. This project is expected to yield directly publishable results and improve the outcome of the core MWA science analysis.

References

Bowman, J. D., Morales, M. F., & Hewitt, J. N. 2009, ApJ, 695, 183
Datta, A., Bowman,[redacted]., & Carilli,C.L. 2010, ApJ, 724, 526
Furlanetto, S.R., Peng Oh,S., & Briggs, F.H. 2006, Phys.Rep., 433, 181
Madau, P., Meiksin, A., & Rees, [redacted]. 1997, ApJ, 475, 429
Thyagarajan, N., Udaya Shankar, N., Subrahmanyan,R., et al. 2013, ApJ, 776, 6
Thyagarajan, N., Jacobs, D., Bowman, J. D, et al. 2015 ApJ, 804, 14

Project Timeline

General Timeline for this academic year is:

- September: Organize data and prepare software analysis tools (and become familiar with how to run the software.)
- October: Focus on processing one source until I perfect the processing steps
- November: Run script on all sources ~100.
- December/January: Compare the power spectrum I receive get from the VLA observations to MWA observations.
- February: Identify discrepancies, look for causes, and investigate findings.
- March: Compute the foreground signature (wedge contribution) from these sources to reionization power spectra (so they can be subtracted by the MWA). It is the "enabling" word in the title. Since we will be looking at VLA observations, we will assume they are very accurate – better than what the MWA can do for the same sources. So using the VLA data to help with foreground subtraction in MWA data should improve the overall results. Hence, our project will help the MWA get beyond its current limits due to foreground subtraction and should ultimately help the MWA deliver deeper, more sensitive observations.
- April: Write up and present your results.

Project Budget

Student Budget: $5,000 would offset tuition and school fees.

Faculty Budget: $3,000 for data storage. $2,000 to finance Michael Busch to attend the 227th AAS meeting this year in Florida: January 4-8th, 2016, Gaylord Palms Resort & Convention Center, Kissimmee, FL

Student

Alexandra Norwood	alnorwo1@asu.edu	Anthropology, Geological Sciences, May 17

Faculty Mentor

Michael Smith	michael.e.smith.2@asu.edu	Professor of Anthropology and Graduate Director, SHESC & ASU-Santa Fe Institute Center for Biosocial Complex Systems

Resume

Alexandra Norwood

701 E. Apache Blvd, #F1068
Tempe, AZ 85281
(626) 222-0394
AlNorwo1@ASU.edu

Research Interests

I am currently pursuing my Bachelor's degree in Anthropology and Geological Sciences, with an archaeological focus. I intend to focus regionally on Northern and Western Europe. My interests include how people have been able to interact with and adapt to their physical environments, as well as the rise of social complexity.

Education

Arizona State University (2013 to present), Tempe, AZ
Barrett, the Honors College
Anthropology major with archaeological focus and Geological Sciences major
Medieval and Renaissance Studies certificate

San Marino High School (2009 - 2013), San Marino, CA
Cumulative GPA of 4.1
Architecture Regional Occupation Program 2011- 2012
Business Management Regional Occupation Program 2011

Field Experience

2015 Archaeological field school
Archaeology Southwest Preservation Archaeology Field School
University of Arizona
National Science Foundation Research Experience for Undergraduates

Awardee

2014 Archaeological field work
Gufuskálar and Skuggi, Iceland
North Atlantic Biocultural Organisation, Fornleifastofnun Íslands
City University of New York

Work Experience

Event and Birthday Party Facilitator (January 2015- Present)
Arizona Museum of Natural History
Kathy Eastman, supervisor

Barrett Ambassador (August 2014- May 2015)
Barrett, the Honors College, Arizona State University
Michelle Hollin, supervisor

Research Assistant (Fall 2013-Present)
Plaza Mapping Project/Urban Services Project, Arizona State University
Dr. Michael Smith, supervisor

Summer Nature Camp Assistant Director (June –August 2013, August 2014, August 2015)
Los Angeles County Arboretum
Ted Tegart, supervisor

Awards and Achievements

2015 Spring Dean's List, Arizona State University
2015 National Science Foundation Research Experience for Undergraduates Award (Archaeology Southwest Preservation Archaeology Field School)
2014 Fall Dean's List, Arizona State University
2014 Spring Dean's List, Arizona State University
2013 Fall Dean's List, Arizona State University
2013-Present Barrett Scholarship, Arizona State University
2013-Present New American University Scholarship, National Scholar, Arizona State University
2013 California Scholarship Federation Sealbearer
2013 National AP Scholar
2012 National Hispanic Scholar
2012 National Merit Commended Student
2011 Outstanding Community Service Award, San Marino

Volunteer Work

President (August 2015-Present)
Undergraduate Anthropology Association, Arizona State University

Vice President (November 2014- Present)
Associated Medieval and Renaissance Undergraduate Students

Mudslinger (October 2014- Present)
Pueblo Grande Museum

Exploration Station Facilitator (September 2014- Present)
Arizona Museum of Natural History

Barrett Mentor (August 2014- Present)
Barrett Mentoring Program, Arizona State University

Mentor (Spring 2015)
Student Educators for Cultural Awareness, Arizona State University

Mentor (Spring 2015)
Page Turners, Arizona State University

Secretary (August 2014-May 2015)
Undergraduate Anthropology Association, Arizona State University

Talent Match Mentor (Fall 2013)
Barrett Talent Match, Arizona State University

Youth Education Intern (June 2011-May 2013)
Los Angeles County Arboretum

Additional Memberships

Phi Beta Kappa 2015-Present
Associated Medieval and Renaissance Studies Undergraduate Students
2014-Present
Alpha Lambda Delta Arizona State University 2014-Present
Barrett Residential Council 2013-Present
Undergraduate Anthropology Association
2013-Present

Presentations

2015 Viking Social Complexity: Settlement and Burial Patterns. Undergraduate Research Symposium, School of Human Evolution and Social Change, Tempe, AZ. April 24, 2015.
2013 Ötzi the Iceman's Body Deposition. Buried Cities and Lost Tribes Honors Presentation, School of Human Evolution and Social Change, Tempe, AZ. December 4, 2013.

References

Margaret C. Nelson, [redacted].
Vice Dean, Barrett Honors College, Arizona State University
President's Professor, School of Human Evolution and Social Change, Arizona State University
MNelson@ASU.edu (480) 965-9520

Michael E. Smith, [redacted].
Professor of Anthropology, School of Human Evolution and Social Change, Affiliated Faculty, School of Geographical Sciences and Urban Planning, Core Faculty, Center for Social Dynamics and Complexity, Arizona State University
Michael.E.Smith.2@asu.edu (480) 727-8724

Ted Tegart
Youth Education Coordinator, Los Angeles Arboretum
Ted.Tegart@arboretum.org (626) 821-5897

Project Title

Origins of public spaces in the earliest cities

Project Narrative

The Urban Revolution—marking the origins of the first cities—was a major turning point in human social and cultural development. New social conditions in dense, crowded cities were stressful for the people that lived in them. Lots of people packed together created a social stress that was addressed by manipulation of architecture and the built environment in order to enable people to coexist in the ways they and their leaders desired. An important part of the layout of a city is the nature of formally defined open spaces that are used for assemblies, trade, and other interactions between community members. These spaces give people a designated forum for interaction, help them navigate the stress of a dense population, and impact how common people perceive each other and their authority and how they move through the built environment. There is a lack of crucial understanding of the origin of these spaces in the earliest cities, and their social context. Such public spaces were built by authorities and planners, but was this done to help autocratic kings control their subjects, or were they built to give people a say in more collective or democratic states?

I will analyze the size, distribution, and architectural features of plazas in a sample of pre-modern cities, and compare the results to plazas in two types of more recent cities: those with collective governments, and those with authoritarian governments. This will allow me to discern if there is a quantifiable relationship between governance and public space. A development of this more complex understanding of the dynamics of early cities is critical to understanding the evolution of both human culture and the modern city.

Many current ideas about plazas and formal open space are based on the assumption that plazas are always a top-down initiative with the intent of rulers to arrange the landscape in a way that supports their power. A new perspective on early societies, however, shows that some early governments were more collective in their organization, providing public services for their population, while others were characterized by despotic kings who exploited their subjects and provided few benefits (Blanton & Fargher 2007). Public spaces are critical to the basic political, social, and economic functions of cities (Stanley et al. 2012) and act as a reflection of the authority responsible for their creation. Governments concerned with centralizing wealth and power used plazas to communicate different messages from those of governments concerned with citizen empowerment. By categorizing public spaces as a public good, we are able to make a prediction that more responsive governments will have more public space, more equitably located, because they are more responsive to the needs of the people.

This project developed from my previous work on the transdisciplinary project, Service Access in Premodern Cities, directed by Michael E. Smith at ASU (Stanley et al 2015). This project assesses inequality in access to services, like public space, between elite and common classes in pre-industrial cities. Project members have devised a method to code the governance type of each city on a scale ranging from collective to authoritarian. In this project I conducted spatial analyses in GIS with digitized maps in order to identify and measure public spaces and their access by urban residents. This project will furnish my project with a number of mapped cities with pre-identified public spaces from different time periods and geographic regions (from ancient China to precolonial Yoruba), with varying cultures and governance types. I will use these cities and add others not part of the project's sample that have adequate mapping and information about governance for my analysis. With GIS, I will measure the number of plazas in each city and their sizes. I will then be able to test differences between cities with the two types of governance systems identified above.
My role in the project will be to gather the data by collecting info from Service Access project into a common format and measuring plazas in a sample of new cities. I will apply the governance scale and carry out comparisons, conducting data analysis. Dr. Smith, as the director of project, will supervise work. He will analyze civic architecture and public spaces at the archaeological site of Calixtlahuaca so that it can be included in this study. He will also help adapt the governance scale to the new cities and conduct the data analysis and city comparisons.

This project has four expected outcomes:(1) the completion of my Honors thesis at Barrett, the Honors College, (2) the presentation of a poster at the Society for American Archaeology's annual meeting in April, (3) and ultimately the publication of a journal article. (4) For Dr. Smith, he will compile quantitative data on the civic architecture and plazas of Calixtlahuaca. His NSF grant for work at the site did not include funds for this kind of analysis.

This project aligns with the interests of the Origins Project in that it addresses the origins and evolution of human culture and social institutions. As more and more of the population of the world shifts away from rural life and moves into cities, it will become increasingly more important to understand the way that government authority engages the people. This relationship can be examined archaeologically to put our modern city-centric lives into a broader historical context. This will deepen our understanding of the dynamics not only of the

earliest cities, but of cities and urban processes in general. There is much to be learned about modern cities from their ancient predecessors.

References

Blanton, RE and LF Fargher (2008) Collective Action in the Formation of Pre-Modern States. Springer, New York.
Stanley, BW, T Dennehy, ME Smith, BL Stark, A York, GL Cowgill, J Novic and G Ek (2015) Urban Service Access in Premodern Cities: An Exploratory Comparison. Journal of Urban History (published online).
Stanley, BW, BL Stark, K Johnston and ME Smith (2012) Urban Open Spaces in Historical Perspective: A Transdisciplinary Typology and Analysis. Urban Geography 33:1089-1117.

Project Timeline

Abstract by Sept 10
Finish Literature Review by Oct 1
Data Collection done by Jan 1
Thesis defense by April 1
Poster by April 4
Paper completed by April 15
Journal Submission in May

Project Budget

Student estimated costs:
$1500 for a computer to collect and process data
$1500 for a GIS license for the computer
$200 for Adobe Creative Suite for computer
$200 for a scanner to digitize maps
$50 for poster for Society for American Archaeology meeting
$500 for flight to meeting in Orlando
$700 for hotel for 4 nights in Orlando
$70 SAA membership dues
$120 SAA meeting registration
$160 for expenses (food,etc) during SAA meeting

Faculty costs:
$5000 to pay a consultant to analyze civic architecture at plazas at Calixtlahuaca. This will include digitizing architectural plans, adapting Autocad maps for graphics output, estimating the volumes of civic architecture, and integrating the results with the project GIS database.

Student

Nitish Peela	npeela@asu.edu	Biomedical Engineering, May 17

Faculty Mentor

Medhi Nikkhah	mehdi.nikkhah@asu.edu	Assistant Professor of Biomedical Engineering

Resume

Nitish Peela
npeela@asu.edu
940 E. Canyon Way, Chandler, AZ, 85249
602.750.8556

SUMMARY: Seeking a suitable position that would utilize my proven aptitude for biomedical research, enable me to assist and collaborate with scientists in interdisciplinary fields, and directly deliver translational research to patients in an efficient manner.

EDUCATION: Barrett, the Honors College at Arizona State University | Major: Biomedical Engineering | CGPA: 3.94

TECHNICAL & NON-TECHNICAL SKILLS

- Research Skills: Statistical analysis, Literature review, Patent-Writing, Conversant with Scholarly Articles
- Computer Information Systems: ImageJ, CGI (Computer generated imagery), Animation in Blender 3D/Maya/3DS MAX, Matlab/Python/Java/HTML
- Laboratory Skills: Sterile Technique, Tissue Engineering, Micropatterning, Microenvironments, Cell Culture, Gel Electrophoresis, UV mutagenesis, Chemical-Based Mutagenesis, Bacterial Transformation, PCR, Animal Care/Animal Testing
- Other Skills: Strong verbal and written communication; Patient Interaction/Bedside Manner; Entrepreneurship/Economics; Financial Analysis

EXPERIENCE AND WORK ACHIEVEMENTS:

ASU School of Biological and Health Systems Engineering: Independent Researcher

May 2014 – Current
• Tissue engineering lab
• Focus on microenvironments to model diseases
• Poster presented at ASU Fulton Undergraduate Research Symposium 2014
N. Peela, F. Sam, M. Nikkhah*. Directed breast cancer cell morphogenesis on micropatterned gelatin methacrylate hydrogels.
• Poster Presentation at AACR (American Association for Cancer Research)

N. Peela et. al. Breast cancer cell invasion in a highly organized three dimensional (3D) microengineered tumor model
• Undisclosed, related journal article in review at Biomaterials

Medicloud: Founder & CEO

October 2014-Current
• Non-profit venture aimed at creating a new medical records system to enable interaction between hospitals and assisted living facilities
• Granted over $20,000 in funding--leading an interdisciplinary team to deploy initial product in May

First Gen Scientists: Founding Member & Program Development Chair

May 2015-Current
• Developing a middle school science curriculum for a non-profit STEM outreach/mentorship program
• Program features a 2:1 mentor:student ratio where we progress through a science curriculum, mentor underprivileged children, and encourage them to consider STEM careers

Chandler Unified School District: Science Research Student-Teacher

August 2013 – Current
• Mentor high school students on ethical obligations, goals of research design, and research presentation at the international level

Premier Emergency Medical Specialists: Emergency Department Scribe

March 2014 – Current
• Take notes and document patient medical history into the computer for physicians in the ER.
• Assist with patient care, speed up triage process, and closely shadow physician

ASU Biodesign Institute, Tempe, AZ: Independent Researcher/Technician

September 2012 – June 2014
• Proposed an original project idea and conducted scholarly research on reducing side effects of antibiotics on livestock
• Poster presented at Biodesign research symposium
N. Peela, K. Roland*. Distinguishing and eliminating side-effects of sub-inhibitory aminoglycoside antibiotics in chickens using an engineered, but naturally resistant probiotic: L. Rhamnosus.

NYU Langone Medical Center, New York, NY: Independent Researcher

May 2012 – August 2012
• Proposed an original project idea on the prevention of C. Difficile infections in humans (an antibiotic-induced side effect)

• Invited to intern at the NYU medical school to develop my research
• Filed for a co-patent (still pending) with the chair of the Skirball Institute in NYU, Dr. Richard P. Novick

AWARDS/HONORS:
Arizona State University, Dean's List

January 2014 - Current

• Recognized as a top tier student at Arizona State University for exemplary record of school work performance.

ASU Presidential Scholar

May 2013 - Current
• Recognized as a top-tier student for academic achievements throughout high school and into college

AACR (American Association of Cancer Research) Research Poster Award

March 2015
• Received a top-ten poster award at the biggest national cancer-research conference in the nation

Edson entrepreneurship funding and CGI-U fellow

October 2014 - Current
• Granted funding, mentorship, and office space to assist in developing my start-up company: Medicloud

Intel ISEF, Finalist

May 2012,

May 2013
• Finalist twice at the biggest international pre-college science and engineering fair with research conducted at NYU and ASU

Project Title

A Novel Three-dimensional Tumor Model to Spatially Assess Cancer Cell-signaling

Project Narrative

Metastatic dissemination of cancer cells is a highly complex and multi-step biological process initiated by cell invasion into the surrounding stroma, which prompts the formation of new capillaries (tumor angiogenesis), and the invasion of cancer cells through the extracellular matrix (ECM) towards these capillaries. The intricacies of cell-signaling make it extremely

difficult to develop a cohesive understanding on the origins of cancer as virtually every step of the metastatic process is governed by such microenvironmental cues. Due to the fundamental lack of understanding on the origins of cancer cell invasion, there is a severely stagnated development of pragmatic treatment options for patients.

Many investigators' efforts have been focused on developing in vivo animal models of cancer. Despite the physiological relevance of these models, they present an abundance of confounding variables, making it challenging to develop causal relationships between specific cell-signals and cancer cell behavior. When studying such relationships, researchers often turn to in vitro models of cancer. The vast majority of previous in vitro studies simply mix cancer cells various cell-signals (cell-cell signaling, proteins, ligands, hormones, etc.) in two-dimensional (2D) monolayer culture. This method is effective in determining signal function as it allows for cells to be in extremely close contact with each other, however, it lacks physiological relevance, making it impossible to draw any meaningful conclusions on the impact of specific cell-signals on cancer cell behavior.

In the human body, cell-signals are spatially distributed throughout three-dimensional (3D) tissue in a complex structure around the tumor. Cell-signals diffuse in gradients through thick tissue and interact with proteins in the ECM, so they induce significantly different responses in 3D tissue than they do in 2D culture. Consequently, in order for an in vitro model of cell-signaling to have physiological significance, it must contain both the biological and biophysical aspects of the native tumor microenvironment. The focus of this one year research project is to microengineer and test a tumor model, embedded with 3D microtissues, that can quantifiably assess the magnitude of cell-signals and the effect they have on cancer cell behavior.

The undergraduate student co-planning this project has substantial experience in terms of creating physiologically relevant, 3D models of cancer cell invasion. His previous efforts have led to a first-author research journal manuscript, which has been submitted (currently in-review) to the journal Biomaterials (2015 Impact factor: 8.5). This manuscript has been deemed meritorious by the editor-in-chief of Biomaterials in the initial stages of the review process. Figure 1A (attached) illustrates an innovative aspect of his previous model where cancer cells are organized into circular constructs representative of a native tumor. This model allows for high-throughput quantification on the invasive profile of the cancer cells (tumor) into the surrounding matrix (tumor stroma) as a function of time. Furthermore, as shown in actin cytoskeleton images (green stain), benign cancer cells (MCF10A cells) form 3D tissue-like tumors, whereas malignant cancer cells (MDA-MB-231 cells) penetrate through 3D ECM and migrate through 3 planes. Our previous findings and expertise provide valuable insight into engineering 3D microtissues supportive of diffusive gradients, organized microarchitecture, and cancer cell invasion.

We propose to create a novel, multi-layer tumor model, illustrated in Figure 2, to create a 3D, morphologically accurate tumor with a multi-layer stromal component, which allows us to study cell-signaling in a physiologically relevant manner (Figure 2). 3D tissue will be engineered and injected through the inlets in this device. The tissue will be comprised primarily of collagen, which is a viscous, synthetic hydrogel that polymerizes into a biomimetic, tissue-like material when exposed to physiological temperatures (37°C). Figure

3A/3B are representative images of a basic microfluidics device created in the Principal Investigator's (Professor Nikkhah) lab. The surface tension, induced by the trapezoidal posts, prevent flow of the collagen through the gaps between the posts. The result is organized tissue that assumes a 3D, circular pattern confined by the posts on day 0, which allows for migration past the posts at later times points (Figure 3C).

For this study, we will engineer breast cancer tissue by encapsulating a highly invasive breast cancer cell line (SUM159 cells) in collagen and injecting it into the tumor compartment. A buffer layer above the tumor mass will be created by injecting plain collagen (representative of the ECM) through the inlet adjacent to the tumor compartment. Above this plain ECM, we will inject our desired cell-signal and observe the reaction of the cancer cells to the signal. By altering the size of the buffer layer at three stages (250um, 500um, and 750um), we will change the effective distance between the signal and the tumor.

In order to validate the model, we will conduct three separate experiments where we inject three different cell-signals into the peripheral layer: Engineered myoepithelial cell tissue, which has been demonstrated to inhibit cancer cell metastasis; ECM with increased collagen concentration (increased ligand density), which has been demonstrated to promote cancer cell metastasis; and a control condition with no specific cell-signal embedded within the peripheral layer. Figure 4 schematically represents the three conditions that we will be testing. We expect to see cancer cells migrating towards the ligands at the highest velocity when the ligands are closest to the tumor compartment. Conversely, we expect to see the highest inhibition of cancer cells when the myoepithelial cells are closest to the tumor compartment. Values will be analyzed and normalized with respect to the control.

This research proposal is part of a global research initiative to incorporate biophysical aspects of the human body into in vitro models of disease. Our efforts are aimed at unveiling the origins of metastatic cancer and determining how cell-signaling prompts tumors to assume an invasive phenotype. The proposed microfluidics device is the first model that enables in vitro study of cell-signaling in a physiologically relevant manner, which can assist in clinical applications such as personalized medicine and high-throughput drug testing. As such, we believe that the project has a transdisciplinary objective and translational impact, which would better enable cancer biologists to tackle the fundamental questions involving cancer cell invasion.

Project Timeline

8/1/2015-9/15/2015: Device Modeling

1. 3D AutoCAD drafting of the microfluidics tumor model
2. Diffusion modeling

9/15/2015 - 10/01/2015: Device Creation

1. Print AutoCAD model, create microfluidics device
2. Model diffusion using fluorescent dyes
3. Compare computer generated results of diffusion modeling to real-time results

10/01/2015 - 02/01/2016: Debugging Phase

1. Test injection ports and posts; assess the need for physical modifications to the model
2. Make modifications, print, and create new model
3. Test tissue engineering techniques; assess cell death and cell morphology to see whether the tissue engineering technique is conducive for creating breast cancer tissue
4. Optimize the tissue engineering technique
5. Optimize the distance between layers with the intent of induce a significant response to cell signals (ie. 250um, 500um, and 750um vs 300um, 600um, and 900um)

02/01/2016 - 04/01/2016: Experimentation Phase

1. Perform the proposed experiment
2. Make quantifiable metrics to assess cell polarity, cell movement, and signal-diffusion
3. Run triplicate samples of each test

04/01/2016 - 05/15/2016: Additional Testing (extra time may be required for a more cohesive project, however, it is more than reasonable to have the most significant parts of this study completed by this end date)

1. Record movies of cellular migration
2. Perform immunofluorescence imaging to observe cytoskeletal organization
3. Quantify results of immunofluorescence imaging
4. PCR/Western plot to determine gene/protein expression

Project Budget

Clean room usage - $200
Silicone wafer - $200
AutoCAD Mask - $100

Type I Collagen (material) - $500
Polydimethylsiloxane (material) - $500

SUM159 Cell line - $200
Myoepithelial Cell line - $300
Media, Flasks, Cell culture materials - $200
Antibodies - $300

Vaccum Plasma Etching Machine - $4,000

Total: ~ $6,500

Depending on time-frame, results, and commitments from collaborating labs, may need to purchase the following:

PCR machine: $3,500
Western Blotting system: $850

Total: ~$10,850