2020-21 Churchill Scholars

Vinay Ayyappan	Johns Hopkins University	Radiology
Anna Biggs	Harvard University	Applied Mathematics
Azim Dharani	Duke University	Chemistry
Thomas Freitag	University of Pittsburgh	Public Policy
Elise Koskelo	Pomona College	Physics
Jamie Lee	US Naval Academy	Machine Learning
Harrison (Wei Tse) Li	UC San Diego	Cancer Research
Alice Lin	Princeton University	Pure Mathematics
Daniel Malawsky	UNC Chapel Hill	Wellcome Sanger Institute
Srinivas Mandyam	University of Pennsylvania	Physics
Salvatore Pace	Boston University	Physics
Mehtaab Sawhney	Massachusetts Institute of Technology	Pure Mathematics
Jasmine Stone	Yale University	Engineering
Macy Vollbrecht	University of Minnesota/Twin Cities	Plant Sciences
Tanay Wakhare	University of Maryland/College Park	Advanced Computer Science
Michael Xiao	University of Utah	MRC Cancer Unit

The Winston Churchill Foundation of the United States is pleased to announce the cohort of 16 Churchill Scholars, including one Kanders Churchill Scholarship in Science Policy, for the 2020-21 academic year.

The Churchill Scholarship and Kanders Churchill Scholarship are for one year of Master's study at Churchill College in the University of Cambridge. The awards cover full tuition, a stipend, travel costs, and the chance to apply for a $2,000 special research grant. The Churchill Scholarship dates to 1963. Churchill College was established in 1960 as a predominantly science and technology college and the National and Commonwealth memorial to Sir Winston Churchill. The Churchill Scholarship fulfils Sir Winston's wish that there always be American students of the highest caliber at the College that bears his name.

The Kanders Churchill Scholarship is awarded from a pool of applicants to the Cambridge Master's in Public Policy. For the 15 Churchill Scholarships in mathematics, science, and engineering, we received 127 nominations from 82 Participating Institutions. Both of those numbers are the highest ever in the history of this competition. The most popular department to which nominees applied, as it is most years, was mathematics, with 31 applicants. Women represented 35% of the nominees and 40% of the winners. Five nominees withdrew to accept other scholarships, meaning that the overall success rate of the remaining pool was 12.3%.

UC-San Diego is celebrating its third Churchill Scholar in four years, which is noteworthy because all three of them came out of a single lab and were supervised by Weg Ongkeko, Associate Professor of Head and Neck Surgery. The University of Maryland/College Park has had four Churchill Scholars in the past three years. The University of Utah now holds the longest active winning streak, with a Churchill Scholar in each of the past five years. The University of Minnesota/Twin Cities placed its fifth Scholar in six years. Both Princeton and Harvard had a successful applicant, cementing their position as the top two institutions in the history of the competition. Princeton has had 43 winners and Harvard has had 39. Among newcomers, Boston University placed its first Churchill Scholar in only its second year as a Participating Institution.

For further information, contact Michael Morse, Executive Director of the Winston Churchill Foundation of the United States, 600 Madison Avenue, Suite 1601, New York NY 10022. Telephone 212-752-3200, Email mmorse@churchillscholarship.org
www.churchillscholarship.org

See our video: Selecting the Best of the Best

Vinay Ayyappan

Churchill Scholar

HOMETOWN
San Jose, California

INSTITUTION
Johns Hopkins University
BS, Biomedical Engineering

TO STUDY
MPhil, Radiology

As cancer cells metabolize the nutrients they need in order to proliferate and grow, they leave behind information that can be used to facilitate cancer diagnosis and treatment. Conventional imaging techniques cannot capture the speed at which these metabolic processes occur, and the compounds involved are too low in concentration to be detected. Dr. Ferdia Gallagher in the Department of Radiology has been at the forefront of driving clinical applications using a new technique called hyperpolarized 13C magnetic resonance imaging (MRI). This could allow the viewing in real-time of the breakdown of a metabolite injected into the body with 10,000 times the sensitivity of traditional techniques. Vinay will perform human trials of hyperpolarized 13C MRI on chemotherapy patients. The goal is to integrate this new imaging technique alongside other methods like tissue sampling and tumor genomics to create highly sensitive, individually tailored treatments for each patient.

Upon his arrival at JHU, Vinay secured a research opportunity where he studied the mechanisms by which breast cancer cells obtain energy and nutrients. He investigated the altered metabolism of a compound called creatine and the role of the CKMT1 gene in the metastasis of breast cancer. These efforts resulted in a second-author publication in *NMR in Biomedicine*, a first-author manuscript under review, and multiple poster presentations as well as the opportunity to present his abstract at the annual International Society of Magnetic Resonance meeting in Paris. In the summer of 2019, he interned at UCSF where he combined biological studies of metabolism and advanced imaging methods with state-of-the-art computational methods for data analysis in investigating telomere maintenance. In the field of bioinformatics he maintained the world's largest open source database on ADP ribosylation. He also found an opportunity at JHU's mechanical engineering department to investigate deep learning methods applied to quantitative phase imaging with implications to improve cancer diagnosis. During the fall of his senior year, he began a collaboration with a group that investigates the use of aspirin as a contrast agent for a new MRI technique called "Chemical Exchange Saturation Transfer."

In addition to academic research, Vinay has been integral to three undergraduate bioengineering design teams focusing on translational research with end products ranging from low-cost reusable biopsy needles to deep learning methods allowing for cancer analysis in resource poor settings. In the fall of 2019, he was nominated as a head teaching assistant. Vinay is a Goldwater Scholar, two-time Astronaut Scholar, and the recipient of two JHU awards for undergraduate research. He had 15 A+ grades with no grades below A. Vinay has elected to begin medical school at the University of Pennsylvania and defer his Churchill Scholarship by two years.

Anna Biggs

Churchill Scholar

HOMETOWN
Saint Paul, Minnesota

INSTITUTION
Harvard University
BA, Mathematics and Physics

TO STUDY
MASt, Applied Mathematics and Theoretical Physics

Anna is preparing for a career in theoretical physics research. Her academic interests lie at the intersection of mathematical physics, quantum field theory, string theory, and quantum information theory. At Cambridge, she proposes a course of study that will strengthen her understanding of supersymmetric gauge theories and address a burgeoning interest in quantum information and the black hole information paradox. Anna has been thinking about using string theory approaches to study the mysteries of black hole physics, where the principles of general relativity and quantum mechanics appear at first to contradict one another.

By the spring of her sophomore year, Anna was eager for an opportunity to apply her coursework in complex analysis and algebraic geometry to research questions. As a Weissman Research Fellow, she worked with Professor Murad Alim's geometric field theory and string theory group at the University of Hamburg. She quickly learned the mathematical background needed to contribute to a summer project in a research area now called "String Mathematics." Her contribution was a novel calculation of certain particle states in the string theory she and Professor Alim were studying, a result that had only been previously sketched in literature. She presented her work at a poster session in 2019 at the National Collegiate Research Conference and is currently in collaboration with Professor Alim on a manuscript for publication. Building on her interest in using differential geometry to answer questions from string theory, she secured a Herchel Smith Fellowship for research with Stanford Professor Shamit Kachru who is active on projects including those combining string theory, algebraic and differential geometry, and quantum field theory. Her work on computing approximations of Ricci-flat metrics on K3 manifolds was ongoing during her senior year under the supervision of a postdoctorate fellow at Harvard's Black Holes Initiative. Anna also has worked on graphene properties in the experimental physics lab of Professor Amir Yacoby as a PRISE Fellow recipient.

She is a Goldwater Scholar, a member of Phi Beta Kappa, recipient of Harvard's Detur Book Prize and a John Harvard Scholar. She was the national winner of the 2016 Cum Laude Paper Prize and a Presidential Scholar. A single A- was all that stood between her and a perfect 4.0 GPA. She worked for the Harvard College Office of BGLTQ Student Life.

Azim Dharani

Churchill Scholar

HOMETOWN
Lewisville, Texas

INSTITUTION
Duke University
BS, Chemistry, Computer Science, and Classical Archaeology

TO STUDY
MPhil, Chemistry

Azim is interested in the intersection of inorganic chemistry and computational biophysics. His research focuses on leveraging the biophysical characteristics of metals for improved anti-cancer metallodrugs and the development of metal-catalyzed solar fuels. Cambridge Professor Erwin Reisner's lab is pioneering semi-artificial photosynthesis research and under his supervision, Azim will explore materials engineering approaches to developing solar fuel cells and the use of transition metal cofactors in simulating enzyme activity.

Azim worked on the design of copper-binding drugs to inhibit the growth of metastatic prostate cancer (MPC). Despite their cancer inhibiting properties, these drugs target both healthy and cancer cells. Azim designed a strategy using prochelators to selectively target MPC cells, thereby reducing the side-effects of these heavy-metal drugs to healthy cells. His contribution to the project resulted in a co-authored publication in a leading chemistry journal. He also did large-scale synthesis of those prochelators and evaluated their anti-cancer properties in mice. He applied his finding to the study of Wilson's disease (a disease of excess copper build-up) and has synthesized another copper prochelator drug to potentially combat this disease. Azim's computational projects include modeling amino acid mutations and simulating how these changes alter the folding stability of *Griffithsin,* a protein with the ability to inhibit HIV by biding to sugars on its viral envelope. At Memorial Sloan Kettering, he worked on the development of a model system to evaluate the accuracy of free energy calculations in order to understand the current state of atomistic computational modeling of small metal-containing molecules. He also completed an internship at DE Shaw Research where he utilized supercomputers specializing in molecular dynamics to investigate an emerging class of proteins called RNA chaperones. The results from this internship project are expected to be published with Azim as a first-author. At DE Shaw, he also became aware of the supercomputer's ability to simulate the activity of metallo-enzymes in an effort to reduce carbon dioxide levels for future solar fuel development.

Azim is an Angier B. Duke Scholar, Goldwater Scholar, and Phi Beta Kappa inductee. He has received several research fellowships, including the American Association Cancer Research Undergraduate Fellowship, American Chemical Society Inorganic Division Award for Undergraduate Research, and an award for best poster and oral presentation from Sloan-Kettering Cancer Center. Azim is a member of the Duke Classics Collegium and published an article on biochemistry and the archaeological record on tumors.

Thomas Freitag

Kanders Churchill Scholar

HOMETOWN
Oreland, Pennsylvania

INSTITUTION
University of Pittsburgh
BS, Neuroscience and Psychology

TO STUDY
MPhil, Public Policy

Thomas's undergraduate research focused on epidemiology and health disparities, primarily on the spread of HIV and on substance abuse. At Cambridge, Thomas plans to explore the science policy challenges in stemming the transmission of HIV. By comparing the success in various countries of pre-exposure prophylaxis (PrEP), which can vastly reduce the spread of HIV, Thomas hopes to make best-practice recommendations for global health organizations.

At the University of Pittsburgh, Thomas worked alongside Dr. Mackey Friedman on the Pitt Men's Study, which is part of the longest-running HIV cohort study of gay and bisexual men in the US. Bringing experience as a neuroscience major to epidemiology, Thomas also collaborated with Dr. James Becker to examine the relationship between chronic HIV infection and neurocognitive decline. Thomas was an AMGEN Scholar in the summer of 2019 and worked at the NIH, looking at how interactions between race, ethnicity, and sexuality may explain disparities in drug and alcohol abuse. Thomas presented their findings at the NIH Summer Poster Day, and this research was subsequently selected for a national conference and publication. Thomas additionally won the David C. Frederick Public Service Internship Award, given to six Pitt students to carry out public service internships. Thomas used their award to work as a Policy Fellow at the City of Philadelphia's Office of LGBT Affairs.

Thomas is spent the 2019-20 academic year as one of two Pitt students to win a highly competitive spot in a year-abroad program at Jesus College, Cambridge. While finishing the Natural Sciences tripos, Thomas has become involved in various Cambridge science policy activities, such as Students for Global Health.

Thomas has a 4.0 average with 22 A+ grades and no grade lower than A. In the challenging Organic Chemistry sequence, Thomas was one of only three students out of 215 total who earned an A+ in both semesters. Thomas was also a member of the nationally renowned Pitt Men's Glee Club, which represented the United States at the centennial anniversary of the Battle of Flanders Field in Waregem, Belgium in October 2017. Thomas's goal is to obtain an MD/PhD, focusing on epidemiology and public policy, with the ultimate aim to help eliminate global health disparities in at-risk populations.

EliseAnne Koskelo

Churchill Scholar

HOMETOWN
Los Alamos, New Mexico

INSTITUTION
Pomona College
BA, Physics and Mathematics

TO STUDY
MPhil, Physics

Cambridge's Quantum Matter Group values the integration of theory and experiment, and Elise will leverage this research approach to gain increased understanding of the underlying physics of materials before pursuing a PhD. She plans to join Professor Siân Dutton's Group in the Cavendish Lab where she will conduct experiments focusing on exotic phases and frustrated magnetism in Ising garnets and other crystals. She will then attempt to understand which theoretical models of quantum behavior best explain experimental observations.

Elise's first research position began in high school at Los Alamos National Lab, where she researched nondestructive methods to identify hidden defects in metal parts and composites using scanning laser ultrasound techniques. She has applied for a US patent based on this technology to inspect 3D printed parts, *in situ,* and developed a number of algorithms to analyze 3D datasets, now essential to evaluation technology. For her senior theses research at Pomona, she investigated the role of "stochastic resonance" in thermoreflectance imaging, in which she developed a complete, experimentally-validated computational and analytical model of how noise can be used to stochastically enhance the resolution of the thermal imaging technique. Elise also received funding for summer research at Leibniz University in Germany where she worked on molecular spectroscopy. This summer, she researched structural phase transitions in 2D materials using density functional theory for the Los Alamos National Lab Computational Physics Summer Workshop.

Elise is a Goldwater Scholar, Phi Beta Kappa, and member of Sigma Xi. She has received numerous awards for scholarship and science research including the SPIE DJ Lovell Scholarship. She was a teaching assistant and leader of two campus special interest organizations including one dedicated to women in physics and astronomy. She is an avid runner and a small business owner selling fiber art. After Cambridge, she will pursue a PhD in Experimental Condensed Matter Physics at Harvard University with an NSF Graduate Research Fellowship.

Jamie Lee

Churchill Scholar

HOMETOWN
Bristow, Virginia

INSTITUTION
United States Naval Academy
BS, Computer Science and Japanese

TO STUDY
MPhil, Machine Learning and Machine Intelligence

Cyber intrusions from hostile entities is a growing threat in both the civilian and military spheres. At Cambridge, Jamie will be taking a taught course in Machine Learning and Machine Intelligence. Because Cambridge currently has some of the leading cybersecurity researchers in the world, she is eager to investigate some of their ongoing efforts involving real-time human and object tracking involving real-world applications in video surveillance, robotics, and human tracking. She has a particular interest in the development of efficient visual tracking algorithms for Unmanned Aerial Vehicles (UAVs) and other aircraft systems which can track and classify humans, ground vehicles, weapons, and other objects of interest. Jamie will serve as an officer in the US Navy's Information Warfare community after her year at Cambridge.

As a Trident Scholar, Jamie worked on the problem of mitigating data leakage through access patterns made by map application users (e.g., Google Maps, Strava). The cloud storage servers that are integrated with the map platforms can still attempt to obtain confidential information about the user during the search query process. She has worked to develop a novel remote-storage data structure that enhances user security at comparable performance levels. Her findings were presented at the 2019 Jean Bartik Computing Symposium and the 2019 Secure and Trustworthy Cyberspace PI Meeting. She also secured an internship position at the National Reconnaissance Office where she developed algorithms that derived more predictive kinematic features to help classify aircraft for better threat assessment. Her work resulted in a paper at the 2019 Military Sensing Symposium. She worked as a program developer at Lawrence Livermore National Labs where she developed a program that helped to improve the accuracy and precision of nuclear energy yield estimates without the need for labor intensive and time consuming manual measurements. She has also worked on the problem of collapsing bee populations caused by a class of neuro-active insecticides called neonicotinoids at the George Mason University Shared Research Instrumentation Facility.

In addition to receiving the Trident Scholar designation, she was selected to present at the Secure and Trustworthy Cyberspace Principal Investigators Meeting, the Military Sensing Symposium and the Jean Bartik Computing Symposium. She was also selected to serve as a student ambassador to represent the US Naval Academy at the Japanese Maritime Officer Candidate School. She was a senior member of the Navy judo team and volunteered for the Women in Cyber and Computing Club.

Harrison (Wei Tse) Li

Churchill Scholar

HOMETOWN
Walnut, California

INSTITUTION
University of California/San Diego
BS, Bioengineering

TO STUDY
MPhil, Cancer Research

Modern sequencing and molecular profiling technologies have generated large amounts of datasets that have yet to be analyzed for biological insights. Harrison is interested in computationally simulating biological gene-gene interaction networks and developing new algorithms to analyze and integrate large-scale bioinformatics datasets, with the goal of teasing out undiscovered patterns and observations. Harrison likes to connect ideas from math, computer science, genetics, biotechnology, and medicine to develop methods that will lead to therapeutic targets at the individual patient level. At Cambridge, he will work with Dr. Florian Markowetz to explore how patterns of aberrations in the copy number of genes may provide insights into their importance in cancer initiation and development.

Harrison has contributed to more than 20 projects that explore key features of tumors, including non-coding RNA dysregulation, dysfunctional immune signaling processes, and the tumor-resident microbiome. Through correlation testing and interrogation of multiple data types, Harrison sought to elucidate the mechanisms by which these features could affect tumor aggressiveness. He also designed and implemented algorithms to integrate multiple types of molecular profiling datasets for patient clustering. Harrison taught himself deep learning techniques in order to stratify cancer patients according to immunologic phenotype, which he inferred from integrating different data sets. Harrison has trained students and fellow lab members in computational analysis and machine learning. His facility with large data sets has enabled him to analyze the immune phenotype, non-coding RNA landscape, and microbiome composition of multiple cancers, including head and neck, prostate, kidney, liver, lung, and bladder cancer. He is the author of eleven papers and is a co-first author in eight of them, with five other manuscripts in preparation or under review. His data-centered research is also complemented by his knowledge of various *in vitro* technologies.

Harrison is a Goldwater Scholar and Regents Scholar and has received multiple awards for his research. He has a 3.99 GPA and received 21 A+ grades. He was captain of UCSD's 2019 iGEM (International Genetically Engineered Machine) team. He enjoys traveling, reading, cooking, poetry writing, running, and hiking. Harrison has deferred his Scholarship by one year and will remain in his undergraduate lab. During the pandemic, he has published two papers on COVID-19's relationship with tobacco and E-cigarette use and recently submitted three additional papers for publication, which looked at co-morbidities in COVID-19 patients and applied machine learning to COVID-19 patient data.

Alice Lin

Churchill Scholar

HOMETOWN
Berkeley Lake, Georgia

INSTITUTION
Princeton University
AB, Mathematics

TO STUDY
MASt, Pure Mathematics

Alice will pursue a career in research mathematics concentrating on number theory and arithmetic geometry. The Part III course will allow her to study some advanced yet foundational materials that she has not yet encountered as an undergraduate. These include a course on differential geometry that will go beyond her undergraduate-level classic theory as well as a algebraic topology course which is indispensable for future work in modern number theory and arithmetic geometry. She will take advantage of the depth of the graduate level classes in algebra and algebraic geometry available to her, such as the courses on representation theory and algebraic surfaces. She is also excited about the opportunity to learn new techniques on the modularity of elliptic curves.

Evolutionary game theory seeks mathematical models for the evolution of biological systems such as cooperation among insects. Under the supervision of Professor Simon Levin and his group at Princeton, Alice's first research project analyzed numerical simulations to understand how players would behave along the continuum between public and private property. In addition to continued studies on theoretical ecology, she also became enchanted with a sequence of courses on algebra and the foundations of number theory. In the summer of 2018, she completed an REU at Boise State where she was part of a number theory team, helping to uncover properties of elliptic pseudoprimes and Carmichael numbers. The poster on this work was awarded the Outstanding Poster Award for undergraduates at the annual joint meeting of the American Mathematical Society and the Mathematical Association of America. She continued her study of elliptic curves through her junior year, further exploring elliptic curves and their modular forms, and wrote an expository paper on the Modularity Theorem and Eichler-Shumura theory. In the summer of 2019 she studied number theory with Professor Ken Ono at Emory University where she and her collaborators produced a paper in the area of modular forms and harmonic Maass forms. She has expanded her work on modular forms for her senior thesis and applied algebraic techniques to study analytic properties of Hilbert modular forms.

In her junior year she received the Peter A. Greenberg '77 Prize from Princeton's Math Department for "outstanding accomplishments in mathematics" and the Shapiro Prize for academic excellence. She held several mentoring roles on campus, including the Mentoring Möbius group to help initiate undergraduates into the world of math research. She is an accomplished violinist and has toured with the Princeton University Orchestra. Her favorite composer is Mahler and she loves social insects. She revived the Princeton Bee Club and was its president.

Daniel Malawsky

Churchill Scholar

HOMETOWN
Chapel Hill, North Carolina

INSTITUTION
University North Carolina/Chapel Hill
BS, Biostatistics and Mathematics

TO STUDY
MPhil, Wellcome Sanger Institute

Genetic variation contributes to the unique phenotypes observed in health and disease and is driven by natural selection and random mutations. Of particular interest are mutations that inactivate genes, as they provide insight into their function. In outbred populations, it is relatively rare to observe complete inactivation of a gene. However, in populations with high rates of consanguinity the probability is increased. Using data from the East London Genes & Health study, Daniel will work with Dr. Hilary Martin at the Wellcome Sanger Institute to analyze data from this study of a consanguineous population to identify individuals with rare inactivating mutations and to study how they impact the metabolomic and phenotypic profiles of individuals. He hopes to elucidate the effect of these mutations on health. Daniel hopes to pursue a research career in population and medical genetics.

During his first research experience in neurobiology, Daniel studied neural circuits related to stress responses in mice. It became clear that he would need to rely heavily on computational and statistical methodologies in order to effectively analyze the complex data produced. He co-developed a semiautomated image analysis pipeline to extract the data needed from the collected images of the brain regions in question. With his interdisciplinary background in chemistry and programming, he contributed to a project in the rising field of Systems Chemistry at Oxford University; the project he worked on was motivated by the unsolved "Origins of Life on Earth" problem and the autocatalytic potential of chemical reaction networks. He also has experience in the field of high-throughput single cell-gene expression analysis where he focused on a type of therapy-resistant brain tumor called medulloblastomas. His contributions to the project earned him co-authorship on a paper published in *Nature Communications* and an upcoming co-first authorship on a paper expected to be published in *Communications Biology*. He is eager to continue developing new analytical methods for large datasets.

He is a recipient of the Morehead-Cain Scholarship as well as several other grant and merit awards including Phi Beta Kappa. He is an accomplished cellist and volunteer community gardener. He has worked in a refugee clinic setting in Tel Aviv, Israel, and enjoys discussing philosophy.

Srinivas Mandyam

Churchill Scholar

HOMETOWN
Basking Ridge, New Jersey

INSTITUTION
University of Pennsylvania
BA, Physics, Mathematics, and Biophysics
MS, Physics

TO STUDY
MPhil, Physics

Professor Jeffrey Baumberg's lab is pioneering the use of three-atom-thick semiconductors called Transition Metal Dichalcogenides (TMDs) in devices called nanocavities in order to harness the untapped quantum properties of these materials. This research could allow for the development of so called "room temperature exciton devices" with the potential to slash energy consumption in large computational systems. However, high quality TMDs are difficult to synthesize reliably. Srinivas co-first authored a paper in *ACS Nano* reporting the first known method of selectively producing large quantities of the bilayer TMD WSe_2 (W=Tungsten, Se=Selenium). At Cambridge, Srinivas will fabricate bilayer WSe_2 and ensconce the material in nanocavities to observe the effect of electrical tuning on the optical responses of these structures. He is excited to see if he can one day create next generation electronic and optoelectronic devices that exploit these unique properties.

Srinivas has extensive undergraduate experience with TMDs. He came up with a clever way to use "growth promoter" chemicals to grow large area bilayer flakes of 2 specific types of TMD. His improved growth methods produced such high quality TMD that it allowed collaborators from another lab to precisely pattern atomic-scale holes in the material to modify its quantum properties. His work led him to publish a comprehensive literature review on the growth of large-area TMDs for the research community. He also worked on biosensors based on graphene field effect transistors (GFETs). Under the mentorship of a senior investigator, he helped to improve his lab's nucleic acid detection to achieve attomolar (10^{-18}) sensitivity. The following summer he worked on a project aimed at developing GFET sensors for the rapid detection of anti-cancer drugs. Srinivas also conceived of an improved method for capturing and detecting methylated DNA, which is a biomarker for cancer. These projects resulted in five publications, with another in review.

Srinivas has been a teaching assistant for five different courses in Physics and Statistics including a graduate course. In addition, he created and taught a weekly elective class at a Philadelphia public middle school on effective public speaking and persuasion skills. He received a grant to study public speaking anxiety remediation in young students. He is a Goldwater Scholar, a Dean's Scholar, and was elected to Phi Beta Kappa as a junior. He is also a NASA PSGC scholar, a Hertz Finalist, and an NSF Graduate Research Fellow. He was the only sophomore winner of the Vagelos Challenge Award in his year. He has 10 A+ grades and is a chorale singer and award-winning metrical poet, among other interests.

Salvatore Pace

Churchill Scholar

HOMETOWN
Hamburg, New York

INSTITUTION
Boston University
BA, Physics
MA, Physics

TO STUDY
MPhil, Physics

Sal is excited about a branch of theoretical physics that describes the behavior of "zillions and zillions" of particles, known as quantum many-body theory. These systems of particles exhibit exotic emergent quantum phenomena when their constituents are strongly interacting with each other. Sal is currently exploring whether the general laws of quantum electrodynamics (QED), which describes how light and matter interact, can emerge from the collective behavior of particles in a physical material. He is continuing this research interest by pursuing his MPhil with Dr. Claudio Castelnovo in the Cavendish Laboratory's theory of condensed matter group.

Sal enjoyed his first taste of scientific research during his freshman year in the field of neutrino physics, where he helped to build an experiment to study the chemical stability of the liquid scintillator used by the SNO+ detector. Toward the end of his sophomore year, Sal was introduced to the Fermi-Pasta-Ulam-Tsingou (FPUT) paradox in the field of condensed matter theory. During the summer before his junior year, he essentially resolved a 60-year old problem of non-linear statistical mechanics. He was the lead author on the paper for this research, which was published as an "Editor's Pick" in the February 2019 issue of *Chaos*. Sal has since completed a second paper published in the November 2019 issue of *Chaos*, of which he is the lead author, expanding on his findings. He presented his FPUT paradox findings at the 2019 and 2020 APS March meetings and has given numerous poster and oral presentations. Sal worked on his senior honors thesis researching emergent QED in a theoretical model of a class of materials called quantum spin ice. He is the lead author of a paper on his findings, which is currently under peer-review.

Sal graduated with a BA and MA with a perfect 4.0 GPA and has already completed the first two years of the physics Ph.D. curriculum at Boston University. Sal is passionate about leaving younger students with a strong impression of math and physics. He was awarded "Learning Assistant of the Year" at BU. Among numerous awards and honors, he is a Goldwater Scholar, a member of Sigma Xi, a recipient of an NSF Graduate Research Fellowship, and is currently a finalist for the LeRoy Apker Award. After Cambridge, Sal will be attending MIT to pursue a Ph.D. in physics. Outside of theoretical physics, he enjoys listening to and attending punk rock shows, playing video games, reading political theory, and everything espresso and coffee-related.

Mehtaab Sawhney

Churchill Scholar

HOMETOWN
Commack, New York

INSTITUTION
Massachusetts Institute of Technology
BS, Mathematics

TO STUDY
Pure Mathematics

Mehtaab chases after those elusive and unexpected moments of mathematical insight which can occur after long periods of struggle with seemingly intractable problems. As a high school participant in the MIT-Primes-USA program, Mehtaab came under the thrall of a branch of mathematics called combinatorics. According to Mehtaab, open problems in combinatorics are often elementary to state and they offer exciting possibilities for high school students because there is a low barrier to entry. Since this initial experience, his main interests have stayed within combinatorics. Mehtaab has deferred his Churchill experience by a year and will be a visiting scholar, collaborating with Professor Tim Gowers.

In 2017 Mehtaab participated in the University of Minnesota-Duluth REU where he and his co-collaborators produced results for publication in: *Electronic Journal of Combinatorics*, *European Journal of Combinatorics*, *SIAM Journal of Discrete Mathematics* and *Journal of Combinatorics*. As a sophomore, Mehtaab teamed up with two fellow undergrads and solved a conjecture first posed in 2001 regarding the maximum number of independent sets in a graph of given degree distribution. Their work was published in the *Journal of Combinatorial Theory Series B*. This was then extended by the same team to more general situations including graph coloring in a paper titled "A Reverse Sidorenko Inequality", which was published in *Inventiones Mathematicae*. Subsequently, he finished two more papers with this team, one solving a problem in additive combinatorics which was published in *Mathematical Proceedings of the Cambridge Philosophical Society* and another paper which improves on an 80 year old result in high dimensional discrete geometry, which was published in *Advances in Mathematics*. He also published results in *Discrete Mathematics* and *Annals of Combinatorics*.

Mehtaab also takes particular delight in creating math problems for competitions like AMC and AIME so that young enthusiasts can discover the joy of stumbling upon "flashes of insight." He has worked for quantitative trading firms over winter and summer breaks. He has earned 27 A+ grades over the course of his undergraduate career with no grade below an A.

Jasmine Stone

Churchill Scholar

HOMETOWN
Austin, Texas

INSTITUTION
Yale University
BS, Computer Science

TO STUDY
MPhil, Engineering

Jasmine's love of swimming spurred a fascination with learning, decision-making and motor control. As a synchronized swimmer, she often wondered how choreography instructions, which are often ambiguous but crucial for synchronization, were interpreted by her teammates. At Cambridge, she will work in the lab of Dr. Guillaume Hennequin, who is a leading theorist in the area of motor control. She will attempt to augment Dr. Hennequin's control theory model of movements with her own quantitative model of how the brain prepares for movements using a new machine learning tool called latent factor analysis via dynamical systems. She plans to pursue a career in computational and theoretical neuroscience, which is an interdisciplinary field that uses quantitative approaches from physics, computer science, engineering, and mathematics.

As a high school student, she secured a neuroscience research position at the University of Texas-Austin where she conceived the idea to test whether visual perception of an object is improved by having physical control of the object. When that experiment proved difficult to design rigorously, she pivoted and instead investigated the role of disparity, a type of depth cue, on perception She developed the experimental paradigm for the experiment to test her hypothesis and developed a series of control conditions that ruled out alternate explanations. She presented that work at two research conferences. At Yale, she also worked with a graduate student on a project at the junction of computational neuroscience and artificial intelligence: using trained recurrent neural networks (RNN's) to study how cortical circuits perform cognitive tasks. She was instrumental in the development of the lab's RNN-training code base and her work has resulted in a publicly released software package, a conference presentation, and a paper in preparation with Jasmine as co-first author. In addition, she has interned at the Howard Hughes Medical Institute's Janelia research campus where she comparatively evaluated algorithms for distinguishing different neurons in calcium-ion images of neural activity.

Jasmine is a Phi Beta Kappa inductee and Goldwater Scholar as well as the recipient of multiple research grants and academic merit awards at Yale, including the Benjamin F. Barge Prize, awarded for excellence in mathematics. She was a nationally ranked high school synchronized swimmer and founded the synchronized swimming club at Yale. She was a first violinist for the Yale Symphony Orchestra and holds two patents pertaining to neuromuscular control. In her summers, she also interned at an CTRL-Labs, a brain-machine interface startup recently acquired by Facebook, and at Google.

Macy Vollbrecht

Churchill Scholar

HOMETOWN
Ames, Iowa

INSTITUTION
University of Minnesota/Twin Cities
BS, Genetics, Cell Biology, and Development

TO STUDY
MPhil, Plant Sciences

Macy's research into mammary gland development during pregnancy and into plant genome engineering spurred her interest in plant developmental biology. She is interested in the genetic control of shoot branching and how plant architecture traits hold important implications for agriculture. At Cambridge, Macy will work with Dr. Ottoline Leyser to study how changes in cytokinin homeostasis and how cytokinin-mediated regulation of another key hormone (auxin) may affect shoot branching. Using the model plant *Arabidopsis thaliana*, she will investigate mutants in a large gene family called Arabidopsis Response Regulators, which regulate cytokinin signaling in this plant, and she will attempt to elucidate the underlying mechanisms involved in shoot architecture.

While in high school, she worked on a gene editing project in zebrafish. She investigated the role of the SOCS3 gene as a potential tumor suppressor by using CRISPR/Cas9 gene editing to create mutant zebrafish with loss-of-function alleles in SOCS3. At the University of Minnesota's Center for Precision Plant Genomics, she engaged in projects ranging from bioinformatics to molecular biology to biochemistry. In one of these projects, she and her collaborators worked on a novel method to create gene edited plants, which led to a paper in *Nature Biotechnology* and the opportunity to present her findings in a seminar normally reserved for faculty and grad students. She and her group also worked on a directed evolution project to engineer an enzyme that conferred herbicidal tolerance in a few plant species. Macy also held a summer internship at a local biotech company where she independently utilized novel genome-engineering strategies to help develop disease and agricultural models in large animals. Her contribution to these data involving site-specific transgene integration in pig cells was later used for an NIH grant submission in the Somatic Cell Gene Editing program. The following summer, she participated in a research program at Cold Spring Harbor Lab where she investigated how the immune system controls the proliferation and gene expression of mouse mammary epithelial cells. Her experimental and computational results elucidated that certain immune cells are important for regulating mammary cell proliferation. She received the Best Undergraduate Poster award at the University of Minnesota's Developmental Biology symposium, and her lab at Cold Spring Harbor continues to use Macy's RNA library datasets.

Macy received an Astronaut Scholarship and multiple recognitions from the University of Minnesota for academic excellence and scientific research. She was an active leader for campus engagement activities, worked as a teaching assistant, and is an ultimate frisbee player, playing competitively on the national-level college women's team.

Tanay Wakhare

Churchill Scholar

HOMETOWN
Gaithersburg, Maryland

INSTITUTION
University of Maryland/College Park
BSc, Mathematics and Computer Science

TO STUDY
MPhil, Advanced Computer Science

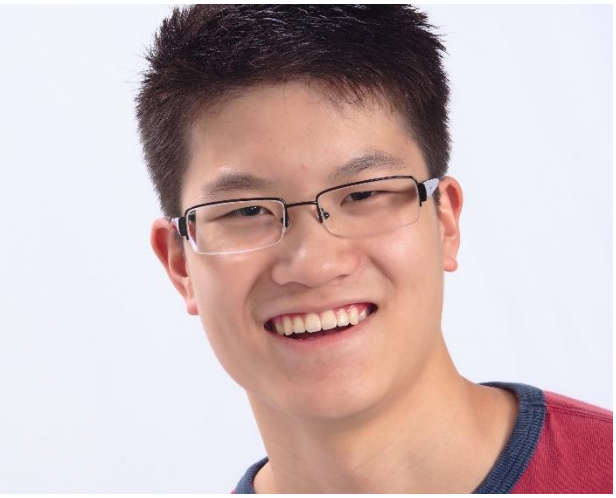
Artificial General Intelligence (AGI) is still only a theoretical possibility, and the promise of a machine that is capable of learning and understanding like a human is still the domain of science fiction. Tanay would like to use his mathematical background to research topics involving theoretical computer science and deep learning, to pursue the possibility of AGI in his lifetime. At Cambridge, he is most excited about engaging with the AI group and Programming, Logic and Semantics group in order to delve into the mathematical formalism of artificial reasoning, which will potentially provide a rigorous justification for the efficacy of deep neural networks.

Tanay spent the summer of 2020 implementing and training recent innovative reinforcement learning algorithms, allowing agents to learn intelligent strategies to solve problems based on only feedback about their performance. In mathematics, he formed a lasting working relationship with Dr. Christophe Vignat from the University of Paris Sud. Together, they co-authored multiple papers about exotic zeta functions, continuous binomial coefficients, automatic sequences, elliptic functions, and the discrete normal distribution. Tanay secured a research position at the National Institutes of Standards and Technology, where he authored two papers with Dr. Howard Cohl on generating functions for basic hypergeometric series. He also collaborated with Dr. Karl Dilcher from Dalhousie University to study the Witten zeta function. He also wrote a solo paper solving an open conjecture on the Jacobi theta function, the building block of elliptic functions. His work has been published in a variety of leading journals.

Tanay is a Goldwater Scholar and the recipient of multiple honors from the University of Maryland, including the University Medal, the highest honor the university bestows on an undergraduate. He has developed and taught three courses at Maryland and has been a teaching assistant seven times. Tanay is thoroughly enamored with travelling, has hiked through 21 National Parks, and has spent time backpacking across Europe and Asia. He minored in archaeology. Tanay has decided to delay his Churchill year until 2021.

Michael Xiao

Churchill Scholar



HOMETOWN
Pleasant Grove, Utah

INSTITUTION
University of Utah
HBS, Biology

TO STUDY
MPhil, MRC Cancer Unit

In middle school, Michael began experimenting in his parents' basement using a UV lamp and watching YouTube videos on how to extract DNA. In high school, his work demonstrating mutagenesis induced by particulate matter and UV light resulted in a first-author published paper (*Mutation Research*), and he was the first-ever high school student to present his work at the Annual Meeting of the American Association of Cancer Research (AACR). At Cambridge, he will join Dr. Christian Frezza's lab where he will be able to build on his previous work investigating intracellular interactions in the context of tumor initiation by combining cell signaling, metabolism, and epigenetics. The Medical Research Council (MRC) is equipped with a state-of-the-art metabolomics facility and LC-MS mass spectrometry platforms so that he can investigate the role of fumarate hydratase in tumor formation.

As a college sophomore, he worked on understanding the signaling control of stem cell function, specifically the role of auto-inhibition in a protein kinase called PASK, which is crucial for adult stem cell function. His first-author work detailing the PASK auto-inhibited state is in submission, and the data that he generated for the project was used to help secure a $1.8M R01 research grant from the National Institutes of Health. He has also worked on the role of a special tyrosine kinase (JAK2) in the blood disorder called *hypereosinophilia*, and his discovery of a novel patient derived variant of JAK2 resulted in a publication in the journal *Blood* as a contributing author. In addition, he explored the role of SIRT5, an enzyme involved in acute myeloid leukemia and its role as a tumor promoter. His results have been submitted to *Cancer Cell* with Michael as co-author. In addition, he has worked on potential applications for cancer diagnostics and immunotherapy involving thymidine kinase 1 which is expressed on some breast and prostate cancer cells; he has presented this work to the AACR while still in high school on three separate occasions.

Michael is a Goldwater Scholar and received the University of Utah's flagship merit scholarship award. He graduated *magna cum laude* (top 2.5% of the University's College of Science). He is a competitive pianist with a wide classical repertoire and won an opportunity to play at Carnegie Hall.

Following his MPhil at Cambridge, Michael plans to pursue further medical and graduate training as an MD/PhD student in the Tri-Institutional MD-PhD Program, a collaboration between Weill Cornell Medicine, The Rockefeller University, and the Memorial Sloan Kettering Cancer Center in New York City.