

## Columbia University Invests in Early-Stage, High-Risk Interdisciplinary Research

*RISE competition identifies four teams to receive funding for innovative research partnerships.*

**NEW YORK, June 24, 2020**—Four teams will receive funding through **Research Initiatives in Science and Engineering** (RISE), one of the largest internal research seed grant competitions within the University, announced Columbia University's Office of the Executive Vice President for Research. The annual award provides funds for interdisciplinary faculty teams primarily from the basic sciences, engineering, and/or medicine to pursue extremely creative and interdisciplinary fundamental research projects. Each team receives \$80,000 per year for up to two years.

Since 2004, the RISE competition has provided Columbia faculty and research scientists with the initial funding necessary to explore paradigm-shifting and high-risk ideas, which normal funding channels would dismiss as too risky or too out-of-the-box without preliminary data. RISE allows our world-class researchers to ask highly-novel questions and propose new methodologies, and catalyzes cross-school collaborations.

The 2020 competition accepted 37 pre-proposals, thereafter inviting eight teams to submit full proposals. Between five and nine reviewers evaluated each full proposal's interdisciplinary quality, potential impact, and innovation.

"This year, we saw an extraordinary assortment of highly competitive applications," says **Victoria Hamilton**, Executive Director of Research Initiatives, and administrator of RISE. "145 reviewers generously lent their time and expertise to help select this year's high risk, and potentially high-reward proposals the RISE competition seeks to fund. We are very proud of these newly awarded teams and look forward to the scientific impact that may result from their research."

### 2020 RISE AWARDEES

***Take a look inside – Magnetic Resonance Imaging of magma analogues to study volcanic eruptions***

**Christopher Boyce** (Chemical Engineering)  
**Einat Lev** (Lamont-Doherty Earth Observatory)

Volcanic eruptions and resulting magma flow involve 3D motion of liquid, solid particles and gas bubbles in 3D opaque systems. Current techniques to characterize these flows involve (i) optical imaging of only the surface flow and (ii) dissection of hardened magma after flowing. These techniques fail to capture the motion of gas, liquid and bubbles in the interior of such systems while the flow is occurring, leaving many unanswered questions and depriving models of robust tests of their validity. Magnetic resonance imaging (MRI) can measure liquid, solid and bubble motion in 3D opaque systems, such as the human body and chemical reactors. Here, we seek to develop techniques and demonstrate the capabilities of MRI to characterize analogs of volcanic eruptions and magma flows.

***High-resolution measurements of cortical traveling waves for reinforcement learning and decision-making***

**Jacqueline Gottlieb** (Neuroscience)  
**Joshua Jacobs** (Biomedical Engineering)

A fundamental question in neuroscience is: How do different brain areas coordinate their activity to support complex behaviors? We recently identified a new type of brain signal in humans—‘traveling waves’ that propagate continuously across the surface of the brain during memory and cognitive processes. In this project we will test for the first time the role of traveling waves in memory and decision making by recording traveling waves from monkeys who are implanted with high density electrode arrays. We will use these rare recordings to measure features of traveling waves during behavior and evaluate whether the properties of these waves change throughout learning and correlate with task performance. Our studies have both basic and translational implications. They may identify a new way in which brain regions interact via spatially organized waves and extend our understanding of neurological diseases related to impaired neuronal communication.

***A novel concept for generating, manipulating, and trapping pure samples of complex organic molecules***

[Sebastian Will](#) (Physics)

[Daniel Wolf Savin](#) (Columbia Astrophysics Lab)

One of the most intriguing results of quantum research over the past century is that today we can control matter down to the level of single atoms. A combination of deep theoretical understanding of atoms with technological breakthroughs in microwave and laser technology made this possible. Quantum control of atoms has opened the door to new applications from ultraprecise atomic clocks to trapped ion quantum computers.

Molecules, being more complex than atoms, have long defied attempts to control them on the quantum mechanical level. Over the last decade, scientists have developed methods to trap single molecules and to control their quantum states, but progress has mostly been limited to highly specialized molecules that have been specifically chosen for proof-of-concept demonstrations. With this project we want to broaden the scope and address the fundamental question: Can the techniques of laser cooling and quantum control be extended towards complex organic molecules?

In this project, we will work on laying conceptual foundations to achieve quantum control over a wide range of molecules with relevance across multiple areas of science, medicine, and industry. At the heart of this study, we will develop schemes for laser cooling of carbon-bearing molecules – starting from simple molecules and advancing to more complex molecules. We expect that our findings can serve as a steppingstone for novel applications in molecular engineering, from fundamental molecular physics, astrobiology, and analytic chemistry to medical diagnostics and quantum technology.

***X-ray atomic pair distribution function to understand inter- and intra-molecular interactions of solvent-water systems for application in temperature swing solvent extraction desalination***

[Ngai Yin Yip](#) (Earth and Environmental Engineering)

[Simon Billinge](#) (Applied Physics and Applied Mathematics)

In solvent-water mixtures, inter- and intra-molecular interactions between solvent and water molecules principally govern bulk properties of the mixture. But, currently, virtually no detailed understanding of these interactions exists. This project aims to develop novel atomic pair distribution function (PDF) methods using the synchrotron x-ray at the National Synchrotron Light Source

II of Brookhaven National Laboratory, for a mechanistic understanding of the solvent-water molecular interactions in temperature swing solvent extraction (TSSE), a disruptive desalination technology being developed at Columbia University. Pioneering the use of atomic PDF to characterize binary liquid mixtures will be an important stride towards establishing the technique as a standard analytical tool to study the ubiquitous phenomenon of solvation and multi-component liquid mixtures. This interdisciplinary research pools together expertise from two separate and traditionally unassociated fields, Prof. Billinge in synchrotron x-ray PDF method and Prof. Yip in solvent-water chemistry and TSSE desalination.

## **PROGRAMMATIC IMPACT**

RISE not only awards critical seed funding for risky and interdisciplinary collaborations; once the funding has ceased, the program tracks how its seed funding contributes to the researchers' abilities to obtain subsequent sponsorship from government agencies and private foundations.

Since 2004, RISE has awarded \$12.4 million to 83 projects. These 83 teams later secured more than \$56.3 million from governments and private foundations. These projects have additionally garnered more than 140 peer-reviewed publications and educated more than 140 postdoctoral scholars and graduate, undergraduate, and high school students. A complete list of **RISE-funded researchers** is available online.

Applications for the **2021 competition** will run from September to early-October 2020, with awarded teams announced by Spring 2021.

For interview requests and additional information, or to partially- or fully-fund a new RISE project, contact Ty Rosa ([ty.rosa@columbia.edu](mailto:ty.rosa@columbia.edu)).

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## **About the Office of the Executive Vice President for Research**

The Office of the Executive Vice President for Research has overall responsibility for Columbia University's research enterprise, encompassing a broad spectrum of research departments, institutes, and centers in the natural and biomedical sciences, the social sciences, and the humanities. The office works to foster the continuation of those creative endeavors and to promote an environment that sustains the highest standards of scholarship, health, and

safety. The office establishes and administers the policies governing the conduct of research at the University, and oversees management of its research programs. It also assists investigators seeking external funding, promotes interdisciplinary research, and awards seed money for early-stage investigations. For more information, visit <https://research.columbia.edu/menulink/office-executive-vice-president-research>.