

Breakthrough Prize in Mathematics Symposia
Bechtel Conference Center
November 10, 2014

11:00 a.m. Welcome
Ralph Cohen, Senior Associate Dean for Natural Sciences, and Barbara Kimball Browning Professor of Mathematics, School of Humanities and Sciences

11:05 a.m. Panel Discussion with Yuri Milner and the 2015 Breakthrough Prize in Mathematics Laureates

Noon Box lunch in Oksenberg and lobby

1:00 p.m. Terence Tao (UCLA) "Polymath Projects: Massively Collaborative Online Mathematics"

Introduced by Timothy Gowers in 2009, "Polymath projects" are online projects in which many mathematicians (both professional and amateur) collaborate on a single research program. While some problems have turned out to not be well-suited to the "Polymath" approach, there have been notable successes, most recently in building upon Yitang Zhang's breakthrough towards the twin prime conjecture. We discuss some past Polymath projects, and speculate on the future utility of this research paradigm for mathematics.

1:40 p.m. Jacob Lurie (Harvard) "Analogy and Abstraction in Mathematics"
A great deal of mathematics is inspired by analogies: that is, relationships (often unexpected) between phenomena which arise in seemingly different contexts. When analogies are sufficiently strong, we often introduce definitions or axioms which attempt to capture the common features of the underlying phenomena. In many cases, these axioms (and the structures they describe) can take on a life of their own and become objects of mathematical study in their own right. In this talk, I'll discuss some examples of this paradigm, drawn from classical abstract algebra and modern algebraic topology.

2:20 p.m. Richard Taylor (Institute for Advanced Study) "The Langlands Program"
The Langlands conjectures provide a remarkable framework linking algebra and geometry. They have been extremely influential in number theory, and in recent years have made contact with physics. In the last 40 years we have made extraordinary progress on these conjectures, but even more remains to be done. Progress on the Langlands conjectures lay behind both Wiles' celebrated proof of Fermat's Last Theorem and the advances made on the Birch-Swinnerton-Dyer conjecture. In this talk I will try to illustrate the Langlands conjectures by looking at some concrete examples.

3:00 p.m. COFFEE BREAK

3:30 p.m. Simon Donaldson (Simons Center for Geometry and Physics) “Geometry in Manifolds of Exceptional Holonomy”

We will first discuss “exceptional” structures on spaces of dimension 7 and 8 and connections with the quaternion and octonion number systems discovered in the 19th century. Then we will try to give an idea of some questions of great current interest in this field (connected to M-theory in physics), in which it seems reasonable to hope for progress over the next few years. These questions involve the exceptional structures themselves, and also geometric objects—special minimal submanifolds and gauge fields—which can be defined in them. The fundamental difficulties, which are formidable, lie in the areas of analysis and partial differential equations.

4:20 p.m. Maxim Kontsevich (Institut des Hautes Études Scientifiques) “Calabi-Yau Motives”

I’ll speculate on a possible interaction between two very different topics/lines of thought in algebraic geometry: (1) Calabi-Yau varieties; i.e. smooth projective varieties with vanishing Ricci curvature (equivalently, the canonical class is trivial), playing a central role in birational geometry, (2) Grothendieck’s yoga of motives; i.e. “natural” building blocks for cohomology of all algebraic varieties.