Title: Surgery on knots and exotic phenomena in 3- and 4-manifolds

Project Leader: Kyle Hayden

Abstract: Many important questions in low-dimensional topology can be reframed as questions about knots and links, simpler objects that we can easily draw by hand. In fact, any smooth, compact 3- or 4-dimensional manifold can be described and manipulated using a framework of knot and link diagrams called "Kirby calculus". This framework was invented in the 1970s but has recently been implemented using software, which enables even beginners to make progress on interesting problems in low-dimensional topology. Moreover, this can be combined with recently-developed programs that compute geometric properties of 3-manifolds and powerful invariants of knots/links like knot Floer homology and Khovanov homology. The software is user-friendly and easy to learn, and can also help make the theoretical material easier to digest. We'll take these tools and apply them to a handful of interrelated questions. One goal is the construction of new examples of "exotic" 4-manifolds, which are topological manifolds that admit multiple distinct smooth structures.