# M*A*T*H COLLOQUIUM

Wednesdays 4 p.m. • Darwin 103 • Coffee, Tea & Cookies @ 3:45

**Sonoma State University Department of Mathematics and Statistics presents a series of informal talks open to the public.**

*"The first thing to understand is that mathematics is an art."* -Paul Lockhart

Feb 1 **A User-Friendly Derivation of $E = mc^2$** — **Rick Luttmann, Sonoma State University (Emeritus)**

Einstein's famous formula quantifies the equivalence of mass and energy. But when Einstein proposed it in his 1906 paper, he wasn't thinking of mass-energy conversion, a phenomenon not then known or even suspected. He was merely trying to update the classical physics formula for Kinetic Energy to allow for the new and counter-intuitive conclusion which his remarkable Theory of Relativity predicted: that mass, time, and distance are not absolute and objective but depend on the speed $v$ (relative to the speed $c$ of light) between the observer and the observed via the factor $\sqrt{1-(v/c)^2}$. We look at the derivation of both the old and the new Kinetic Energy formulae and sketch briefly where the $\sqrt{1-(v/c)^2}$ factor comes from.

Feb 8 **The Exceptional Platonic Solids** — **Andrew Conner, St. Mary's College**

Since ancient Greece, scientists have been fascinated by the 3-dimensional figures we call the "Platonic solids." There are only five: the tetrahedron, cube, octahedron, dodecahedron and icosahedron. In this talk, I'll explain why there are only five, and I'll illustrate a surprising connection between the list of Platonic solids and the apparently unrelated problem of classifying complex polynomials with simple isolated critical points.

Feb 15 **The Natural Statistics of Binocular Disparity and Blur in Everyday Life** — **Marty Banks, Vision Science Program, University of California, Berkeley**

The retinal images people experience depend on the visual scene and where in the scene they look. Many properties of the visual system seem to derive from the statistics of this stream of images. But to test this, the statistics must be measured. We did this by developing an eye-and-scene tracker that measures gaze direction and scene distances. It is mobile, so participants performed natural tasks while we collected the statistical data. The statistical data confirm that many properties of the visual system conform to the statistics of retinal images one encounters in everyday activities.

Feb 22 **From Counting to Quantum Physics** — **Emily Clader, San Francisco State University**

Enumerative geometry is concerned with answering questions like: "given five points in the plane, how many ellipses pass through all five of them?" These problems have a rich history, including some techniques that were not always mathematically rigorous but still produced the right answers (usually). Mathematicians' attempts to carefully develop the subject of enumerative geometry have led to many recent advances, and even to some unexpected connections with the physics of string theory. In this talk, I will give a tour of some of the problems, pitfalls, and successes in the history of enumerative geometry.

Mar 1 **Making Math** — **Mike Persinger, James Monroe School; SSU Math/Stats and Education faculty**

Through Project Make the Way, Santa Rosa kindergarten through 8th-grade students are learning math through making: starting with a Maker challenge, they encounter and explore grade-level mathematics. We will try out a challenge, see examples of children at work, and see some results of engaging in mathematics through these challenges.

Mar 8 **The Joy of Modeling and Mathematica!** — **Students from Fall 2016 Math 180 and Math 470 classes**

Modeling without clay or glue? The *joy* of Mathematica? We'll see both. Come see amazing student projects from Martha Shott's Mathematical and Statistical Modeling course and Nick Dowdall's Mathematical Programming course. Learn about applications of matrices, differential equation, regression, and programming logic to natural systems, puzzles, and more!

Mar 15 **No Talk—Spring Break**

Mar 22 **Learning to Engage in Mathematical Practices through Formative Assessment Lessons** — **Kimberly Seashore, San Francisco State University**

Formative assessment is a process of eliciting students' understanding of particular concepts and then using that information to design and enact instruction that is more effective than it would otherwise have been (Black and Wiliam, 1998). Research has demonstrated substantial learning benefits from intentional use of formative assessment techniques to analyze student thinking and modify classroom activities—techniques such as exit tickets, group work, and peer feedback. I will present the findings of a study of teachers making use of lessons developed by the Mathematics Assessment Project (MAP) embedded with formative assessment practices. These lessons show evidence of changes in the teachers' and students' engagement with student thinking, mathematical content, and practices as part of the lesson. I will also share some of the methodological challenges in studying teacher learning around complex teaching practices.

Mar 29 **Mathematics Gives You Wings** — **Margot Gerritsen, Director of Institute for Computational and Mathematical Engineering and Professor, Stanford University**

Math Festival

Is it difficult to believe that linear algebra, of all subjects, is critically important and downright beautiful? In this talk I will discuss the ways in which linear algebra is at the very core of science and engineering, and is foundational to hot areas such as data science. Did you know, for example, that the algorithm that started Google is nothing but an eigenvalue problem? Did you know that machine learning needs orthogonal decompositions and that many programs that recommend movies or books (or people!) you might like are really just big matrix completion problems?

Apr 5 **Hyperbolic Geometry and the Art of M.C. Escher** — **Martha Byrne, Sonoma State University**

In this talk, we'll explore the bizarre world of hyperbolic geometry where parallel lines are not what you expect, the enchanting art of Dutch artist M.C. Escher where nothing is as it seems, and the fascinating places these two worlds overlap. We'll start by talking about geometric axioms and how one small change in assumptions creates a whole new (logically consistent) geometry in which many of the "rules" you think you know are broken, one in which squares don't even exist. Next we'll talk about tiling the Euclidean plane and look at Escher's tessellations. Finally, we'll bring together hyperbolic geometry and Escher's tessellations.

Apr 12 **The Dehn-Somerville Relations and the Catalan Matroid** — **Anastasia Chavez, University of California, Berkeley**

A *polytope* is a geometric object with straight sides, often called an $n$-polytope where $n$ is its dimension. For example, a polygon is a 2-polytope and a cube is a 3-polytope. The $f$-vector of a $d$-polytope stores the number of faces of each dimension: so the $f$-vector of a cube is (8, 12, 6) (8 vertices, 12 edges, 6 faces). For many polytopes $P$, the *Dehn-Sommerville relations* condense the $f$-vector into the $g$-vector, which has about half the length. Thus, to determine the $f$-vector of $P$, we only need to know approximately half of its entries. This raises the question: Which such subsets of the $f$-vector of such a polytope are sufficient to determine the whole $f$-vector? It turns out that the answer is given by the *Catalan matroid,* a beautiful combinatorial object we will describe. (joint work with Nicole Yamzon)

Apr 19 **Predicting the Quality of Bordeaux Wine** — **Grace Brown, Sonoma State University**

Bordeaux wines have been made in much the same way for centuries. Yet, there are differences in quality from year to year that can be quite large. In 1990, Princeton economist Orley Ashenfelter devised a statistical model to predict the quality of Bordeaux vintages. In this talk, we will present and explain Ashenfelter's results, showing that the factors that affect fluctuations in wine vintage quality can be explained in a simple quantitative way. We will show that a straightforward statistical analysis predicts the quality of a vintage, and hence its price, from the weather during its growing season. Along the way we will cover the basics of linear regression and predictive modeling.

Apr 26 **Understanding the Dynamics of the Antarctic Ice Sheet** — **Noemi Petra, University of California, Merced**

In the first half of the talk, I will discuss the Applied Mathematics graduate program at the University of California, Merced, namely the requirements, admission process, curriculum, and faculty research interests. In the second half of the talk, I will focus on my research that combines mathematics such as numerical analysis, linear algebra and statistics to get a better understanding of the dynamics of the Antarctic ice sheet by uncovering the hidden world beneath the ice. Satellites have been recording Antarctic ice flow at the surface of the continent for decades. However, to understand the behavior at the top, one has to look at interactions happening deep below where the ice meets the Antarctic continent. In this talk, I will present a modified least squares technique that will allow us to infer unknown parameters in the ice sheet model that characterize the friction between the continental rock and the ice. We hope that this research will help climate scientists to better understand the flow of Antarctic ice from the continent into the sea and its effect on sea level.

May 3 **Native American-based Mathematics Materials for Integration Into Undergraduate Courses** — **Charles P. Funkhouser, PI, and Patrick Weasel Head, Tribal Cultural Liaison, California State University, Fullerton**

Our project has developed and researched undergraduate mathematics materials based in the culture and mathematics of Native American Peoples for integration into undergraduate courses. Mathematics topics include probability and statistics, number theory, transformational geometry, calculus, and pre-service elementary and secondary education-related content. These materials—both paper and electronic—are classroom ready, and are developed and piloted in consultation with Tribes in the Rocky Mountains, the Plains, the Pacific Northwest, and the Southwest. We are currently beginning new culturally-based efforts with other Tribes and mathematicians throughout the U.S., as well as broadening the lesson content domain into all areas of STEM. This work is an NSF DUE-funded project.

May 10 **No Talk—Last week of instruction**

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