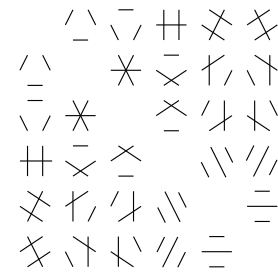# Mathematics Seminar

Rocky Mountain Algebraic Combinatorics Seminar

Getting to the roots: From X-ray crystallography to factoring polynomials

Bernhard Bodmann
University of Houston

This talk concerns a problem in non-linear signal reconstruction which has a long history, unsolved problems and many modern applications: signal recovery from intensity measurements. A notorious example is X-ray crystallography, the determination of a function from the magnitude of its Fourier transform. After a brief overview of the history of this inverse problem, we study a toy model, determining a complex polynomial from its magnitudes on the unit circle. This simple problem already exhibits the main difficulties that need to be overcome in X-ray crystallography and points to methods from harmonic analysis and real algebraic geometry that resolve the underdetermined nature of intensity measurements. The talk will conclude with an alternative to a construction by Cynthia Vinzant, addressing the minimal number of quantities that are needed for recovery in the cubic case, and an open problem.

Spikes, Graphs and Modulations: Phase Retrieval for Finitely-Supported Complex Measures

Bernhard Bodmann
University of Houston

This talk continues the discussion of mathematical models for X-ray crystallography. Here, we consider the task of recovering a finitely supported complex measure from observing the magnitude of its Fourier transform or the magnitude of differences of its Fourier transform at several locations. Following a strategy by Alexeev and others, the structure of the locations used for these intensity measurements is encoded in a graph. More precisely, a vertex in the graph represents a magnitude measurement of the Fourier transform at a given frequency, and the edge represents the magnitude of a (modulated) difference between the values of the Fourier transform at two points. We show that a measurement chosen in accordance with a Ramanujan graph of degree at least 3 and a sufficiently large number of vertices is sufficient for identifying the complex measure up to an overall multiplicative constant. The material presented in this talk is joint work with Ahmed Abouserie.

Weber 223
4–6 pm, Friday, August 25, 2023
(Refreshments 3:30–4 pm)
Colorado State University
4 pm, Friday, August 25, 2023

This is a joint Denver U / UC Boulder / U of Wyoming / CSU seminar that meets biweekly.
Anyone interested is welcome to join us at a local restaurant for dinner after the talks.