

## Spring 2017

### ▪ January 23

**Speaker:** N/A

**Title:** Organizational Meeting

**Abstract:** We will discuss schedule and speakers for this semester

### ▪ January 31 (Tuesday, 4:15-5:15)

**Speaker:** Alexander Borisov (Binghamton)

**Title:** Rigidity problems for polygons and polyhedra

**Abstract:** Every triangle can be uniquely determined, up to isometry, by three “simple measurements” (sides or angles). For a generic quadrilateral one needs five simple measurements. However some quadrilaterals, including squares, can be described by just four simple measurements. I will present a number of results regarding this and related phenomena, both positive and negative, for polygons and some polyhedra, based on my 2010 Monthly paper, joint with Mark Dickinson and Stuart Hastings. If time permits, I will also discuss some related notions and results: Cauchy rigidity theorem, flexible polyhedra, Bellows Conjecture, and Dehn invariant. Most of the talk will be elementary.

### ▪ February 6

**Speaker:** Jaiung Jun (Binghamton)

**Title:** Geometry of hyperfields in a view of Berkovich theory

**Abstract:** I will discuss possible research directions on geometry of hyperfields in connection to abstract tropical curves and Berkovich theory of analytic spaces. In particular, we will discuss how the tropical projective line can be considered as the abstract curve associated to the tropical function field (properly defined).

### ▪ February 13

**Speaker:** Changwei Zhou (Binghamton)

**Title:** Overview of Arakelov intersection theory

**Abstract:** In today’s talk we give an overview of the basic set up of Arakelov intersection theory and discuss some introductory material on Faltings-Riemann-Roch theorem using metrized line bundles. The talk roughly follows Lang’s book and Faltings’ original paper Calculus on Arithmetic Surfaces, plus some examples.

### ▪ February 20

**Speaker:** TBA

**Title:** TBA

**Abstract:** TBA

### ▪ February 27

**Speaker:** Patrick Milano (Binghamton)

**Title:** The Riemann-Hurwitz formula

**Abstract:** Let  $X$  and  $Y$  be compact Riemann surfaces, and let  $f$  be a non-constant holomorphic map from  $X$  to  $Y$ . The Riemann-Hurwitz formula relates the genus of  $X$ , the genus of  $Y$ , the degree of  $f$ , and the amount of ramification of  $f$ . We will outline a proof of the formula. As an application, we will compute the genus of the Fermat curve  $X^n + Y^n = Z^n$ .

▪ **March 14 (Tuesday, 4:15-5:15, room: 309 WH)**

**Speaker:** Martin Ulirsch (University of Michigan)

**Title:** The moduli stack of tropical curves

**Abstract:** The moduli space of tropical curves (and its variants) are some of the most-studied objects in tropical geometry. So far this moduli space has only been considered as an essentially set-theoretic coarse moduli space (sometimes with additional structure). As a consequence of this restriction, the tropical forgetful map does not define a universal curve (at least in the positive genus case). The classical work of Deligne-Knudsen-Mumford has resolved a similar issue for the algebraic moduli space of curves by considering the fine moduli stacks instead of the coarse moduli spaces.

In this talk I am going to give an introduction to these fascinating moduli spaces and report on ongoing work with Renzo Cavalieri, Melody Chan, and Jonathan Wise, where we propose the notion of a moduli stack of tropical curves as a geometric stack over the category of rational polyhedral cones. Using this  $\mathbb{A}^1$ -categorical framework one can give a natural interpretation of the forgetful morphism as a universal curve. Moreover, I will propose two different ways of describing the process of tropicalization: one via logarithmic geometry in the sense of Fontaine-Kato-Illusie and the other via non-Archimedean analytic geometry in the sense of Berkovich.

▪ **March 21 (Tuesday, 4:15-5:15)**

**Speaker:** Jaiung Jun (Binghamton)

**Title:** Introduction to hyperrings and hyperfields

**Abstract:** We introduce hyperrings and hyperfields. These are algebraic structures which generalize the classical commutative rings and fields. In this talk, we aim to introduce these rather exotic structures and illustrate several examples. We also discuss how hyperrings and hyperfields show up and fit into the classical theory, in particular, algebraic geometry and combinatorics. If time permits, we discuss how hyperfields can be used to reformulate some basic definitions of Berkovich's theory of analytic spaces.

▪ **March 27**

**Speaker:** Noah Giansiracusa (Swarthmore College)

**Title**(tentative): Tropicalizing schemes

**Abstract**(tentative): I'll discuss joint work with my brother, Jeff Giansiracusa, in which we extend tropicalization to a scheme-theoretic setting by writing down explicit equations cutting out tropical varieties. Tropical geometry has been rapidly gaining momentum and achieving exciting results in a variety of areas; our hope is that by expanding the scope to allow non-reduced structure and basing tropical methods on algebraic foundations that the range of applications will increase, though the program is still in its early steps. Connections to matroids and

to Berkovich analytification will be mentioned.

▪ **April 4** (Tuesday, 4:15-5:15)

**Speaker:** Alexander Borisov (Binghamton)

**Title:** Looking for Keller maps: a report on the hunt

**Abstract:** Keller maps are the counterexamples to the Jacobian conjecture. While we do not know if they exist, we have some ideas on how they might “look like” and where they might “live”. I will describe my ongoing work on finding them, in dimension two. There will be complicated maps, large trees, mysterious drawings, and 100+ degree polynomials.

▪ **April 24**

**Speaker:** Neil Epstein (George Mason)

**Title:** Generic matroids - a bilevel matroid-like structure on sets with topological structure

**Abstract:** Matroids are not a traditional go-to structure within the field of commutative algebra. However, we show that given a finitely generated standard graded algebra of dimension  $d$  over an infinite field, its graded Noether normalizations obey a certain kind of ‘generic exchange’, allowing one to pass between any two of them in at most  $d$  steps. We prove analogous generic exchange theorems for minimal reductions of an ideal, minimal complete reductions of a set of ideals, and minimal complete reductions of multigraded  $k$ -algebras. We unify all these results into a common axiomatic framework by introducing a structure we call a **generic matroid**, which is a common generalization of a topological space and a matroid.

We suspect that generic matroids fit into a much more general context, hence my interest in presenting this work at a place like Binghamton which has several experts in matroids and matroid-like structures.

This work is joint with Joseph Brennan.

▪ **April 25 (Tuesday, 4:15-5:15)**

**Speaker:** Micah Loverro (Binghamton)

**Title:** Affine group schemes and representations

**Abstract:** I will introduce smooth affine reductive and semisimple group schemes and a problem about classifying representations corresponding to representations of the Lie algebra.

▪ **May 1**

**Speaker:** Junguk Lee (Yonsei University, Korea)

**Title:** On the structure of certain valued fields

**Abstract:** For any two complete discrete valued fields  $K_1$  and  $K_2$  of mixed characteristic with perfect residue fields, we show that if each pair of  $n$ -th residue rings is isomorphic for each  $n \geq 1$ , then  $K_1$  and  $K_2$  are isometric and isomorphic. More generally, for  $n_1, n_2 \geq 1$ , if  $K_2$  is large enough, then any homomorphism from the  $n_1$ -th residue ring of  $K_1$  to the  $n_2$ -th residue ring of  $K_2$  can be lifted to a homomorphism between the valuation rings. We can find a lower bound for  $n_2$  depending only on  $K_2$ . Moreover, we get a functor from a category of certain principal Artinian local rings of length  $n$  to a category of certain complete discrete valuation rings of mixed characteristic with perfect residue fields, which naturally

generalizes the functorial property of unramified complete discrete valuation rings. The result improves Basarab's generalization of the AKE-principle for finitely ramified henselian valued fields, which solves a question posed by Basarab, in the case of perfect residue fields. This is joint work with Wan Lee.

▪ **May 9 (Tuesday, 4:15-5:15)**

**Speaker:** John Brown (Binghamton)

**Title:** Classifying finite hypergeometric groups, height one balanced integral factorial ratio sequences, and some step functions

**Abstract:** (This is the second half of the candidacy exam talk. The first part is at the Algebra Seminar. The title and abstract are for both parts). In this talk we will discuss some connections between hypergeometric series, factorial ratio sequences, and non-negative bounded integer-valued step functions. We will start with a finiteness criterion for hypergeometric groups by Beukers and Heckman, then show how this leads to the classification by Bober of integral balanced factorial ratio sequences of height one, and thus a proof that a conjectured classification of a certain class of step functions by Vasyunin is complete.

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