

# ABSTRACTS

## Songpon Sriwongsa

King Mongkut's University of Technology Thonburi, Thailand

**Title:** *On classes of groups defined by classes of formal languages Lie algebras*

**Abstract:** An orthogonal decomposition problem of Lie algebras over the complex numbers has been studied since the 1980s. It has many applications and relations to other areas of Mathematics and Sciences such as Quantum information theory. The problem may be called Winnie-the-Pooh due to the name of a well-known conjecture for this problem of Lie algebra  $sl_n$ .

In this talk, we consider orthogonal decomposition problem over a field of prime characteristic. We define a classical orthogonal decomposition of a modular Lie algebra and construct it for Lie algebra  $sl_n$  under some sufficient conditions. Additionally, we analyze for more details of the problem when  $n = 2, 3$  and  $4$ .

The talk will contain three parts: A brief history of the problem and relation with other fields, the Winnie-the-Pooh conjecture over the complex numbers, and the main results of this work for the case of prime characteristic fields.

This is joint work with Y. Meemark.

## Kenzi Satô

Laboratory of Mathematics, Faculty of Engineering, Tamagawa University, Japan

**Title:** *Around the Banach-Tarski paradox*

**Abstract:** For two bounded subsets with non-empty interior of 3-dimensional Euclidean space, one of them can be partitioned into finite pieces such that the other can be constructed by moving the pieces. It is possible for two solid balls with different radii, so it is a paradox, which was established by Banach and Tarski. But it is not a contradiction, because the pieces can be non-measurable. On the other hand, the paradox is not valid on 2-dimensional Euclidean space. In particular, Lebesgue measure on 2-dimensional Euclidean space can be extended to all subsets such that the extended measure satisfies finite additivity. The essential difference of 3-dimensional and 2-dimensional Euclidean spaces is whether the congruence transformation groups on them have free subgroups of rank 2 or not. In this talk, paradoxes and around will be considered.

## Akitoshi Kawamura

Research Institute for Mathematical Sciences, Kyoto University, Japan

**Title:** *Scheduling recurring tasks with frequency requirements*

**Abstract:** An instance of the pinwheel scheduling problem consists of several recurring tasks, each of which must be performed with a given frequency, i.e., at least once in a certain number of days. We want to devise a (perpetual) schedule for performing the tasks, one per day, while satisfying each task's requisite frequency. In this talk, I will discuss various aspects of this and related problems, including necessary and sufficient conditions for schedulability, and algorithms for finding or optimizing the schedules.

## Attila Egri-Nagy

Akita International University, Japan

**Title:** *Hierarchical Decompositions of Semigroups - Back to the Basics*

**Abstract:** Hierarchical decompositions of transformation semigroups (Krohn-Rhodes theory) can be used to understand the underlying computational structure. In other words, they are cognitive tools to study discrete dynamical systems that can be modeled as finite state automata. However, there are still many open questions about how to use this tool exactly. In this talk, we will look at the decompositions of familiar algebraic objects, most notably the full transformation semigroups. We aim to gain a deeper understanding of the properties of hierarchical decompositions while working with different representations of well-studied objects.

## Paul Hriljac

Department of Mathematics, Embry-Riddle Aeronautical University, USA

**Title:** *Some NP complete problems based on algebra and algebraic geometry over finite fields*

**Abstract:** We define fiber bundles over the affine space of matrices of a given size and show that the problem of determining membership in the induced bundle over determinantal varieties is an NP complete problem. Using this membership problem, we then create families of univariate polynomials over finite fields and show that the question of membership for elements of field in the union of roots for a given family is NP-complete. Finally, we show that the existence of a Turing machine which can solve these problems in polynomial time implies that certain high degree univariate polynomials must have very low algebraic complexity.

## Carl-Fredrik Nyberg Brodda

Korea Institute for Advanced Study (KIAS), Republic of Korea

**Title:** *The freeness problem for parabolic subgroups of  $SL(2, Q)$*

**Abstract:** I will discuss some recent progress on the freeness problem for parabolic subgroups of  $SL(2, Q)$ , studying some consequences of the Greenberg-Shalom conjecture. This includes a description of some congruence subgroups of  $SL(2, Z[1/p])$  and studying a series of new and surprising conjectures.

## Collin Bleak

University of St Andrews, School of Mathematics and Statistics, UK

**Title:** *On classes of groups defined by classes of formal languages*

**Abstract:** We introduce the classes of finitely generated groups EpiLC, where "LC" refers to a language class such as "Regular", "Context Free", "Context Sensitive", etc., and offer some initial observations on these classes of groups, with particular focus on epiregular groups. In particular, a group  $G$  with finite generating set  $X$  is epiregular if there is a regular language  $R$  on the set  $X$ , so that

- 1) for any word  $w$  in  $R$ , the evaluation of  $w$  in  $G$  as a product of generators is never trivial, and
- 2) for every  $g$  in  $G$  there is some  $w$  in  $R$  so that the evaluation of  $w$  is  $g$ .

Some results are: Being epiregular is independent of the generating set chosen, there are uncountably many finitely generated groups which are not epiregular (indeed, even if we insist of solvable of derived length 3), and stronger still, for any EpiLC group  $G$  with a computable presentation and with LC amongst reasonable classes (regular, context free, context sensitive, recursively enumerable, etc.) the group  $G$  will have solvable word problem. Other results of interest: the class of epiregular groups contains the Right angled Artin groups and even the class of autostackable groups (in particular, R. Thompson's group  $F$ ). Joint with Raad Al-Kohli and Luke Elliott.

## Tatsunari Watanabe

Mathematics Department, Embry-Riddle Aeronautical University, USA

**Title:** *The freeness problem for parabolic subgroups of  $SL(2, Q)$*

**Abstract:** I will discuss some recent progress on the freeness problem for parabolic subgroups of  $SL(2, Q)$ , studying some consequences of the Greenberg-Shalom conjecture. This includes a description of some congruence subgroups of  $SL(2, Z[1/p])$  and studying a series of new and surprising conjectures.