Title and Abstract of talks

1. **Speaker: Luis Paris**

   Title: The $K(\pi, 1)$ conjecture for Artin groups. (3 lectures)

   Abstract: If a, b are two letters and m is an integer ≥ 2, we denote by $\Pi(a, b, m)$ the word $aba \cdots$ of length m. Let $M = (m_{s,t})_{s,t \in S}$ be a Coxeter matrix. The Coxeter group W of M is generated by S and is subject to the relations $s^2 = 1$ for all $s \in S$, and $\Pi(s, t, m_{s,t}) = \Pi(t, s, m_{s,t})$ for all $s, t \in S$, $s \neq t$, $m_{s,t} \neq \infty$. The Artin group A of M is the group obtained from the above presentation by removing the relations "$s^2 = 1$ for all $s \in S$". A space $N(W)$ can be described from W using the canonical action of W as a reflection group. The fundamental group of this space is known to be precisely the Artin group A. The $K(\pi, 1)$ conjecture (due to Arnold, Brieskorn, Pham, and Thom) says that this space in an Eilenberg MacLance space for A. Such a space is of importance in the calculation of the cohomology of the group A. In this series of lectures we give a precise statement of this conjecture, illustrating it with examples and placing it in its context. Afterwards, we present the status of the conjecture, intermediate known results, and used techniques.

2. **Speaker: Koji Nuida**

   Title: 1) On the isomorphism problem for Coxeter groups and related topics, I

   2) On the isomorphism problem for Coxeter groups and related topics, II

   Abstract: The isomorphism problem for Coxeter groups is a problem of, given standard presentations of two Coxeter groups, determining whether the two groups are isomorphic (as abstract groups) or not. This problem is quite non-trivial especially for the case of infinite Coxeter groups (finitely or non-finitely generated), and many observations and partial solutions have been given so far. In the talk, I will give a survey of the research topic as well as some relevant research on the structure of Coxeter groups.

3. **Speaker: Ivanov, Alexander A**

   Title: 1) Monster group

   2) Sporadic geometries

   Abstract:

4. **Speaker: Ilaria Cardinali**

   Title: An outline of polar spaces: basics and advances(3 lectures)

   Abstract: Polar spaces have been widely studied over the years and almost all fundamental questions about them, such as their classification and the description of remarkable examples, have already been answered. In this series of lectures we shall provide a quick overview of the theory of polar spaces starting from the classical polar spaces, as algebraically described by sesquilinear and pseudo-quadratic forms, and then enlarging the perspective to abstract polar spaces wherein the classical polar spaces naturally sit. The target point of this general background is naturally the classification theorem of thick polar spaces of rank at least 3.

   Three research topics related to the theory of polar spaces have been selected: we shall report on the state of the art in them in an as complete as possible way. They are: polar spaces of infinite rank; embeddings of polar spaces in groups; (embeddings of) dual polar spaces.

   We now provide a more detailed program of the lectures.

   The first day is dedicated to the background of the theory of polar spaces. We shall consider at first classical polar spaces, thus introducing the algebraic notion of sesquilinear forms and pseudo-quadratic forms. Next, we will move to abstract polar spaces adopting the '1-all axiom'. This lecture will be concluded by stating the classification theorems. The material of this part is mainly taken from [1, Chapters 7-10] and [12].

   In the second and third day we will deal with some research topics. We shall start by discussing polar spaces of infinite rank. It has to be observed that several properties that hold for polar spaces of finite rank fail to hold when we allow the rank of the polar space to be infinite. We shall report on the state of the art and describe an example of polar

space of infinite rank. The material of this section is mainly taken from [11].

Next we shall focus on embeddings of polar spaces in groups. After having given the basic definitions of morphism and of hull of an embedding, we report on two results which completely solve the problem of the non-abelian hull of a projective embedding of a polar space. Our reference paper is [10].

The last topic we shall deal with is projective embeddings of dual polar spaces. We will give the definition of homogeneous, polarized, universal and minimal embedding of a dual polar space and we shall provide an update survey of the known results on these embeddings for classical thick dual polar spaces. The material of this section is contained in a series of papers ([2], [3], [4], [5], [6], [7], [8], [9]).

References:

1. F. Buekenhout and A. Cohen, *Diagram geometry: related to classical groups and buildings*. Springer, 2012.
2. R.J. Blok and B.N. Cooperstein. The generating rank of the unitary and symplectic grassmannians. *J. Combin. Theory Ser. A* 119, No.1 (2012), 113.
3. R.J. Blok, I. Cardinali, B. De Bruyn, A. Pasini. Polarized and homogeneous embeddings of dual plar spaces. *J. Alg. Combin.*, 30 (2009), 381-399.
4. I. Cardinali, B. De Bruyn and A. Pasini. Minimal full polarized embeddings of dual polar spaces. *J. Algebraic Combin.* 25 (2007), 7-23.
5. B.N. Cooperstein, *On the generation of dual polar spaces of unitary type over finite fields*, European J. Comin. 18 (1997), 849-856.
6. B.N. Cooperstein, *On the generation of dual polar spaces of symplectic type over finite fields*, J. Combin. Th. A 83 (1998), 221-232.
7. B.N. Cooperstein and E.E. Shult, *A note on embedding and generating dual polar spaces*, Adv. Geom. 1 (2001), 37-48.
8. B. De Bruyn and A. Pasini. Generating symplectic and Hermitian dual polar spaces over arbitrary fields nonisomorphic to $\mathbb{F}_2$. *Electron. J. Combin.* 14 (2007), #R54, 17pp.

9. A. Kasikova and E.E. Shult. *Absolute embeddings of point-line geometries.* J. Algebra 238 (2001), 265-291.

10. A. Pasini. Embeddings and expansions. *Bull. Belg. Math. Soc. Simon Stevin* 10 (2003), 585-626.

11. A. Pasini. On polar spaces of infinite rank. *J. Geom.* 91, 1-2 (2009), 84-118.

12. J. Tits. *Buildings of Spherical type and Finite BN-pairs.* Lecture Notes in Mathematics 386, Springer, Berlin, 1974.

5. **Speaker: T. N. Venkataramana**

   Title: Arithmeticity of Certain Symplectic Hypergeometric Groups

   Abstract: We give a sufficient condition on a pair of primitive polynomials that the associated hypergeometric group (the monodromy group of a hypergeometric differential equation) is an arithmetic subgroup of the integral symplectic group.

6. **Speaker: Tom De Medts**

   Title: Moufang sets and exceptional groups (3 talks)

   Abstract:

7. **Speaker: Koen Struyve**

   Title: Affine buildings: metric properties and rigidity

   Abstract: Affine buildings are a class of geometries naturally associated to groups of Lie type defined over fields with valuation. This theory was developed by F. Bruhat and J. Tits based upon the work of N. Iwahori and H. Matsumoto. Apart from being incidence geometries these objects form important examples of CAT(0) metric spaces.

   In the first of the two talks I will discuss affine buildings (and the slightly more general class of Euclidean buildings) from a metric point of view. Many of the concepts will be explained using the 1-dimensional case, which are trees without endpoints.

   The second talk is focused on some rigidity results for trees and Euclidean buildings concerning quasi-isometries and their buildings at infinities. In particular I will present the following new result.

Theorem: *If Δ is a locally finite irreducible Euclidean building of rank at least two, then its building at infinity completely determines Δ.*

In addition a construction of Counterexamples in the locally infinite case will be sketched.

References

1. F. Bruhat and J. Tits, *Groupes Réductifs sur un Corps Local, I: Données radicielles valuées*, Publ. Math. I.H.E.S. **41** (1972), 5-25.

2. N. Iwahori and H. Matsumoto, *On some Bruhat decomposition and the structure of the Hecke rings of p-adic Chevalley groups*, Publ. Math. I.H.E.S. **25** (1965), 5-48.

8. **Speaker: Mehmet Koca**

   Title: 1)Rank3 Coxeter groups, quaternions, polyhedra, chiral polyhedra and their duals;

   2) Rank 4 Coxeter groups, quaternions, 4D polytopes and their dual polytopes;

   3)Quasicrystallography as the projections of the Lie algebra lattices(Here I include projections of E8 to H4, D6 to H3 and A4 to H2 and give some details of the last one).

   Abstract:

9. **Speaker: Maneesh Thakur**

   Title: (three lectures)

   Abstract:

10. **Speaker: Donna Testerman** (three lectures)

    Title: Exceptional groups of Lie type: subgroup structure and unipotent elements

    Abstract: In this series of lectures, we will touch on various topics which arise when studying the subgroup structure of the exceptional groups of Lie type, both finite and algebraic.

    We begin with a discussion of the determination of the maximal subgroups of the algebraic and finite exceptional groups. We sketch a

proof of a result which allows one to describe certain maximal subgroups of the finite groups via the classification of the maximal closed positive-dimensional subgroups in the exceptional algebraic groups. We conclude by discussing the remaining open cases in this area.

Another topic which we will address is the determination of subgroups which contain representatives of specific classes of elements. We concentrate on unipotent elements. We first consider elements of order p in groups defined over fields of characteristic p, and indicate precisely when such an element lies in an A_1-type subgroup. We then discuss properties of overgroups of regular unipotent elements.

In the final part, we will discuss the structure of the double centralizer of a unipotent element in a simple algebraic group, dividing the discussion into two parts; we treat the case of all simple groups in good characteristic, where there are characteristic independent results. We then describe some recent work dealing with the exceptional groups defined over fields of bad characteristic.

11. **Speaker: S Senthamaraikannan**

    Title: Schubert Varieties, Coxeter elements, GIT quotients (two lectures)

    Abstract:

12. **Speaker: Peter Sin**

    Title: On the structure of Classical Permutation Modules

    Abstract: In these lectures we will consider the permutation action of classical groups on the sets of subspaces of their standard modules. We will concentrate on the submodule structure of associated permutation modules for the classical groups and discuss some connections with algebraic groups, finite geometry and coding theory.

    Lecture 1. Permutation modules (in the defining characteristic) for The general linear group and affine group.

    Lecture 2. Permutation modules (in the defining characteristic) for the Symplectic group and other classical groups.

    Lecture 3. Cross-characteristic permutation modules for classical groups.

13. **Speaker: Bruce Cooperstein** (2 talks)

    Title: Witt-type theorems for subspaces of exceptional geometries

    Abstract: We show the transitivity of $Aut(\Gamma)$ on certain subspaces where Γ is one of the geometries $E_{6,1}$ or $E_{7,7}$. In particular, we classify all the subspaces of Γ which are isomorphic to the Grassmannian geometry $A_{n,k}$.

    Title: Generating Sets for Lie Geometries

    Abstract: A Survey. We survey what is currently known about the generation of many Lie Geometries, including symplectic and unitary Grassmannians and some exceptional geometries.

14. **Speaker: Vikraman Balaji**

    Title: Representations of Fuchsian groups and principal homogeneous spaces under Bruhat-Tits group schemes

    Abstract:

15. **Speaker: Sudhir Ghorpade**

    Title: Automorphisms of Grassmann varieties

    Abstract: Beginning with the Fundamental theorem of Projective Geometry, we will motivate and discuss a classical theorem of Chow concerning the line preserving bijections of Grassmann varieties. Recall that given a finite dimensional vector space V and a positive integer $d \leq \dim V$, the Grassmann variety $G_d(V)$ consists of all d-dimensional subspaces of V. It can naturally be viewed as a projective algebraic variety via the Plücker embedding. Alternatively, it can be viewed as the quotient of the general linear group $GL(V)$ by the parabolic subgroup of nonsingular linear transformations $g : V \to V$ that preserve a fixed d-dimensional subspace of V. There is thus a nice interplay of the group structure and geometry or in other words, of the two topics that form the main theme of this workshop and conference.

    If there is time and interest, we will also discuss some applications to the theory of linear error correcting codes. This will be based on a joint work with Krishna Kaipa.

16. **Speaker: Bart De Bruyn**

Title: The uniqueness of the generalized octagon of order $(2,4)$ containing a suboctagon of order $(2,1)$

Abstract: In [2], Tits constructed a class of generalized octagons using a family of simple groups discovered by Ree [1]. More precisely, Tits showed that with every field $\mathbb{F}$ of characteristic two having an endomorphism σ satisfying $x^{\sigma^2} = x^2$, $\forall x \in \mathbb{F}$, there corresponds a generalized octagon $O(\mathbb{F},\sigma)$ of order $(|\mathbb{F}|,|\mathbb{F}|^2)$. The generalized octagon $O(\mathbb{F},\sigma)$ is called a *Ree-Tits octagon* and is known to have full suboctagons of order $(|\mathbb{F}|,1)$. In this talk, I will discuss the following classification result.

Theorem. *The Ree-Tits generalized octagon of order* $(2,4)$ *is, up to isomorphism, the unique generalized octagon of order* $(2,4)$ *which contains a full suboctagon of order* $(2,1)$*.*

References

[1] R. Ree. A family of simple groups associated with the simple Lie algebra of type (F_4). *Amer. J. Math.* 83 (1961), 401–420.

[2] J. Tits. Les groupes simples de Suzuki et de Ree. *Séminaire Bourbaki* 13 (1960/61), No. 210, (1961), 18 pp.

17. **Speaker: Bhaskar Bagchi**

Title: The non-existent projective plane of order ten revisited

Abstract: