# 7th East Asian Conference on Algebraic Topology (EACAT)

# December 01-06, 2017

Title and Abstract (Invited Talks)

- **Nikolay Abrosimov** (Sobolev Institute of Mathematics, Russia)

  Title: Geometry of Knots and Links: fundamental polyhedra and hyperbolic volumes.

  Abstract: We overview the geometry of some knots and links. We consider a geometric structure on knots and links complement. We present fundamental polyhedra related to them. We find conditions for the existence of geometrical structures on them, as well as trigonometrical and algebraic identities between lengths and angles. We observe the volume calculation for knots and links, especially in hyperbolic case. In particular, we consider the Hopf link, the figure eight knot $4_1$ with additional bridge and the link $6^2_2$.

- **Valeriy Bardakov** (Sobolev Institute of Mathematics, Russia)

  Title: Virtual braids and simplicial groups.

  Abstract: On the set of pure virtual braids $VB_n, n = 1, 2, ...$ will be define a simplicial group $VP_*$ and its simplicial subgroup $T_*$, which is generated by $VP_2 = F_2$. It will be discuss some properties of these simplicial groups. In particular, presentation in generators and relations, homotopy types and so on. Also, will be discuss connections of these groups with homotopy groups of 2-sphere.

- **Samik Basu** (Indian Association for Cultivation of Science, India)

  Title: Homotopy groups of highly connected manifolds.

  Abstract: We discuss a new method of computing (integral) homotopy groups of certain manifolds in terms of the homotopy groups of spheres. The techniques used in this computation also yield formulae for homotopy groups of connected sums of sphere products and CW complexes of a similar type. In all the families of spaces considered here, we verify a conjecture of J. C. Moore. This is joint work with Somnath Basu.

- **Somnath Basu** (Indian Institute of Science Education and Research Kolkata, India)

  Title: Grassmannian of oriented 3-planes

Abstract: We shall introduce a space $W^n_{2,1}$ associated to the Grassmannian $\tilde{G}_{n,3}$ of oriented 3-planes in $\mathbb{R}^n$. Using spectral sequences and Gysin maps, we can provide the list of indecomposables in the cohomology ring of $\tilde{G}_{n,3}$, leading to an almost complete description of its cohomology ring..

- **Priyavrat Deshpande** (Chennai Mathematical Institute, India)

  Title: Combinatorial aspects of moduli space of planar polygons.

  Abstract: A linkage is a mechanism built with rigid bars that are connected using freely revolving joints. We come across many linkages in our daily life, for example, a desk lamp, deploy-able mirror, vehicle suspensions, a robot arm etc. The configuration space of a linkage is the set of its all possible states. A mathematical object that models this space is the moduli space of planar polygons. Given $n$ real numbers, this moduli space is the set of all orientation-preserving isometry classes of $n$-gons with these numbers as side lengths. Under certain favourable conditions, the moduli space is a closed, orientable manifold. In this talk I will first introduce a regular cell structure on the moduli space due to G. Panina. The cells of this structure can be described using certain partitions of the set $1, \cdots, n$, which give combinatorial insights into how this space looks. I will then report on the ongoing work, with N. Adhikari, of constructing a perfect (discrete) Morse function on these spaces as well as computing their higher homotopy groups.

- **Shane D'Mello** (Indian Institute of Science Education and Research Mohali, India)

  Title: Real algebraic knots.

  Abstract: The talk will be an overview of some of the developments in real algebraic knots including an application of braid groups in the construction of real algebraic knots of low degree.

- **Haibao Duan** (Chinese Academy of Sciences, China)

  Title: The integral cohomology ring of the projective unitary groups.

  Abstract: The projective unitary group $PU(n)$ is the quotient group of the unitary group $U(n)$ by its center subgroup $S^1$. Based on a Gysin type exact sequence relating the cohomologies of $U(n)$ and $PU(n)$, we determine the integral cohomology ring $H^*(PU(n))$ by explicit constructed generators.

- **Siddhartha Gadgil** (Indian Institute of Science, India)

  Title: String Topology and the Geometric decomposition of three-dimensional manifolds.

Abstract: By the Thurston-Perelman Geometrization theorem, every three-dimensional manifold has a unique decomposition into Geometric pieces. We show that this decomposition is essentially captured by String Topology. This is joint work with Moira Chas.

- **Sergei Ivanov** (Saint Petersburg State University, Russia)

  Title: Homology of $R$-completions of groups and finite $R$-bad spaces.

  Abstract: In the talk I will remind the Bousfield-Kan theory of $R$-completions and $R$-homological localizations of spaces and its connection with the theory of $R$-completions and $HR$-localizations of groups. Then I will present our new results in this theory (with Roman Mikhailov). In particular, we prove that the second mod-$p$ homology group of a free pro-$p$-group (considered as a discrete group) $H_2(F^p, Z/p)$ is uncountable and the second rational homology group of the rational completion of a free group (considered as a discrete group)$H_2(F^Q, Q)$ is uncountable. Using this we prove that the wedge of two circles is a $Q$-bad space which is the first example of a finite $Q$-bad space.

- **Ruizi Huang** (National University of Singapore, Singapore)

  Title: Homotopy exponent problem and Cohen's combinatorial group methods.

  Abstract: Homotopy exponent is a classic topoic in homotopy theory which concerns torsion summands of homotopy groups. After the achievement of determining the homotopy exponents of Moore spaces and odd spheres, Cohen initiated a combinatorial group approach to study homotopy exponents theoretically around 1990s. His method encoded certain homotopy information in combinatorial groups, by analysing which one can understand the original general homotopy groups. The main goal is then to find suitable relations in Cohen's combinatorial groups to attack the homotopy exponents. In this talk, we will talk about necessary backgrounds and main progresses along this direction including a joint work with Jie Wu.

- **Nguyen H. V. Hung** (Vietnam National University, Vietnam)

  Title: The Singer transfer for the infinite real projective space.

  Abstract: The Singer transfer is expected to be a useful tool in the study of the Ext groups over the Steenrod algebra by means of the Peterson hit problem and the invariant theory.

  A chain-level representation of the Singer transfer for any left $\mathcal{A}$-module is constructed. We prove that the image of the Singer transfer $Tr_*^{\mathbb{R}P^\infty}$ for the infinite real projective space is a module over the image of the transfer $Tr_*$ for the sphere. Further, the algebraic Kahn-Priddy homomorphism is an epimorphism from $\operatorname{Im} Tr_*^{\mathbb{R}P^\infty}$ onto $\operatorname{Im} Tr_*$ in positive stems. The indecomposable elements $\widehat{h}_i$ for $i \geq 1$ and $\widehat{c}_i, \widehat{d}_i, \widehat{e}_i, \widehat{f}_i, \widehat{p}_i$ for $i \geq 0$ are detected, whereas the ones $\widehat{g}_i$ for $i \geq 1$ and $\widehat{D}_3(i), \widehat{p}'_i$ for $i \geq 0$ are not detected by the Singer transfer $Tr_*^{\mathbb{R}P^\infty}$. This transfer is shown to be non-isomorphic in the homological degrees at least 4. We prove that the squaring operation on the domain of $Tr_*^{\mathbb{R}P^\infty}$ is eventually isomorphic. This phenomenon leads to the so-called "stability" of the Singer transfer for the infinite real projective space under the iterated squaring operation. This is a joint work with Luu X. Truong.

- **Seiichi Kamada** (Osaka City University, Japan)

  Title: Doodles on surfaces, virtual diagrams on the plane, and commutator identities.

  Abstract: If two generically immersed loops in a surface are homotopic then they are related by a finite sequence of 3 types of local moves up to isotopy. The moves are $R1$, $R2$, $R3$ according to a monogon, bigon or trigon which is involved. A doodle on a surface is an equivalence class of loops in surfaces modulo $R1$, $R2$ and surgery on the ambient surfaces called stabilization. This is a generalization of the original definition of a doodle by R. Fenn and P. Tayler in 1979 and that by M. Khovanov in 1997. We introduce the notion of a virtual doodle on the plane, and show that doodles on surfaces are in one-to-one correspondence to virtual doodles on the plane. This is analogous to the fact that link diagrams on surfaces up to stabilization are in one-to-one correspondence to virtual links on the plane. We also discuss the relationship between doodles and commutator identities in free groups. This is a joint work with Andrew Bartholomew, Roger Fenn and Naoko Kamada.

- **Akio Kawauchi** (Osaka City University, Japan)

  Title: Homology of $4D$ universe for every 3-manifold.

  Abstract: A $4D$ universe is a $4-$dimensional boundary-less connected oriented manifold with every $3-$dimensional closed connected oriented manifold embedded. A $4D$ punctured universe is a $4-$dimensional boundary-less connected oriented manifold with the punctured manifold of every 3-dimensional closed connected oriented manifold embedded. It is known that every $4D$ universe and every $4D$ punctured universe are open 4-dimensional manifolds. If a $3-$dimensional closed connected orientable manifold is considered as a $3D$ universe, then every spacetime is embedded in every $4D$ universe and hence every $4D$ universe is a classifying space for every spacetime. As a previous result, any $4D$ universe and $4D$ punctured universe are known to have infinity of some homological indexes. In this talk, it is shown that the second rational homology groups of every $4D$ universe and every $4D$ punctured universe are always infinitely generated.

- **Shizuo Kaji** (Yamaguchi University, Japan)

  Title: Point and diagonal classes in flag varieties.

  Abstract: The zero locus of a generic section of a vector bundle over a manifold defines a sub-manifold. A classical problem in geometry asks to realise the fundamental class of a specified sub-manifold in this way. We study the point in a generalised flag manifold and the diagonal in the direct product of two copies of a generalised flag manifold.

These classes are important since they are related to ordinary and equivariant Schubert polynomials.

- **Ramesh Kasilingam** (Indian Statistical Institute Bangalore, India)

  Title: Exotic smooth structures on Complex Projective Spaces.

  Abstract: A smooth manifold homeomorphic to the standard sphere $S^m$ is known as a smooth homotopy $m$-sphere. The existence of smooth homotopy $m$-spheres was studied in the amazing work of Kervaire and Milnor. The set of diffeomorphism classes of smooth homotopy $m$-spheres $\Theta_m$ ($m \geq 5$) forms a group under the operation of connected sum and is related to computations in stable homotopy theory. Using these computations, we determine the number of smooth structures on the complex projective space $\mathbb{C}\mathbf{P}^n$ for $n \leq 8$ (up to isotopy, more precisely, concordance).

- **Shintaro Kuroki** (Okayama University of Science, Japan)

  Title: Equivariant cohomology of a certain class of torus orbifolds.

  Abstract: A torus manifold is a $2n$-dimensional closed manifold with the half dimensional torus action with non-empty fixed points. This object is introduced by Hattori and Masuda in [6] as a generalization of toric manifolds. The equivariant cohomology (over the integer coefficient) of torus manifolds with vanishing odd degree cohomology is computed by Masuda-Panov in [9, 8] by generators and relations. In this talk we generalize their result to a certain class of torus "orbifolds" (this object is also studied in [6]) by using the GKM method introduced in [4, 5]. This is a joint progress work with Alastair Darby and Jongbaek Song.

## References


[1] A. Bahri, M. Franz, and N. Ray, *The equivariant cohomology ring of weighted projective space*, Math. Proc. Cambridge Philos. Soc. **146** (2009), 395–405.

[2] A. Bahri, S. Sarkar, and J. Song, *On the integral cohomology ring of toric orbifolds and singular toric varieties*, arXiv:1509.03228.

[3] A. Darby, S. Kuroki and J. Song *Equivariant cohomology of torus orbifolds*, preprint.

[4] M. Goresky, R. Kottwitz and R. MacPherson, *Equivariant cohomology, Koszul duality, and the localization theorem*, Invent. Math. **131** (1998), 25–83.

[5] V. Guillemin and C. Zara, *One-skeleta, Betti numbers, and equivariant cohomology*, Duke Math. J. **107**, (2001), 283–349.

[6] A. Hattori and M. Masuda, *Theory of multi-fans*, Osaka J. Math. **40** (2003), 1–68.

[7] H. Kuwata, M. Masuda, and H. Zeng, *Torsion in the cohomology of torus orbifolds*, arXiv:1604.03138.

[8] H. Maeda, M. Masuda, and T. Panov, *Torus graphs and simplicial posets*, Adv. Math. **212** (2007), 458–483.

[9] M. Masuda, T. Panov, *On the cohomology of torus manifolds*, Osaka J. Math. **43** (2006), 711–746.

- **Jong Bum Lee** (Sogang University, South Korea)

  Title: Infra-nilmanifolds of the generalized Heisenberg group $\mathrm{Nil}^{m+1}$.

  Abstract: The group $\mathrm{Nil}^{m+1} = \mathbb{R}^m \rtimes_\sigma \mathbb{R}$ generalizes the classical Heisenberg group $\mathrm{Nil}^3$. It is a connected and simply connected $m$-step nilpotent Lie group. Taking a lattice $\Gamma_{m+1}$ of $\mathrm{Nil}^{m+1}$ consisting of points with integer components, we prove that for $m \geq 3$ there is no infra-nilmanifold that is essentially covered by the nilmanifold $\Gamma_{m+1}\backslash\mathrm{Nil}^{m+1}$.

- **Fengchun Lei** (Dalian University of Technology, China)

  Title: TBA.

  Abstract: TBA.

- **Gao Man** (Singapore)

  Title: Approximation techniques in persistent homology computations .

  Abstract: Rips complexes captures global features of point clouds in Euclidean space. However, since the Rips complex contains a large number of simplices , persistent homology computations for large point clouds are infeasible. This leads to the problem of constructing approximations of persistent homology with a smaller number of simplices. In this talk we will discuss some recent work on this approximation problem

- **Timur Nasybullov** (Katholieke Universiteit Leuven, Belgium)

  Title: Complete invariant for fused links.

  Abstract: One of the most important problems in knot theory is the knot recognition problem, is determining the equivalence of two knots. A complete algorithmic solution of this problem exists but it has unknown complexity. Virtual knot theory is a generalization of classical knot theory which was introduced by L. Kauffman in 1999 [4]. For virtual knots it is also very important to solve the knot recognition problem. In the talk we are going to deal with one simplification of classical and virtual knot theories called fused knot theory which were studied by several authors [1, 2, 3] and solve the knot recognition problem for fused links in polynomial time.

References

[1] V. Bardakov, P. Bellingeri, C. Damiani, Unrestricted virtual braids, fused links and other quotients of virtual braid groups, J. Knot Theory Ramifications, V. 24, N. 12, 2015, 1550063.
[2] A. Fish, E. Keyman, Classifying links under fused isotopy, J. Knot Theory Ramifications, V. 25, N. 7, 2016, 1650042.
[3] T. Kanenobu, Forbidden moves unknot a virtual knot, J. Knot Theory Ramifications, V. 10, N. 1, 2001, 89–96.
[4] L. Kauffman, Virtual knot theory, European J. Combin., V, 20, 1999, 663–690.

- **Fedor Pavutnitskiy** (National University of Singapore, Singapore)

  Title: Functorial decompositions of spectral sequences.

  Abstract: In this talk we will discuss how to lift direct product decompositions of loop spaces on the level of spectral sequences. Main example for us will be the interaction of Selick-Wu decomposition of loop space over suspensions and unstable Adams spectral sequence. The combinatorial aspects of James-Hopf map, which plays crucial role in this interaction, will be discussed.

- **P. Sankaran** (Institute of Mathematical Sciences, India)

  Title: Topology of generalized Dold manifolds.

  Abstract: Let $\sigma : X \to X$ be a smooth involution of a compact connected manifold $X$ with non-empty fixed point set. Then the space $P(m, X)$, defined as the quotient of $S^m \times X$ by the identification $(v, x) \sim (-v, \sigma(x))$, is a smooth manifold which we call a generalized Dold manifold. These manifolds are particularly interesting when $\sigma$ is a complex conjugation with respect to an almost complex structure on $X$. Under some mild hypotheses, we obtain results on (stable) parallelizability and cobordism of these manifolds. This is based on joint work with Avijit Nath.

- **Takashi Sato** (Osaka City University, Japan)

  Title: Hessenberg varieties and hyperplane arrangements.

  Abstract: Let $G$ be a semisimple linear algebraic group, $T$ a maximal torus of $G$, and $B$ a Borel subgroup of $G$ containing $T$. Hessenberg varieties are subvarieties of the flag variety $G/B$. A Hessenberg variety $\mathrm{Hess}(N, I)$ is determined by two data: one is an element $N$ of the Lie algebra of $G$ and the other is a "good" subset $I$ of the positive root system of $G$. When $N$ is a regular nilpotent element, the Hessenberg variety $\mathrm{Hess}(N, I)$ is called a regular nilpotent Hessenberg variety. In this talk, we assume that $N$ is regular nilpotent.

  Recall that a root is a linear map from the Lie algebra $\mathrm{Lie}(T)$ to $\mathbb{R}$. Hence we can assign a root its kernel. When a subset $I$ of the positive root system is given, we can obtain a hyperplane arrangement in $\mathrm{Lie}(T)$. When $I$ is the whole positive root system, $\mathrm{Hess}(N, I)$ is equal to the flag variety $G/B$. Hence Hessenberg varieties are generalization of the flag variety. As we can read the geometrical properties of $G/B$ from the Weyl arrangement, we can read those of $\mathrm{Hess}(N, I)$ from the corresponding hyperplane arrangement. For example, we can obtain information of cellular decompostion of $\mathrm{Hess}(N, I)$.

  This is a joint work with Takuro Abe, Tatsuya Horiguchi, Mikiya Masuda, and Satoshi Murai.

- **Debasis Sen** (Indian Institute of Technology Kanpur, India)

  Title: Higher cohomology operations and $R$-completion.

  Abstract: Let $R = \mathbb{F}_p$ or a field of characteristic 0. For each $R$-good topological space $Y$, we define a collection of higher cohomology operations which, together with the cohomology algebra $H^*(Y;R)$ suffice to determine $Y$ up to $R$-completion. We also provide a similar collection of higher cohomology operations which determine when two maps $f_0, f_1 : Z \to Y$ between $R$-good spaces inducing the same algebraic homomorphism $H^*(Y;R) \to H^*(Z;R)$ are $R$-equivalent. (This is a joint work with David Blanc.)

- **Yongjin Song** (Inha University, South Korea)

  Title: Maps from configuration spaces and moduli spaces.

  Abstract: Some functions from configuration space to moduli space of surface may induce homomorphisms on their fundamental groups which are braid gorups and mapping class groups of surface, respectively. In the analysis of them, we should deal with some branched coverings over a disk with two points removed. This study gives us more understandings about embeddings of braid group into mapping class group. On the other hand, we show that these maps in the level of classifying spaces of groups is compatible with the action of little 2-cube operad so that it should induce trivial homomorphism between stable homology group of braid groups and that of mapping class groups.

- **Tulsi Srinivasan** (Ashoka University, India)

  Title: The Lusternik-Schnirelmann category of general spaces.

  Abstract: The Lusternik-Schnirelmann category (LS-category) is a topological invariant that has historically been studied for absolute neighbourhood retracts. I will talk about how the theory of the LS-category can be extended to Peano continua like the Menger and Pontryagin spaces. I will then discuss current work applying these results to the boundaries of hyperbolic groups with an aim to finding an analogue to the Bestvina-Mess formula. I will also talk about how these techniques can be applied to topological complexity.

- **Dong Youp Suh** (Korea Advanced Institute of Science and Technology, South Korea)

  Title: Flag Bott-Samelson Varieties and Flag Bott Tower.

  Abstract: A Bott-Samelson variety is a well-known object in algebraic geometry and representation theory, which is a nonsingular algebraic variety $X_I$ constructed from a semi-simple complex Lie group $G$. Topologically a Bott-Samelson variety is the total space of an iterated $\mathbb{C}P^1$-fibrations. There is an induced action of the maximal torus $T$ of $G$ on $X_I$ from the left multiplication of $T$ on $G$.

On the other hand a Bott-tower $B_n$ is a nonsingular toric variety constructed from the projectivizations of iterated sums of two complex line bundles. Like a Bott-Samelson variety, a Bott tower is topologically the total space of an iterated $\mathbb{C}P^1$-fibrations.

Grossberg and Karshon discovered a nice relation between Bott-Samelson varieties and Bott towers in 1994. Indeed, for a given Bott-Samelson variety $X_I$, there is a one parameter family of of complex structures ${X_I}^t$ on $X$ so that ${X_I}^1 = X_I$ and ${X_I}^0 = B_n$ for some Bott tower $B_n$.

In this talk, we generalize these spaces and relations to a flag Bott-Samelson variety $X_{\mathcal{I}}$ and a flag Bott tower $F_m$, so that each $X_{\mathcal{I}}$ degenerates into $F_m$ via one parameter family of complex structures, and they are diffeomorphic to the total space of an iterated flag space fibrations. In general, a flag Bott tower $F_m$ is not a toric variety, but there is a much higher-rank torus action than the maximal torus of $G$, so that with this torus action $F_m$ is a GKM-manifold.

We also discuss more results on related representation theory and combinatorics if time permits.

This is a joint work with Eunjeong Lee, and partly with Shintaro Kuroki and Naoki Fujita.

- **Dai Tamaki** (Shinshu University, Japan)

Title: Stratifications on Classifying Spaces of Categories.

Abstract: In this talk we introduced a stratification on the classifying space $BC$ of a small (topological) category $C$ in such a way that strata are labelled by objects of $C$. We show that, under a reasonable condition, this stratification is a cylindrically normal stellar stratification in the sense of [T]. As an application, a "cell decomposition" of the canonical 2-categorical model for discrete Morse theory introduced in [NTT] is obtained.

References

[NTT] Vidit Nanda, Dai Tamaki and Kohei Tanaka, *Discrete Morse theory and classifying spaces*, `arXiv:1612.08429`.

[T] Dai Tamaki, *Cellular stratified spaces*, `arXiv:1609.04500`.

- **Ajay Singh Thakur** (Indian Institute of Technology Kanpur, India)

Title: Nonexistence of almost complex structure on the product $S^{2m} \times M$.

Abstract: In this talk we shall discuss a necessary condition for having an almost complex structure on the product $S^{2m} \times M$, where $M$ is an even dimensional orientable closed manifold. We shall see that if the Euler characteristic $\chi(M) \neq 0$, then except for finitely many values of $m$, we do not have almost complex structure on $S^{2m} \times M$. We will discuss the special cases when $M$ is a point, even dimension sphere and complex projective space. As an application, the nonexistence of almost complex structures on Dold manifolds will be discussed. This talk is based on a joint work with P. Chakraborty.

- **Andrei Vesnin** (Sobolev Institute of Mathematics, Russia)

  Title: Pogorelov polyhedra, Coxeter groups, and hyperbolic 3-manifolds.

  Abstract: The class $R$ of Pogorelov polyhedral consists of combinatorial 3-dimensional polyhedra of simple combinatorial type, different from a tetrahedron, without 3- and 4-belts of faces. In particular, $R$ contains the dodecahedron and fullerenes. By the results by Pogorelov (1967) and Andreev (1970), $R$ is exactly the class of polytopes which can be realized in a hyperbolic 3-space with all dihedral angles to be right. Let $G$ be Coxeter group, generated by reflection of faces of a polytope from $R$. We will discuss a method to construct hyperbolic 3-manifolds with fundamental groups commensurable with $G$. Various generalizations of the method and the relations with moment-angle manifolds will be presented.

- **Xiangjun Wang** (Nankai University, China)

  Title: The homotopy element $\beta_{p^2/p^2-1}$ and its applications.

  Abstract: In this talk, I will introduce the Adams-Novikov spectral sequence and the homotopy element $\beta_{p^n/p^n-1}$ in the ANSS. Based on the method of infinite decent, I will give a proof of the existence of $\beta_{p^2/p^2-1}$.

- **Peter Wong** (Bates College, Maine, USA)

  Title: On the exponents of $[J(X), \Omega(Y)]$.

  Abstract: F. Cohen first investigated the groups $[J(X), \Omega(Y)]$ where $J(X)$ denotes the James construction of X. When$X = \mathbb{S}^1$ is the circle, $[J(\mathbb{S}^1), \Omega(Y)]$ is in 1-1 correspondence with the set $\prod_{i=2}^{\infty} \pi_i(Y)$ but the group structure is far from being abelian in general. In this talk, we make use of the group structure of $[J(\mathbb{S}^1), \Omega(\mathbb{S}^k)]$ to give bounds on the exponents of $[J(\mathbb{S}^1), \Omega(\mathbb{S}^k)]$, generalizing a classical result of Cohen-Moore-Neisendorfer. It is a joint work with Marek Golasinski and Daciberg Goncalves.

- **Jie Wu** (National University of Singapore, Sinagpore)

  Title: Cobordism classes of maps and covers for spheres.

  Abstract: We show that for $m > n$ the set of cobordism classes of maps from $m$–sphere to $n$–sphere is trivial. We give a relation between cobordant triviality and 2-cell complexes. From this, we can give the constructions of the extensions of some null–cobordant maps of spheres to some explicit cobordisms $W$. The determination of the cobordant homotopy groups of spheres admits applications to the covers for spheres. This is a joint work with Oleg Musin.

- **Xuezhi Zhao** (Capital Normal University, China)

Title: TBA.

Abstract: TBA.

# Title and Abstract (Posters)

- **Surojit Ghosh** (Ramakrishna Mission Vivekananda University, India)

  Title: Equivariant maps related to the topological Tverberg conjecture.

  Abstract: Using equivariant obstruction theory we construct equivariant maps from certain universal spaces to representation spheres for cyclic groups, products of elementary Abelian groups and dihedral groups. Restricting them to finite skeleta constructs equivariant maps between spaces which are related to the topological Tverberg conjecture. This answers negatively a question of Özaydin posed in relation to weaker versions of the same conjecture. Further, it also has consequences for Borsuk-Ulam properties of representations of cyclic and dihedral groups. This is a joint work with Samik Basu.

- **Amrendra Gill** (Indian Institute of Technology Ropar, India)

  Title: Unknotting virtual knots by arc shift move.

  Abstract: We introduce two new local operations, arc shift and region arc shift, on a virtual knot diagram $D$. By taking minimum number of arc shift (region arc shift), denoted by $A(K)$ $(R(K))$, needed to unknot a virtual knot, we establish that this number is a numerical invariant for virtual knots. Further, by comparing the region arc shift with forbidden number $(F(K))$ of virtual knot $K$, we establish that $R(K) \leq F(K)$, thus making region arc shift a faster unknotting operation than forbidden moves. We provide an explicit example of virtual knot $K$, where the inequality is strict. This is a joint work with M. Prabhakar.

- **Kirandeep Kaur** (Indian Institute of Technology Ropar, India)

  Title: Gauss diagrams, unknotting numbers and trivializing numbers of spatial graphs.

  Abstract: We introduce Gauss diagrams and four kinds of unknotting numbers of a spatial graph. R. Hanaki introduced the notion of pseudo diagrams and the trivializing numbers of knots, links and spatial graphs whose underlying graphs are planar. We generalize the trivializing numbers without the assumption that the underlying graphs are planar. Finally we discuss relations among the unknotting numbers and the trivializing numbers. This is a joint work with S. Kamada, A. Kawauchi, M. Prabhakar.

- **Sheikh Mohd** (Pusan National University, South Korea)

  Title: Knots and their polynomials.

  Abstract. A knot is a link with one component. The Jones polynomial is a Laurent polynomial $\mathbf{V}_L(t)$ in the variable $\sqrt{t}$ which is defined for every oriented link $L$ but depends on that link only up to orientation preserving diffeomorphism, or equivalently isotopy of . In this paper, we study the reducibility and irreducibility of the Jones polynomial. Also, we will present some new properties satisfied by the Jones polynomial of a knot. This is a joint work with Lee Sang Youl.

## References

[1] Adams, Colin C.2004. The Knot Book. Providence, Rhode Island: American Mathematical Society.
[2] Livingston, C. 1993. Knot Theory. Washington, DC: The Mathematical Association Of America.

- **Anurag Singh** (Indian Institute of Technology Kanpur, India)

Title: Homotopy type of neighborhood complexes of Kneser graphs, $KG_{2,k}$.

Abstract: A. Schrijver identified a family of vertex critical subgraphs of Kneser graphs called the stable Kneser graphs $SG_{n,k}$. A. Bjórner and M. de Longueville proved that the neighborhood complex of the stable Kneser graph $SG_{n,k}$ is homotopy equivalent to a k-sphere. It is also known that the neighborhood complex of $KG_{n,k}$ is homotopy equivalent to the wedge sum of k-spheres. The main objective here is to give the exact number for $KG_{2,k}$ i.e. to show that the homotopy type of the neighborhood complex of $KG_{2,k}$ is a wedge sum of $(k+4)(k+1)+1$ spheres of dimension k. Further we will construct a maximal subgraph $S_{2,k}$ of $KG_{2,k}$ whose neighborhood complex deformation retracts onto the neighborhood complex of $SG_{2,k}$. This is a joint work with Nandini Nilakantan.

## References

[1] Anders Björner and Mark de Longueville. *Neighborhood complexes of stable Kneser graphs.* Combinatorica, 23(1)(2003) 23-34.
[2] Benjamin Braun. *Independence complexes of stable Kneser graphs.* Electronic Journal of Combinatorics, 18(1)(2011).
[3] Benjamin Braun and Matthew Zeckner. *Deformation ratracts of neighborhood complexes of stable Kneser graphs.* Proceedings of the American Mathematical society, 142(2)(2014) 413-427.
[4] Robin Forman. *Morse theory for cell complexes* . Advances in Mathematics, 134(1)(1998) 90-145.
[5] Jakob Jonsson. *Simplicial complexes of graphs*, Vol. 1928 of Lecture notes in Mathematics. Springer-Verlag, Berlin, 2008.
[6] Dimitry Kozlov. *Combinatorial algebraic topology*, Vol. 21. Algorithhms and Computation in Mathematics. Springer Science & Business Media, 2007.
[7] László Lovász. *Kneser's conjecture, chromatic number, and homotopy.* Journal of Combinatorial Theory Series A, 25(3)(1978) 319-324.
[8] A Schrijver. *Vertex-critical subgraphs of Kneser graphs.* Nieuw Archief voor Wiskunde, 26(3)(1978) 454-461.