The background of the cover is a dark, atmospheric landscape. In the upper left, a large, dark celestial body, possibly a planet or moon, is partially visible against a deep blue and black sky. The lower portion of the image shows a rugged, rocky terrain with various shades of grey and black, suggesting a desolate, extraterrestrial environment. The overall mood is mysterious and scientific.

**ABDUS SALAM
SCHOOL OF MATHEMATICAL
SCIENCES**

**NATIONAL CENTER FOR
MATHEMATICS**

ANNUAL REPORT 2018

ABDUS SALAM

SCHOOL OF MATHEMATICAL SCIENCES & NATIONAL CENTER FOR MATHEMATICS

GOVERNMENT COLLEGE UNIVERSITY, LAHORE



REPORT 2018



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“ Let us strive to provide equal opportunities to all so that they can engage in the creation of Physics and science for the benefit of all mankind. ”

Abdus Salam Speech at the Nobel Banquet,
December 10, 1979

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ABOUT THE SCHOOL

Established in 2003 as an independent center for mathematical sciences, the school is affiliated with the Government College University, Lahore. Abdus Salam School of Mathematical Sciences (AS-SMS) has rapidly evolved into a center of excellence for research as well as advanced learning in mathematical sciences; More than one hundred and fifty five students have already received doctorates in Mathematics since the school's inception.

The school aspires to be a center of excellence in mathematical sciences carrying out cutting edge research which pushes the frontiers of knowledge and to be a place which

*“help men who are creative and deep and active
and struggling scholars and scientists to get the
job done that it is their destiny to do.”*

Robert J. Oppenheimer

The school aims to achieve this by providing faculty and the students with all the help they need and the facilities they require to carry out the work that is their destiny to do. The school makes every effort to provide quality education to its graduate students by engaging faculty which is best in the world in their areas of expertise. A testament to these efforts, AS-SMS was named among the three Emerging Regional Centers of Excellence by the European Mathematical Society in 2011.

The school takes various initiatives for disseminating to the Pakistani academic community the latest developments in mathematical sciences. The school organizes a large number of seminars, colloquia, research schools, intensive courses and lecture series which are open to all students and faculty in the country

MESSAGE FROM THE VICE CHANCELLOR

There is no doubt that the development and prosperity of a nation is tied to the importance it places and efforts it makes to promote education in all areas but specially in science, technology and mathematics. The crucial role mathematics plays in all natural sciences and its need for technological advancement requires mathematicians with a deep understanding of the subject who can then disseminate a proper understanding of the subject to students of mathematics, natural sciences and engineering. The School of Mathematical Sciences was established in 2003 by the Higher Education Commission at the Government College University (Lahore) to train the next generation of mathematical scientists who carry out work at the frontiers of their field.



The school was later named as Abdus Salam School of Mathematical Sciences to pay tribute to one of the most illustrious student and later faculty member of the Government College University (Lahore) Prof. Abdus Salam who had won the 1979 Nobel prize in physics. The school enjoys the reputation of being a center for excellence in mathematics. The faculty members of the school are endeavoring to build modern research center by organizing seminars, invited lectures, workshops and other academic activity for students and faculty of all universities in Pakistan.

The school now has research collaboration with leading research institutions such as Center of Mathematical Sciences and Applications at Harvard university, Simon Center for Geometry and Physics and Center for Theoretical Physics of the Universe at Seoul National University. I sincerely wish the school success in the various initiatives being planned for the future.

Hassan Amir Shah (SI)
Chairman Board of Governors
Vice Chancellor,
Government College University, Lahore

MESSAGE FROM THE DIRECTOR GENERAL

The influence of science and technology has completely reshaped the world in the last hundred years. The economic benefits that we derive from it have made its understanding and development one of corner stones of economic policies in almost all countries. The appreciation of science and mathematics should not only be because of its immediate or longer term economic benefits but also as a tool for understanding the world we live in and the societal benefits such an understanding brings. The science today is asking and in some answering the most fundamental questions about the universe. It is developing a world view from the very small to the very big. Thanks to the work of physicists such as Abdus Salam we now have a very good understanding of the particles that make up the world.



At the very large scale we have a very good understanding of how the universe evolved from few seconds after the Big Bang. Scientists can now make measurements which have an accuracy equivalent to measuring the distance to the nearest star with an error smaller than the width of a human hair. In coming years we will see many technologies based on these and similar experiments just as technologies we take for granted today came from experiments of the past. This is also one of the reasons for a longer term investment in fundamental sciences. Unfortunately, in Pakistan we have not been able to develop this beyond the horizon perspective and are lagging in all areas of science, engineering and mathematics.

The Abdus Salam School of Mathematical Sciences is one of the few places in the country where cutting edge research in areas of mathematics and theoretical physics is being carried out. The School has also played an important role in the development of mathematics research and education in the country. With more than 140 graduates teaching in a number of public and private sector universities in Pakistan the school's efforts in producing good mathematicians is now influencing mathematics around the country.

The school also hosts the National Center for Mathematics and in this role is actively involved in the promotion of mathematical sciences in the country. All over the world the universities are the primary driving force behind pure and applied research. The school and the center emphasize the need for Pakistani universities to conduct research directed towards problem solving and organize various academic activities to help students of all universities learn not only the basics but also the cutting edge work in areas of mathematics and theoretical physics. Some of the leading mathematicians and physicists of the country have contributed to these activities. In the coming years the school and the center plans to carry out academic activities throughout the year related with research and teaching of mathematical sciences in the country with the hope of changing the research culture in the country from that of paper writing to problem solving.

Ghulam Murtaza
Director General
Salam Chair & Distinguished National Professor,
Government College University, Lahore



PROGRAMMES

The school offers full time M.Phil and Ph.D programs in Mathematics. The students are admitted to the M.Phil program based on their GPA in the undergraduate studies, performance in the admission examination and the interview conducted by the faculty of the school. In the past the school had an M.Phil leading to Ph.D program in which students who performed well in the M.Phil continued their studies for the Ph.D degree. Starting in 2016 the school eliminated M.Phil leading to Ph.D program on the recommendation of the HEC and admission to Ph.D program now requires a separate admission examination.

M.Phil Program of the school is of two year duration with each academic year divided into two semesters. In the first two semesters the students take courses and the last two semesters are devoted to working on a thesis. The course work in M.Phil requires students to take ten core courses which cover all important areas of mathematics.

Students with M.Phil, MS or an equivalent degree in mathematics can apply for admission to the Ph.D program and are admitted after passing an admission test prepared by the faculty of the school. During the first two semester the students in the PhD program take various courses from a list of core courses which would be of help in their research. The students have to pass a comprehensive examination after finishing the course work and before starting research. The school has 23 M.Phil and 33 Ph.D students at the moment. Keeping in mind the best international practices and unlike most public sector universities the school provides all its students financial assistance to ensure they can devote all their time to course work and research.

Admission Requirements for the MPhil Program

Applicants having an M.Sc Mathematics degree or a four year B.S Mathematics degree are eligible to apply. Applicants waiting for the result of their final exam or those in the final semester of the M.SC or the four years B.S program can also apply.

Admission to the program will be based upon past academic performance, admission test and interview conducted by the School. The School will require exclusive time commitment from its students. Financial assistance will be provided to the students, subject to the availability of funds.

Admission Requirements for the PhD Program

Applicants having an MPhil/MS or equivalent degree in Mathematics, from an institution recognized by HEC, are eligible to apply if they have at least 3.00/4.00 CGPA or First Division in MPhil/MS or equivalent degree program. Applicants waiting for the result of their final examination or those in the final semester of the MPhil/MS or equivalent degree program can also apply.

FACULTY

The school has both local and foreign faculty engaged in teaching, research and M.Phil/Ph.D student supervision. The faculty also interacts, collaborates and mentors the postdoctoral fellows of the school.



Afshan Sadiq
Assistant Professor

Ph.D: Abdus Salam School of Mathematical Sciences (2011)

Specialization:
Computational Algebraic
Geometry
Email: afshanadil@sms.edu.pk



Imran Anwar
Associate Professor

Ph.D: Abdus Salam School of Mathematical Sciences (2008)

Specialization:
Combinatorial Commutative
Algebra
Email: imrananwar@sms.edu.pk



Amer Iqbal
Visiting Professor

Ph.D: Massachusetts Institute of Technology (2000)

Specialization: Theoretical
and Mathematical Physics
Email: amer@alum.mit.edu



Hassan Azad
Visiting Professor

Ph.D: University of Notre Dame, USA (1977)

Specialization: Differential
Geometry

Email: Hassan.azad@sms.edu.pk



Fiazud Din Zaman
Visiting Professor

Ph.D: Cranfield University, U.K (1976)

Specialization: Applied
Mathematics

Email: f.zaman@sms.edu.pk

VISITING FOREIGN FACULTY

The visiting foreign faculty of the school visit the school to teach courses and to supervise MPhil/PhD students. They also offer intensive courses and short lecture series on topics of interest to students. The foreign faculty currently engaged in teaching and research activities with MPhil/PhD students and postdoctoral fellows include the following esteemed individuals:



Dorin Popescu
University of Bucharest
Bucharest, Romania



Johann Davidov
Institute of Mathematics and
Informatics Bulgarian Academy
of Sciences, Sofia, Bulgaria



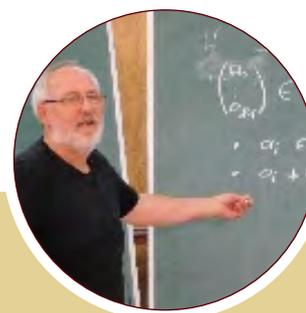
Vieru Dumitru
"Gh. Asachi" Technical
University of Iasi, Romania



Barbu Berceanu
Institute of Mathematics of the
Romanian Academy Bucuresti,
Romania



Dimitar A. Kolev
Department of Mathematics
University of Chemical
Technology and Metallurgy,
Sofia, Bulgaria



Gerhard Pfister
Fachbereich Mathematik
Universitat Kaiserslautern
Germany



Andrea Fenovcikova
 Department of Applied
 Mathematics and Informatics
 Technical University of Kosice,
 Kosice, Slovakia



Dan Grigore Timotin
 Institute of Mathematics
 of the Romanian Academy
 Bucharest, Romania



Constantin Fetecau
 Academy of Romanian
 Scientists Bucuresti, Romania



Tiberiu Dumitrescu
 University of Bucharest,
 Romania.



Christian Blanchet
 University Paris Diderot, Paris,
 France



Tim Romer
 University of Osnabruck,
 Germany



Ali Akbar Yazdanpur
 Institute for Advanced Studies
 in Basic Sciences (IASBS),
 Zanjan, Iran



**Mohamad Rached
 Mneimné**
 University Paris VII - Denis
 Diderot, France



Rein Leo Zeinstra
 University of Hamburg
 Osterstrasse Hamburg,
 Germany



Tzanko Donchev
University of Architecture, Civil
Engineering and Geodesy
Bulgaria



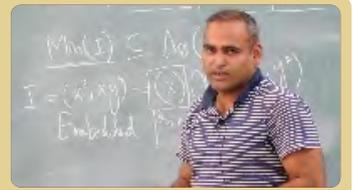
Viviana Ene
Ovidius University of
Constanta, Romania

POSTDOCTORAL FELLOWS

The school has always tried its best to provide space and facilities to young researchers to enhance their skills and understanding by interacting with eminent foreign and local faculty of the school who are experts in their areas of research. The Postdoctoral Fellowships are offered by the school every year to local and foreign scientist to spend nine months in the school. In recent years the financial support has been increased to make the fellowship more attractive for recent graduates. In the last couple of years the school had the following postdoctoral fellows:

Safyan Ahmed

PhD: Abdus Salam School of Mathematical Sciences
Combinatorial Commutative Algebra



Muhammad Azeem Khadam

PhD: Abdus Salam School of Mathematical Sciences
Algebraic Geometry



Muhammad Nouman Muteeb

PhD: Scuola Internazionale Superiore di Studi Avanzati (SISSA)
Theoretical Physics



Rewayat Khan

PhD: Abdus Salam School of Mathematical Sciences
Functional Analysis



M.PHIL & PH.D

COMPLETION/ADMISSIONS-2018



The Students who finished their MPhil during the year 2018

Aqeel Tahir Ahmed

Supervisor: Constantin Fetecau

Thesis Title: Time Fractional Oseen Problem for Newtonian and Second Grade Fluids

Aqsa Bashir

Supervisor: Tiberiu Dumitrescu

Thesis Title: Structural Results for the Stable Integral Domains

Fazal Abbas

Supervisor: Imran Anwar

Thesis Title: On Persistence of Cohen-Macaulay Property of Edge Ideals

Kamran Shakoor

Supervisor: Johann Davidov

Thesis Title: Harmonic Almost Hermitian Structures on Riemannian and PSEUDO-Riemannian Manifolds

Muhammad Ans Nazar

Supervisor: Constantin Fetecau

Thesis Title: Axisymmetric Flows of Newtonian and Second Grade Fluids

Muhammad Mosin

Supervisor: Rein Leo Zeinstra

Thesis Title: Classical Approximation Theorems in Complex Analysis Modern Proofs and Applications

Muhammad Zahid

Supervisor: Afshan Sadiq

Thesis Title: Classification of Real Singularities

Najma Ahmed

Supervisor: Vieru Dumitru

Thesis Title: Natural Convection with Damped Thermal Flux

Rizwan Anjum

Supervisor: Georgi E. Karadzhov

Rearrangement- **Thesis Title:** Invariant Function Spaces

Rizwan Jahangir

Supervisor: Imran Anwar

Thesis Title: Theory of Polyomino Ideals

Shahid

Supervisor: Rein Leo Zeinstra

Thesis Title: On Nakano-Orlicz Sequence Spaces

Zohaib Nadeem

Supervisor: Tiberiu Dumitrescu

Thesis Title: Factorization into Invertible and Prime Ideals

The Students who finished their PhD during the year 2018

Ali Raza

Supervisor: Georgi E. Karadzhov

Thesis Title: General Holmstedt's Formulae for the K-Functional and Optimal Sobolev Embeddings

Muhammad Awais Umar

Supervisor: Martin Bača

Thesis Title: Properties of Graphs with H-Covering and Prescribed H-Weights

Muzammil Mukhtar

Supervisor: Tiberiu Dumitrescu

Thesis Title: Commutative Rings with Two-Absorbing Factorization

Rizwan Ahmed

Supervisor: Tzanko Donchev

Thesis Title: Some Classes of Multivalued Dynamical Systems

Khawar Mehmood

Supervisor: Gerhard Pfister

Thesis Title: Classification of Irreducible Parameterized Plane Curve Singularities

Shamsa Kanwal

Supervisor: Gerhard Pfister

Thesis Title: Modular and Parallel Computation of R-Standard Bases

Saba Sultan

Supervisor: Martin Bača

Thesis Title: On the Metric Dimension and Minimal Doubly Resolving Sets of Families of Graphs

Asma Khalid

Supervisor: Dorin Popescu

Thesis Title: Algorithmic Methods in the Construction of General Neron Desingularization

Rewayat Khan

Supervisor: Dan Grigore Timotin

Thesis Title: Matrix Valued Truncated Toeplitz Operators

Muhammad Irfan

Supervisor: Andrea Semanicová

–Fenovčíková

Thesis Title: Properties of Reflexive and Cordial Labelings

List of Admitted Students in M.Phil program-2018



ALEENA



ANIQA YOUSAF



FARIHA SHAFQAT



FASAHAT FATIMA



H. ABDUL HASIB



HAMZA HAMEED



HINA UROOJ



JUNAID RAZZAQ



M. AMEER HAMZA



M. JAVAID QAYOOM



M. SAQIB



MUJTABA ALI



QASIM ALI



SADIA MUNIR



SAJJAD AKBAR



SYEDA HIFFZA ARIF



WAJEEHA ALAM

List of Admitted Students in Ph.D program-2018



AQSA BASHIR



BARKAT MIAN



FAZAL ABBAS



KAMRAN SHAKOOR



M. ZAHID



NAJMA AHMED



RIZWAN ANJUM



SHAHID



YASIR MASOOD

RESEARCH HIGHLIGHTS

The school has active research groups in mathematics and theoretical physics.

- Differential Geometry
- Multiplicative Ideal Theory
- Computational Algebraic Geometry
- Graph Theory
- Strong and Shifted Stability for Cohomology of Configuration spaces of manifolds
- Dynamical System

DIFFERENTIAL GEOMETRY

1. The twistor construction for Riemannian manifolds has been extended to the case of manifolds endowed with generalized metrics (in the sense of generalized geometry à la Hitchin) [1] The generalized twistor space associated to such a manifold is defined as the bundle of generalized complex structures on the tangent spaces of the manifold compatible with the given generalized metric. This space admits natural generalized almost complex structures whose integrability conditions have been found in [1]. An interesting feature of the generalized twistor space is the existence of intrinsic isomorphisms.

2. New twistorial examples of non-Kähler almost Hermitian manifolds with Hermitian Ricci tensor have been constructed by means of a natural almost Hermitian structures on the twistor space of an almost Hermitian four manifold [2]. This can be considered as a continuation of previous works on geometry of twistor spaces.

3. Non-trivial examples of Riemannian almost product structures have been constructed on the product bundle of the positive and negative twistor spaces of an oriented Riemannian four-manifold. The Gil-Medrano and Naveira types of these structures have been determined and geometric interpretation of the corresponding classes has been given.

Publications in 2018

1. Generalized metrics and generalized twistor spaces,
J. Davidov,
Mathematische Zeitschrift, Springer, 2018,

ISSN:1432-1823,
DOI:<https://doi.org/10.1007/s00209-018-2071-8>, ISI IF:0.874.

2. Twistorial examples of almost Hermitian manifolds with Hermitian Ricci tensor.
J. Davidov, O. Mushkarov,
Acta Mathematica Hungarica, 156, 1, Springer, 2018, ISSN:0236-5294, DOI:10.1007/s10474-018-0833-8, 194-203. ISI IF:0.481.

3. Almost complex structures that are harmonic maps.

J. Davidov, A. Haq, O. Mushkarov,
Journal of Geometry and Physics, 124, Elsevier, 2018, ISSN:0393-0440,
DOI:10.1016/j.geomphys.2017.09.010, 86-99.
ISI IF:0.712

4. Harmonicity of the Atiyah-Hitchin-Singer and Eells-Salamon almost complex structures,
J. Davidov, O. Mushkarov,
Annali di Matematica Pura ed Applicata, 197, 1, Springer, 2018, ISSN:0373-3114,
DOI:<https://doi.org/10.1016/j.geomphys.2017.09.010>, 185-209. ISI IF:1.066

MULTIPLICATIVE IDEAL THEORY

In February 2018, Dr. Tiberiu Dumitrescu attended Conference on Rings and Factorizations organized by Karl-Franzens-Universität Graz, Austria. At this conference, he gave a talk about his joint work with his former PhD student Dr. Tusif Ahmad, about ISP integral domains. Recall that an integral domain D is an ISP-domain if every proper ideal of D can be written as an invertible ideal multiplied by a nonempty product of proper radical ideals. This concept was introduced and studied by Ahmad and Dumitrescu in [1]. At Graz Conference, Dumitrescu met and had a fruitful exchange of ideas with professors working in Multiplicative Ideal Theory: Barucci, Cahen, Chang, Fontana, Finocchiaro, Frisch, Geroldinger, Houston, Jaballah, Loper, Park, Roitman, Tartarone, Wiegand. In spring 2018, Dumitrescu presented the basics of Multiplicative Ideal Theory (MIT) in a series of lectures delivered in SMS. These lectures were primarily intended to help his MPhil students (at that time) Aqsa Bashir and Zohaib Nadeem to prepare their MPhil theses.

For writing their MPhil theses, Bashir and Nadeem studied and understood difficult MIT papers (e.g. [2-9]). In late spring 2018, Bashir and Nadeem wrote their MPhil theses (Bashir about stable integral domains, Nadeem about integral domains with combined invertible-prime factorization). The theses received a good appreciation from referees as regarding difficulty, technical aspects, organization, and original facts. Bashir and Nadeem defended successfully their theses in early Fall 2018. They also gave several well-received SMS popular talks explaining their work.

Vaughan, Yeagy [10] and Olberding [11] studied the integral domains whose ideals are products of radical ideals. Ahmed and Dumitrescu [12] gave two different extensions of these results for commutative rings with zero-divisors. A confirmation of the good quality of results in [12] came recently. In [13], Olberding and Reinhart further extended these ideas to multiplication lattices acknowledging that many of their proofs are inspired by [12]. Stimulated by the approach in [13], Dumitrescu wrote a paper [14] (submitted for Graz 2018 Proceedings book) where he extended/unified (in the setup of multiplicative lattices) many results around the so-called Bazzoni's Conjecture.

References

SP-rings with zero-divisors,
M. T. Ahmed and T. Dumitrescu,
Comm. Algebra 45 (2017), 4435–4443.

Domains with invertible-radical factorization, to appear in Bull. Korean. Math. Soc.
M. T. Ahmed and T. Dumitrescu,

Class semigroups of Prüfer domains,
S. Bazzoni,
J. Algebra 184 (1996), 613-631.

A Bazzoni-type theorem for multiplicative lattices,
T. Dumitrescu,
Manuscript.

Globalizing local properties of Prüfer Domains
B. Olberding,
J. Algebra, 205, 480-504 (1998).

Factorization into prime and invertible ideals,
B. Olberding,
J. London Math. Soc. 62 (2000), 336-344.

On the Classification of Stable Domains,
B. Olberding,
J. Algebra, 243, 177-197(2001).

On the Structure of Stable Domains,
B. Olberding,
J. Comm. Algebra, 30(2), 877-895 (2002).

Factorization into radical ideals, in Arithmetical properties of commutative Rings and monoids (S. Chapman, editor),
B. Olberding
Lect. Notes in Pure Appl. Math. Vol 241.
Chapman & Hall, 363-377, 2005.

Factorization into prime and invertible ideals II,
B. Olberding,
J. London Math. Soc. 80 (2009), 155-170.

Finitely stable rings,
B. Olberding,
J. Commutative Algebra 269-291, (2014).

Radical factorization in commutative rings, monoids and multiplicative lattices,
B. Olberding and A. Reinhart,
Math. Arxiv: 1811.00242v1, math.AC, 2018.

Factoring ideals into semiprime ideals,
N. Vaughan and R. Yeagy,
Can. J. Math. 30 (1978), 1313-1318.

COMPUTATIONAL ALGEBRAIC GEOMETRY

The Computational Algebra and Singularity Theory group at SMS led by Gerhard Pfister consists of Afshan Sadiq, Shamsa Kanwal, Khawar Mehmood, Nimra Javed, Ali Ahmed, Zunaira Kosar, and Asma Khalid. The group worked on some projects in collaboration with the former SMS students Muhammad Ahsan Binyamin, Faira Kanwal Janjua, Deebea Afzal, Junaid Alam Khan. The group has been working on the following problems:

Classification of parameterized curve singularities (Mehmood, Javed)
Special Standard bases and modular computations (Kanwal, Afzal)
Binomial modules and primary decomposition (Ahmed, Sadiq)

Special Methods of primary decomposition for modules (Sadiq)
 Classification of hypersurface singularities (Binyamin, Kanwal Janjua)
 Computational aspects of Neron desingularization (Kosar, Khalid)
 Sagbi bases for G-algebras (Khan, Binyamin)

The group obtained a lot of interesting results which are published in several Journals:

Tangent Space at the Orbit of an Algebraic Group Action,
 D. Afzal, S. Kanwal, G. Pfister:
 Bull. Math. Soc. Sci. Math. Roumanie 61 (109) 2 (2018), 135-146

An Uniform General Neron Desingularization in Dimension One,
 A. Khalid, G. Pfister, D. Popescu:
 J. Algebra Appl. 17, No. 6, Article ID 1850105, 10 p. (2018)

Standard Bases with Special Generators of the Leading Ideal,
 S. Kanwal, G. Pfister:
 Bull. Math. Soc. Sci. Math. Roumanie 61(109) 1, 69-81 (2018),

Constructive Neron Desingularization of Algebras with Big Smooth Locus,
 Z. Kosar, G. Pfister, D. Popescu:
 Commun. Algebra 46(5), 1902-1911 (2018),

Simple Singularities of Parametrized Plane Curves in Positive Characteristic,
 K. Mehmood, G. Pfister:
 Commun. Algebra 46, No. 9, 3996-4006 (2018)

Recognition of Unimodal Map Germs from the Plane to the Plane by Invariants,
 S. Aslam, M.A. Binyamin, G. Pfister :
 Int.J. Algebra Comput. 28, No. 7, 1199-1208 (2018)

Algorithm for Primary Submodule Decomposition without Producing Intermediate Redundant Components,
 A. Sadiq,
 Journal of Algebra and its applications (2018)

Several articles which have already been submitted will be published in 2019.

At the end of August 2018, A. Sadiq and Gerhard Pfister organized a workshop "**Algebraic Geometry in Applications**". The aim of the workshop was to give an overview of methods in algebraic geometry and their applications in various fields of mathematical and non-mathematical sciences. There was also a course in which it was shown how the existing computer algebra systems could be used to handle nontrivial examples in the above-mentioned theories and how the algorithms based on Groebner bases are implemented in these systems. The workshop turned out to be very successful.

In 2019 we will concentrate our research on the following problems:

Classification of simple parameterized space curve singularities in characteristic p (Javed)
 Classification of parameterized curve singularities in n -space, $n \geq 4$ (A. Sadiq, K. Mehmood, F. Kanwal Janjua)
 Binomial modules and primary decomposition (A. Sadiq, D. Afzal)
 Special Methods of primary decomposition for modules (A. Sadiq)
 A classifier for special types of Singularities (M.A. Binyamin)

GRAPH THEORY

The Graph Theory group at SMS investigated an entire H -irregularity strength of plane graphs as a modification of the well-known total and entire face irregularity strengths. Estimations on this new graph characteristic were obtained and determined the precise values of these parameters for graphs from two families of plane graphs to demonstrate that the obtained bounds are tight [1-7].

A concept of the edge irregular reflexive k -labeling was recently introduced. This concept is a modification of edge irregular total k -labeling where our research group has several significant results. This is a reason that we started research on edge irregular reflexive k -labeling and we determined the exact values of the reflexive edge strength for cycles, Cartesian product of cycles and for join graphs of the path and cycle with two copies of K_2 [13-14].

The concept of resolving set has many different applications in the areas of network discovery and verification, in robot navigation and in chemistry. We continued the research on this topic and investigated the properties of doubly resolving sets. We determined the minimal doubly resolving set and its cardinality for necklace graphs. This family of graphs is interesting to consider, in the sense, that its metric dimension depends on the parity of order n . We proved that the minimal doubly resolving set is 3 for every n [4, 10, 11].

Discovery of the fullerene molecules and related forms of carbon such as nanotubes has generated an explosion of activity in chemistry and materials science. The aim of research in this topic is the investigation of the structural properties of fullerenes. In our case, we investigated the existence of 3-total edge product cordial labelings for toroidal fullerenes and for Klein-bottle fullerenes and we described the construction which proves the existence of such labeling for the cubic bipartite Klein-bottle polyhex [5].

The concept of H-covering was recently introduced for investigation of labelings of graphs. We used partition subsets of integers for describing desired H-antimagic labelings. We proved some sufficient conditions for the Cartesian product of two graphs admitting an H-covering to be H-antimagic for several values of difference [2, 3, 8].

Moreover, we studied the topological integer additive set-labelings of star graphs [6], edge irregularity strength of complete m -ary trees [12] and distance irregular labelings [9]. We characterized graphs with finite inclusive distance vertex irregularity strength and we obtain precise values of this graph invariant for several classes of graphs.

References

On irregularity strength of diamond network
Hinding, Nurdin; Firmayasari, Dian; Basir, Hasmawati; M. Baca, A. Semanicová-Fenovčíková
AKCE International Journal of Graphs and Combinatorics
Volume/Page: Volume: 15 Issue: 3 Pages:

291-297
DEC 2018

Super (a, d)-H-antimagic labeling of subdivided graphs
A. Taimur, M. Numan, G. Ali, A. Mumtaz, A.S. Fenovčíková
Open Mathematics, Volume/Page: Volume: 16
Pages: 688-697
JUN 22 2018

Cycle-supermagic labelling of some classes of plane graphs
M. Numan, G. Ali, M. Asif, A.S. Fenovčíková
Science Asia, Volume/Page: Volume: 44
Issue: 2 Pages: 129-134
APR 2018

On the metric dimension and diameter of circulant graphs with three jumps
M. Imran, A.Q. Baig, S. Rashid, A.S. Fenovčíková
Discrete Mathematics, Algorithms and Applications, Volume/Page: 10(1), 1850008
(2018) [17 pages] FEB 2018

On total edge product cordial labeling of fullerenes
M. Baca, M. Irfan, A. Javed, A.S. Fenovčíková
Electronic Journal of Graph Theory and Applications
Volume/Page: Volume: 6 Issue: 2 Pages:
238-249, 2018

On topological integer additive set-labeling of star graphs
H.M. Radiapradana, S.W. Saputro, E. Suwastika, O. Neswan, A.S. Fenovčíková
Electronic journal of graph theory and applications
Volume/Page: Volume: 6 Issue: 2 Pages:
341-346, 2018

Entire H-irregularity Strength of Plane Graphs
M. Baca, N. Hinding, A. Javed, A.S. Fenovčíková
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Volume/Page: Volume: 10765 Pages: 3-12,
2018

On H-antimagicness of Cartesian product of graphs

M. Baca, A.S. Fenovčíková, M.A. Umar, D. Welyyanti

Turkish Journal of Mathematics, Volume/Page: 42(1) (2018), 339-348, 22.01.2018

On inclusive distance vertex irregular labelings

M. Baca, A.S. Fenovčíková, S. Slamin, A. Kiki

Electronic Journal of Graph Theory and Applications

Volume/Page: Volume:6 Issue:1 Pages:61-83, 2018

On fractional metric dimension of comb product graphs

S.W. Saputro, A. S. Fenovčíková, M. Baca, M. Lascsáková

Stat. Optim. Inf. Comput. Volume/Page: 6 (2018), 150–158, March 2018

Minimal doubly resolving sets of necklace graph

A. Ahmad, M. Bača, S. Sultan,

Mathematical Reports Volume/Page: 20(2), pp. 123-129, 2018

Computing edge irregularity strength of complete m-ary trees using algorithmic approach

A.Ahmad, M.A.Asim, M.Bača, R.Hasni, UPB Scientific Bulletin, Series A: Applied Mathematics and Physics

Volume/Page: 80(3), pp. 145-152, 2018

Note on edge irregular reflexive labelings of graphs

M. Baca, M. Irfan, J. Ryan, A.S. Fenovčíková, D. Tanna

AKCE International Journal of Graphs and Combinatorics,

Volume/Page:

doi.org/10.1016/j.akcej.2018.01.013, online 20 January 2018

Vertex irregular reflexive labeling of prisms and wheels

D. Tanna, J. Ryan, A.S. Feňovčíková, M. Bača,

AKCE International Journal of Graphs and Combinatorics

Article in Press 2018

STRONG AND SHIFTED STABILITY FOR COHOMOLOGY OF CONFIGURATION SPACES OF MANIFOLDS

Integral homological stability for configuration spaces studied by G. Segal [7] and D. MacDu [5]. The rational homological stability for unordered configuration spaces of connected manifolds was discovered by Th. Church [3] and extended by O. Randal-Williams [6] and B. Knudsen [4]: In the paper [1] me and my advisor Prof. Barbu Berceanu characterized the manifolds satisfying strong stability: We introduced an algebraic tool sequence of weighted spectral sequences to analysis the cohomology of configuration spaces of manifolds. As a first application, we proved the bigraded version of classical stability of configuration spaces of manifolds. In the third part of the paper, we introduced the four new types of stabilities in the top cohomology of configuration spaces of manifolds so called shifted stabilities (shifted stability, extended shifted stability, Poincaré polynomial shifted stability, spectral shifted stability). Currently we are working on the cohomology of configuration spaces of projective spaces [2]. Some of the results of our second article already proved in the end of the first paper.

One more application of our work will be appear in my article “Homological proof for non-contractibility of configuration spaces”. Our two research articles submitted in the Journals and one in preparation.

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strong and shifted stability for cohomology of configuration spaces,
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B. Berceanu, M. Yameen,
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Th. Church,
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Topology 14, 1 (1975), 91-107.
Homological stability for unordered configuration spaces,
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DYNAMICAL SYSTEM

The dynamical systems group led by Dimitar Kolev consists of A. Ahmed and K. Haider and is currently working on a project "Existence of limit cycles to piecewise, smooth systems in \mathbb{R}^2 ". This project is devoted to the existence of limit cycles of piecewise-linear (PWL) systems with a singularity of type "focus-focus" and "focus-center". Our investigation is a supplement to the classification of E. Freire et al. in their notable work [6]. Our first goal is to show the existence of a stable limit cycle for the system of type "focus-focus" at certain relations of its parameters. The second goal is to establish a method of constructing a limit cycle. Also, we give examples for both cases "focus-center" and "focus-focus" illustrating our assertions.

The study of PWL systems goes back to A. Andronov et al. [1] and continues with unceasing interest to nowadays. The methods and development of the research of PWL systems can be seen in the monograph of M. di Bernardo et al. [2] as well in the survey of O. Makarenkov and J. S. W. Lamb [19]. The monograph of A. F. Filippov [5], and the works of J. Llibre et al. [4], also [3, 13, 6, 11] would be of interest.

The existence of limit cycles as well as determining their maximal number has been a basic problem of interest for many mathematicians and has been thoroughly studied (see [4, 9, 13-18]). This is no less interesting task than the Hilbert's sixteenth problem concerning smooth in

classical sense dynamical systems. We note that two remarkable studies [4] and [6] have motivated us to investigate the above-stated problem. In [4] the authors have considered the case "focus-focus" and have estimated the maximal number N of limit cycles of the considered system by $2N - 4$. In the second paper, [6], it is proved a fundamental statement (Theorem 4.5), where we focus our attention on the item (b4). It is the case when the sum of the real parts r and l of eigenvalues of A^+ and A^- , respectively, in the system under consideration is negative $r + l < 0$. Then the authors state that "there is always a stable crossing periodic orbit. If in addition $rl = 0$, then the above crossing periodic orbit is unique." However, we assert that when l sweeps the interval $(0; 3/2]$ provided that the rest of the parameters are fixed then there exists a unique stable limit cycle, and for $l > 3/2$ there is no limit cycle. Our observation shows that in the above-mentioned case there exists such a special combination of the parameters of the considered PWL system for which the maximal number of limit cycles estimated in [4] as well the existence in [6] should be reconsidered in a more precise way.

We have established a method by which we proved the existence of a special configuration of five parameters leading to the existence of a unique stable limit cycle, that is a periodic orbit whose period can be found by solving a transcendent equation. An exact estimate of this period was obtained. We applied this theory on a two-dimensional system describing most generally the qualitative behavior of two-dimensional excitable membrane models.

The following papers are devoted to problems connected with dynamical systems:

[1] Q. Din, T. Donchev, D. Kolev, Stability, Bifurcation Analysis and Chaos Control in Chlorine Dioxide-Iodine-Malonic Acid Reaction, Communications in Mathematical and in Computer Chemistry, Vol. 79 (2018), number 3, pp. 577-606. (IF 3.63)

[2] T. Donchev, D. Kolev, Stability for perturbed nonautonomous differential equations under impulsive effect Communications in Applied Analysis, 21, No. 3 (2017), 325-335.

[3] A. Ahmad, K. Haider, D. Kolev Existence of limit cycles to piecewise smooth systems in R^2 , submitted under consideration in the journal "Mathematical Methods in the Applied Sciences". C. Preparation of a book entitled "Lecture Notes on ODE and Dynamical Systems".

It is devoted to basic topics of the qualitative theory of ODE and dynamical systems with important statements and a lot of examples.

D. Short courses delivered during the last year.

A short course delivered during the spring of 2018:

Lectures on ODE and Dynamical systems.

4) Difficulties.

We know that the limit cycle to any PWL system is not smooth due to the fact that it is obtained by two different trajectories belonging to different linear systems each one possessing different equilibrium point. It turns out that to find two proper different trajectories forming a unique limit cycle even for the linear systems is too difficult task. The difficulties arise mainly due to the fact that many parameters influence on the behavior of the trajectories of every PWL system. In our case one may reduce their number to five parameters.

5) Future goals of the project.

1) To establish analogical method for study of similar system in R^3 .

2) To continue the effective study in the case of nonlinear perturbations of the PWL systems in R^2 and R^3 .

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The number of limit cycles in general planar piecewise linear systems,
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One-parameter bifurcations in planar Filippov systems,
Yu. A. Kuznetsov, S. Rinaldi, A. Gragnani,
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Discontinuous bifurcations of periodic solutions,
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J. Llibre, M.A. Teixeira, Torregrosa,
*J. International Journal of Bifurcation and
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Three nested limit cycles in discontinuous
 piecewise linear differential systems with two
 zones,
 J. Llibre, E. Ponce,
*Dynamics of Continuous, Discrete & Impulsive
 Systems, Series B* 19, 325-335 (2012).

On the existence and uniqueness of limit cycles
 in planar continuous piecewise linear systems
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 J. Llibre, D.D. Novaes, M.A. Teixeira,
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Piecewise linear differential equations and
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 A. Tonnelier, W. Gerstner,
Physical Review E 67, 021908, 1-16 (2003).

STRING THEORY

The string theory at the school continued its study of little string theories engineered by a certain class of Calabi-Yau threefolds denoted by $X_{N,M}$. In [1] we studied a class of eight-supercharge little string theories (LSTs) on the world-volume of N M5-branes with transverse space $S^1 \times (C^2/Z_M)$. These M-brane configurations compactified on a circle are dual to M D5-branes intersecting N NS5-branes on $T^2 \times R^{7,1}$ as well as to F-theory compactified on a toric Calabi-Yau threefold $X_{N,M}$. We argued that the Kähler cone of $X_{N,M}$ admits three regions associated with weakly coupled quiver gauge theories of gauge groups $[U(N)]^M$, $[U(M)]^N$ and $[U(\frac{NM}{k})]^k$ where $k = \gcd(N,M)$. These provide low-energy descriptions of different LSTs. The duality between the first two gauge theories is well known and is a consequence of the S-duality between D5- and NS5-branes or the T-duality of the LSTs. The triality involving the third gauge theory is new and we demonstrated it using several examples.

In [2] we studied the topological string partition function of a class of toric Calabi-Yau threefolds $X_{N,M}$ at a generic point in the Kähler moduli space. These manifolds engineer little string theories in five dimensions or lower and are dual to stacks of M5-branes probing a transverse orbifold singularity. Using the refined topological vertex formalism, we explicitly calculated a generic building block which allowed us to compute the topological string partition function of $X_{N,M}$ as a series expansion in different Kähler parameters. Using this result we gave further explicit proof for a duality found previously in the literature, which relates $X_{N,M} \sim X_{N^0, M^0}$ for $NM = N^0 M^0$ and $\gcd(N,M) = \gcd(N^0, M^0)$.

In [3] the web of dual gauge theories engineered from a class of toric Calabi-Yau threefolds was explored. In [1], we have argued for a triality structure by compiling evidence for the fact that every such manifold $X_{N,M}$ (for given (N,M)) engineers three a priori different, weakly coupled quiver gauge theories in five dimensions. The strong coupling regime of the latter is in general described by Little String Theories. Furthermore, we also conjectured that the manifold $X_{N,M}$ is dual to X_{N^0, M^0} if $NM = N^0 M^0$ and $\gcd(N,M) = \gcd(N^0, M^0)$. Combining this result with the triality structure, we argued in [3] for a large number of dual quiver gauge theories, whose instanton partition functions can be computed explicitly as specific expansions of the topological partition function $Z_{N,M}$ of $X_{N,M}$. We illustrated this web of dual theories by studying explicit examples in detail. We also undertook first steps in further analyzing the extended moduli space of $X_{N,M}$ with the goal of finding other dual gauge theories.

- [1] Triality in Little String Theories
B. Bastian, S. Hohenegger, A. Iqbal, S. J. Rey
Physical Review D 97 (4), 046004
- [2] Dual Little Strings and their Partition Functions
B. Bastian, S. Hohenegger, A. Iqbal, S. J. Rey
Physical Review D 97 (10), 106004
- [3] Beyond Triality: Dual Quiver Gauge Theories and Little String Theories
B. Bastian, S. Hohenegger, A. Iqbal, S. J. Rey
Journal of High Energy Physics 2018 (11), 16

COLLABORATIVE RESEARCH VISITS BY STUDENTS, POSTDOCTORAL FELLOWS & FACULTY

The school provides generous travel grants to its students and faculty to attend academic events and to carry out collaborative research. This important initiative has resulted in many interesting and important results which have appeared as publications in top mathematics and theoretical physics journals.

In the past couple of years the following students have made use of the school's travel grant to attend workshops, conferences and to visit their supervisors when they are abroad.

Ali Ovais (Slovakia)
Muhammad Ahsan Khan (Romania)
Zunaira Kosar (Romania)
Muhammad Yameen (Romania)
Awais Shaukat (France and Den Mark)
Ali Raza (South Africa and Turkey)

The faculty travel grant was initiated and provides the faculty travel and other support to attend workshops, conferences and to make collaborative visits. The faculty travel grant resulted in the following visits by the faculty.

M. Azeem Khadam

Postdoctoral Fellow

Max-Planck Institute of Mathematics in Applied Sciences (MPI MIS), Leipzig, Germany visit as a Researcher.
August 27, 2018 to September 24, 2018.

M. Nouman Muteeb

Postdoctoral Fellow

High Energy, Cosmology & Astroparticle Physics Section of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy visit
September 01, 2018 to September 30, 2018.

The faculty travel grant was initiated and provides the faculty travel and other support to attend workshops, conferences and to make collaborative visits. The faculty travel grant resulted in the following visits by the faculty.

Amer Iqbal

Visiting Professor

1. Simon Center for Geometry and Physics, Stony Brook University, New York visit to attend the workshop "Categorification in Mathematical Physics" April 09, 2018 to April 13, 2018.
2. SISSA Trieste, Italy visit as an invited Speaker for the "VIII Workshop on Geometric Correspondences", June 11, 2018 to June 15, 2018.
3. Simon Center for Geometry and Physics, Stony Brook University, New York visit to attend "Simon Summer Workshop 2018" July 16, 2018 to August 10, 2018.

Imran Anwar

Associate Professor

1. Dalhousie University, Halifax, NS Canada visit an invited Visiting Professor
March 15, 2018 to April 15, 2018.
2. University of Osnabrück visit to attend "Combinatorial Categories in Algebra and Topology" November 22-24, 2018 and worked on International collaborations for students, postdoctoral fellows and faculty at the School working in the area of Algebra and Category theory.

Afshan Sadiq

Assistant Professor

1. Attend Two workshops at Louisiana State University, Baton Rouge "Spring Mini Courses in Analysis and Geometry", February 09-11, 2018 and "Graduate Workshop in Algebraic Geometry for Women and Mathematicians of Minority Genders" Harvard and MIT, USA
February 17-18, 2018.
2. Technische Universität Kaiserslautern, Germany invited as a researcher
April 10, 2018 to April 25, 2018.

COLLABORATIVE ACTIVITIES OF ASSMS & NCM WITH OTHER PAKISTANI UNIVERSITIES

1. “One day International Symposium on recent trends in Applied Mathematics (IWRTAM-2017)”, University of Engineering & Technology, Lahore, Lahore. **December 05, 2017**
2. Workshop on Topics in Topology, Lahore University of Management Sciences (LUMS), Lahore **February 22-24, 2018**
3. Seminar on Fundamentals of Fluid Dynamics and Transport Phenomena, Khwaja Fareed University of Engineering & IT (KFUEIT), Rahim Yar Khan. **March 09, 2018**
4. One Day Symposium on Combinatorial Graph Theory and its Applications in collaboration Centre of Advanced Studies in Pure & Applied Mathematics (CASPAM) Bahauddin Zakariya University, Multan. **March 19, 2018**
5. “One day International Symposium on recent trends in mathematics”, Lahore College for Women University (LCWU), Lahore. **April 24, 2018**
6. “2018 International Conference on Mathematics and its Applications” Department of Mathematics, GC University Lahore. **November 13-15, 2018**



CASM WORKSHOP
IN COLLABORATION WITH
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES &
NATIONAL CENTRE FOR MATHEMATICS



Topics in Topology

FREE REGISTRATION



Topological spaces arise naturally in almost every branch of mathematics. This has made topology one of the great unifying ideas of mathematics and has found numerous applications in Biology, Physics, Computer Science and Robotics.

This three-day workshop is aimed at graduate students and young researchers with little background in topology and some interest in its application.

There will be three mini lecture series on selected topics from lower dimensional topology, Morse theory and algebraic topology followed by short tutorials. We hope to present invariants of braids and links, Morse homology leading to Floer theory, and cohomology of generalized configuration spaces.

SPEAKERS

- ♦ **Alberto Arabia** (Senior Researcher, IMJ-CNRS / Université Paris Diderot – Paris 7, France)
- ♦ **Barbu Berceanu** (Professor, IMAR & ASSMS, Romania)
- ♦ **Christian Blanchet** (Professor, IMJ-CNRS / Université Paris Diderot – Paris 7, France)
- ♦ **Haniya Azam** (LUMS, Pakistan)

Workshop Dates:
22-23 February, 2018
Venue: LUMS
24 February, 2018
Venue: ASSMS

ORGANISERS

Haniya Azam (LUMS)
Imran Anwar (ASSMS)
Shaheen Nazir (LUMS)
Amer Rasheed (CASM, LUMS)

Registration deadline: 18 February 2018

Register @ <http://sbasse.lums.edu.pk/department/mathematics/casm-workshop-topics-in-topology>

For information, please contact:
Dr. Amer Rasheed
amer.rasheed@lums.edu.pk,
Maryam Amir
maryam.amir@lums.edu.pk
Tel:+92-42-35608284/8217,
Fax:+92-42-35741673.

INFORMATION, BLACKHOLES AND QUANTUM PHYSICS: THEORETICAL PHYSICS AT THE CROSSROADS

26-30 MARCH, 2018
AS-SMS, LAHORE

Registration and Detailed Program: www.sms.edu.pk/bhw
Deadline to register: 16 February, 2018

This workshop, through topical lectures, aims to provide an introduction to fundamental problems in black-hole physics which are the focus of intense interest in current research in quantum information theory, quantum gravity and quantum field theory. The workshop should be of interest to students and researchers alike. Financial support to attend the workshop is available for serious students.

Speakers:

Pervez Hoodbhoy (FCC)

Amer Iqbal (AS-SMS)

Can Kozcaz (Bogazici)

Asghar Qadir (NUST)

Babar Qureshi (MIT)

- ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
- NATIONAL CENTER FOR MATHEMATICS, GCU, LAHORE
- HIGHER EDUCATION COMMISSION, H-9, ISLAMABAD

WORKSHOP-1

This is first time in the last ten years that a workshop on quantum gravity was being organized in Pakistan. Although classical general relativity is active area of research in Pakistan but its quantization and other possible ways of discussing quantum effects in gravitational physics, such as loop quantum gravity or string theory, are not being actively pursued although it is without question the most important area of theoretical physics with a lot of work going on in universities abroad. The workshop aims to introduce this area to Pakistani students and researchers so that they too can take part in the global effort to obtain a theory of quantum gravity. This can lead to collaboration between groups in Pakistan and research groups abroad.

Speakers



Pervez Amirali Hoodbhoy



Asghar Qadir



Babar Ahmed Qureshi



Can Kozcaz



Amer Iqbal

NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE



ALGEBRAIC GEOMETRY AND ITS APPLICATIONS

AUGUST 27 - 30, 2018

Speakers:

Deeba Afzal (University of Lahore)
Hassan Azad (King Fahd University of Petroleum & Minerals)
Muhammad Ahsan Binyamin (GC University, Faisalabad)
Nazeran Idrees (GC University, Faisalabad)
Shamsa Kanwal (Govt. Girls Degree College, Jhelum)
Junaid Alam Khan (IBA, Karachi)
Arnfinn Laudal (University of Oslo)
Gerhard Pfister (University of Kaiserslautern)
Muhammad Imran Qureshi (University of Tübingen)
Afshan Sadiq (AS-SMS GC University, Lahore)
Andreas Steenpaß (University of Kaiserslautern)
Ignacio Luengo (Catedrático de Universidad)
Sohail Zafar (UMT, Lahore)

For details contact: afshanadil@sms.edu.pk

Last date for registration: August 06, 2018

Registration form is available at: <http://sms.edu.pk/agw>

Organizers: Hassan Azad, Gerhard Pfister, Afshan Sadiq

Funding for the workshop provided by the Higher Education
Commission & the Pakistan Science Foundation

WORKSHOP-2

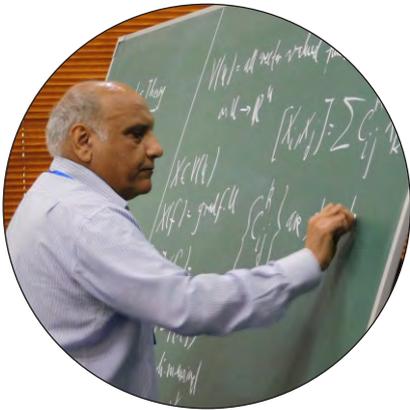
The objective of this workshop was to discuss and highlight the recent developments in algebraic geometry. Emphasis will be on explaining the applications of algebraic geometry to various other areas of mathematics including geometry and computational algebra. The main topics covered in the workshop include classification of algebraic varieties, singularity theory, Lie theory and applications to various fields. Initial talks will focus on algebraic geometry followed by advanced talks and research sessions on its applications. The workshop can be of great help to a well-motivated young researcher in developing the understanding of these important areas of mathematics and to lead them to new projects based on important problems in these areas.

Speakers

Deeba Afzal (University of Lahore)
 Hassan Azad (King Fahd University of Petroleum & Minerals)
 Nazeran Idrees (GC University, Faisalabad)
 Shamsa Kanwal (Govt. Girls Degree College, Jhelum)
 Junaid Alam Khan (IBA, Karachi)
 Arnfinn Laudal (University of Oslo)
 Gerhard Pfister (University of Kaiserslautern)
 Muhammad Imran Qureshi (University of Tübingen)
 Afshan Sadiq (AS-SMS GC University, Lahore)
 Andreas Steenpaß (University of Kaiserslautern)
 Ignacio Luengo (Catedrático de Universidad)
 Sohail Zafar (UMT, Lahore)



SPEAKERS



NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE



SECOND WINTER WORKSHOP ON ADVANCED TOPICS IN MATHEMATICS: ANALYSIS AND DYNAMICS IN NUMBER THEORY

DECEMBER 13 - 18, 2018

The workshop will focus on recent developments in certain areas of number theory including diophantine approximation, modular forms and connections of number theory with dynamical systems

Speakers:

Shaun Cooper (Massey University, New Zealand)

Karl Dilcher (Dalhousie University, Canada)

Mumtaz Hussain (La Trobe University, Australia)

Simon Kristensen (Aarhus University, Denmark)

Last date for registration: November 23, 2018

Registration form is available at: <http://sms.edu.pk/NTW-2018>

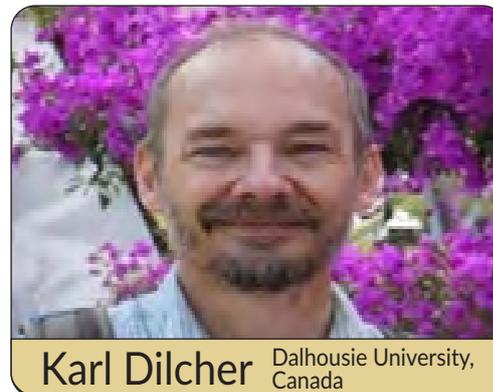
For details contact: info@sms.edu.pk

Sponsored by the Punjab Higher Education Commission.

WORKSHOP-3

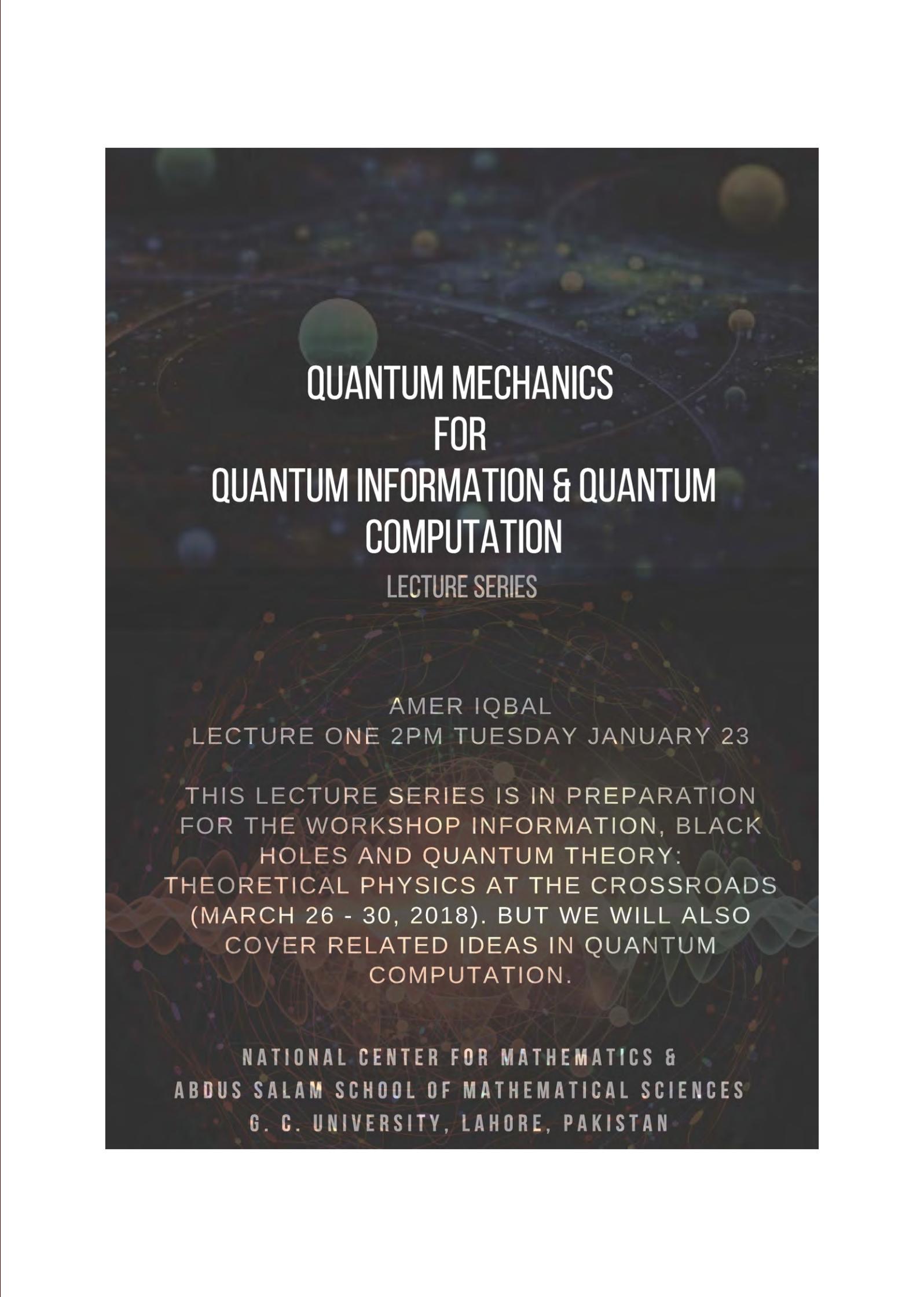
This workshop was feature four short courses on various topics in number theory ranging from beginner's to the advanced level. Briefly, the short course on the following listed topics. Ramanujan's theta functions and series for $1/\pi$ will survey the main properties of theta functions that have applications in number theory. In particular, by taking inspirations from Ramanujan, a large number of explicit examples will be discussed. Introduction to analytical number theory will focus on fundamentals in analytical number theory such as continued fractions, prime number theorem, Riemann zeta function and Euler's formula. Dynamical methods in number theory will focus on classical and modern applications of ergodic theory and dynamical systems in Diophantine problems. Metric number theory will focus on the quantitative study of density of rational numbers in real number system. In particular, the course will focus on range of ideas and techniques in Diophantine approximation and fractal geometry.

Speakers





**JANUARY
2018**

The background is a dark, deep blue space filled with numerous small, glowing particles in various colors (green, yellow, orange, red, purple). Some of these particles are connected by thin, faint lines, suggesting orbits or paths. There are also larger, semi-transparent spheres in shades of green and blue, some of which appear to be part of a larger, more complex structure. The overall effect is that of a quantum mechanical or cosmological visualization.

QUANTUM MECHANICS FOR QUANTUM INFORMATION & QUANTUM COMPUTATION

LECTURE SERIES

AMER IQBAL

LECTURE ONE 2PM TUESDAY JANUARY 23

THIS LECTURE SERIES IS IN PREPARATION FOR THE WORKSHOP INFORMATION, BLACK HOLES AND QUANTUM THEORY: THEORETICAL PHYSICS AT THE CROSSROADS (MARCH 26 - 30, 2018). BUT WE WILL ALSO COVER RELATED IDEAS IN QUANTUM COMPUTATION.

NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
G. C. UNIVERSITY, LAHORE, PAKISTAN

NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES
G. C. UNIVERSITY, LAHORE

QUIVER GAUGE THEORIES, GRADED QUIVERS AND TORIC CALABI-YAUS

AZEEM HASAN
THE CITY UNIVERSITY OF NEW YORK



11AM WEDNESDAY JANUARY 24, 2018

Recently introduced graded quivers provide a unifying language for describing a large class of SUSY gauge theories in various even dimensions. A subclass of these theories dubbed toric theories have mesonic moduli spaces which are toric Calabi Yau.

The interactions of these theories are encoded in a graph embedded in torus of appropriate dimension called the periodic quiver. We will discuss some recent progress in understanding the map between periodic quivers and the corresponding Calabi Yau. We will also present "3d printing" an algorithm for constructing lower dimensional theories from the data of higher dimensional ones or equivalently higher dimensional Calabi Yau from the data of lower dimensional ones. We will focus on going from 4 dimensional field theories to 2 dimensional ones but the generalization to other dimensions is straightforward.



NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES
G. C. UNIVERSITY, LAHORE

Hilbert Function Spaces

Waleed Noor

IMECC Universidade Estadual de Campinas Campinas Brazil

In this lecture the goal is to introduce an area of modern analysis loosely termed Hilbert functions spaces. It involves the study of various separable Hilbert spaces of holomorphic functions and their operators. These methods have proven fruitful in resolving longstanding open problems, and provide paths to several others yet unresolved problems. Some of the topics that will be discussed are:

The Hardy, Bergman and Dirichlet spaces

Beurling's characterization of the shift-invariant subspaces

The invariant subspace problem (ISP)

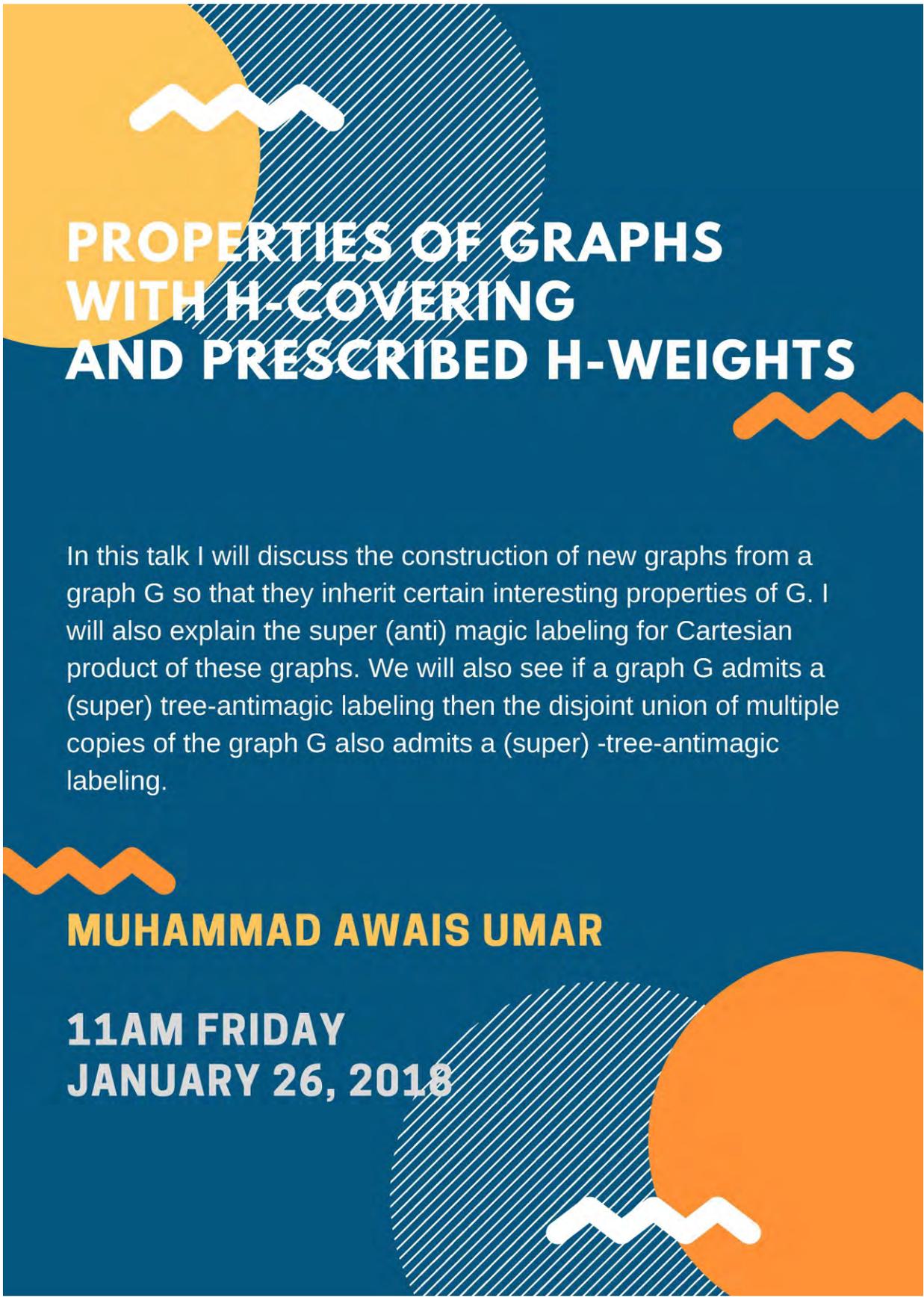
Cyclic and hypercyclic operators

Linear dynamics versus topological dynamics

The Hilbert space of Dirichlet series and the Riemann zeta function

A Hilbert space reformulation of the Riemann hypothesis.

2PM THURSDAY JANUARY 25, 2018



PROPERTIES OF GRAPHS WITH H -COVERING AND PRESCRIBED H -WEIGHTS

In this talk I will discuss the construction of new graphs from a graph G so that they inherit certain interesting properties of G . I will also explain the super (anti) magic labeling for Cartesian product of these graphs. We will also see if a graph G admits a (super) tree-antimagic labeling then the disjoint union of multiple copies of the graph G also admits a (super) -tree-antimagic labeling.

MUHAMMAD AWAIS UMAR

**11AM FRIDAY
JANUARY 26, 2018**

Advanced Topics in Theoretical Physics

**TOPOLOGY AND STRONGLY INTERACTING
FERMIONS**

NOUMAN TARIQ BUTT

SYRACUSE UNIVERSITY

2PM TUESDAY JANUARY 30, 2018

We study a 4d lattice model of massless fermions interacting through a particular four fermion term. Exact symmetries prevent the generation of bilinear fermion mass. Using an auxiliary field representation we generate the one-loop effective action and show that it has non-trivial topological features which manifest in the form of Hopf defects. Fermions propagating in the background of these defects become massive without breaking any symmetries. Furthermore pairs of such defects experience a logarithmic interaction. We argue that a phase transition separates a phase where these defects proliferate from a broken phase where they are bound tightly. We conjecture that by tuning one additional operator the broken phase can be eliminated with a single BKT-like phase transition separating the massless from massive phase.

Based on arXiv:1708.06715

**NATIONAL CENTER FOR MATHEMATICS
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G. C. UNIVERSITY, LAHORE**

Basic Notions Seminar

The Theory of General Relativity

LECTURE 2: DIFFERENTIAL GEOMETRY
OF SURFACES

AMER IQBAL

This lecture series is in preparation for the workshop *Information, Black Holes and Quantum Theory: Theoretical physics at the crossroads* (March 26 - 30, 2018).

Friday | January 26, 2018 | 2:30pm-4:00pm

To attend email: info@sms.edu.pk

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SCIENCES, G. C. UNIVERSITY, LAHORE



**FEBRUARY
2018**

Basic Notions Seminar

The Theory of General Relativity

LECTURE 3: CONNECTION AND PARALLEL
TRANSPORT

AMER IQBAL

This lecture series is in preparation for the workshop *Information, Black Holes and Quantum Theory: Theoretical physics at the crossroads* (March 26 - 30, 2018).

Thursday | February 1, 2018 | 2:00pm-3:15pm

To attend email: info@sms.edu.pk

NATIONAL CENTER FOR MATHEMATICS &
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SCIENCES, G. C. UNIVERSITY, LAHORE

ADVANCED TOPICS IN THEORETICAL PHYSICS

AN INTRODUCTION TO SEIBERG-WITTEN THEORY

MUHAMMAD ALI SHEHPER
UNIVERSITY OF TEXAS AT AUSTIN

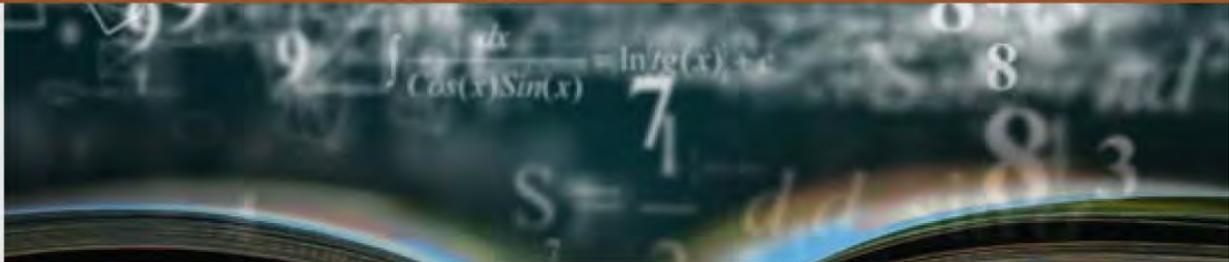
10:30AM - 12:05PM FRIDAY FEBRUARY 2, 2018

GIVEN A QFT, IT IS OFTEN ASKED WHAT IS ITS LOW ENERGY DYNAMICS. IN NON-SUPERSYMMETRIC THEORIES, THIS QUESTION CANNOT BE ANSWERED EXACTLY AND WE SUFFICE OURSELVES WITH AN APPROXIMATE ANSWER OBTAINED FROM PERTURBATION THEORY, THAT HOLDS IN THE WEAK-COUPLED REGIME ONLY.

SEIBERG AND WITTEN, IN THEIR SEMINAL PAPER IN 1994, PROPOSED THAT THE AFORE-MENTIONED QUESTION CAN BE ANSWERED EXACTLY FOR N=2 SUPER YANG-MILLS BY EMPLOYING THE EXTRA CONDITION OF SUPERSYMMETRY. IN THESE TALKS, I REVIEW THEIR PAPER (HEP-TH/9407087).

NATIONAL CENTER FOR MATHEMATICS &
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G. C. UNIVERSITY, LAHORE

FUNWAY OR RUNAWAY: USING TECHNOLOGY FOR EFFECTIVE TEACHING IN MATHEMATICS



Wasiq Hussain

FORMAN CHRISTIAN COLLEGE UNIVERSITY

There is a major concern that the students doing major in mathematics or in a mathematics based field should be prepared more effectively when taking mathematics courses. These courses can be at undergraduate/postgraduate level.

My talk focuses on the development of an instructional technique to effectively teach mathematics to students using technology leading to concept clarity and making it fun but not a boring subject. With the use of multimedia/technology time spent in writing on board will be saved in explaining the concepts and the time spent to copy from the board will be spent in understanding the concept. Key points/working, where required, can be written/ done on board respectively.

Effective use of technology showing detailed calculations, proofs with integration of animations, hand made models, pictures and cartoons into mathematics courses can enhance the conceptual understanding and interest in mathematics. This further removes the misunderstanding that "Mathematics is a dry subject".

I will explain this instructional technique by discussing some examples from Ordinary Differential Equations, Mechanics and Real Analysis.

2:30PM Tuesday February 6, 2018

NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
G. C. UNIVERSITY, LAHORE

SOBOLEV SPACES

GEORGI KARADZHOV
BULGARIAN ACADEMY OF SCIENCES

In this lecture series the following topics will be covered:

Weak Sobolev derivatives
Distributions
classical Sobolev spaces
Embeddings and compact embeddings
Fractional Sobolev spaces
Tempered distributions
Generalized Sobolev spaces
Optimal embeddings

TUESDAY 2PM
FEBRUARY 13, 2018

**NATIONAL
CENTER FOR
MATHEMATICS**

**ABDUS SALAM
SCHOOL OF
MATHEMATICAL
SCIENCES**

**GC UNIVERSITY,
LAHORE**

Basic Notions Seminar

The Theory of General Relativity

LECTURE 4: THE RIEMANN CURVATURE
TENSOR

AMER IQBAL

This lecture series is in preparation for the workshop *Information, Black Holes and Quantum Theory: Theoretical physics at the crossroads* (March 26 - 30, 2018).

Thursday | February 15, 2018 | 2:00pm-3:15pm

To attend email: info@sms.edu.pk

NATIONAL CENTER FOR MATHEMATICS &
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SCIENCES, G. C. UNIVERSITY, LAHORE

LECTURE SERIES

SOBOLEV SPACES

GEORGI KARADZHOV
BULGARIAN ACADEMY OF SCIENCES

LECTURE TWO

3PM FEBRUARY 20, 2018

**IN THIS LECTURE SERIES THE
FOLLOWING TOPICS WILL BE
COVERED:**

**WEAK SOBOLEV DERIVATIVES
DISTRIBUTIONS
CLASSICAL SOBOLEV SPACES
EMBEDDINGS AND COMPACT
EMBEDDINGS
FRACTIONAL SOBOLEV SPACES
TEMPERED DISTRIBUTIONS
GENERALIZED SOBOLEV SPACES
OPTIMAL EMBEDDINGS**

**NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES, GC UNIVERSITY, LAHORE**

Basic Notions Seminar

The Theory of General Relativity

LECTURE 5: THE GEOMETRY OF LORENTZ
TRANSFORMATIONS

AMER IQBAL

This lecture series is in preparation for the workshop *Information, Black Holes and Quantum Theory: Theoretical physics at the crossroads* (March 26 - 30, 2018).

Wednesday | February 21, 2018 | 2:30-3:45pm

To attend email: info@sms.edu.pk

NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES, G. C. UNIVERSITY, LAHORE



CASM WORKSHOP
IN COLLABORATION WITH
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES &
NATIONAL CENTRE FOR MATHEMATICS



Topics in Topology

FREE REGISTRATION



Topological spaces arise naturally in almost every branch of mathematics. This has made topology one of the great unifying ideas of mathematics and has found numerous applications in Biology, Physics, Computer Science and Robotics.

This three-day workshop is aimed at graduate students and young researchers with little background in topology and some interest in its application.

There will be three mini lecture series on selected topics from lower dimensional topology, Morse theory and algebraic topology followed by short tutorials. We hope to present invariants of braids and links, Morse homology leading to Floer theory, and cohomology of generalized configuration spaces.

SPEAKERS

- ♦ **Alberto Arabia** (Senior Researcher, IMJ-CNRS / Université Paris Diderot – Paris 7, France)
- ♦ **Barbu Berceanu** (Professor, IMAR & ASSMS, Romania)
- ♦ **Christian Blanchet** (Professor, IMJ- CNRS / Université Paris Diderot – Paris 7, France)
- ♦ **Haniya Azam** (LUMS, Pakistan)

Workshop Dates:
22-23 February, 2018
Venue: LUMS
24 February, 2018
Venue: ASSMS

ORGANISERS

Haniya Azam (LUMS)
Imran Anwar (ASSMS)
Shaheen Nazir (LUMS)
Amer Rasheed (CASM, LUMS)

Registration deadline: 18 February 2018

Register @ <http://sbasse.lums.edu.pk/department/mathematics/casm-workshop-topics-in-topology>

For information, please contact:
Dr. Amer Rasheed
amer.rasheed@lums.edu.pk,
Maryam Amir
maryam.amir@lums.edu.pk
Tel: +92-42-35608284/8217,
Fax: +92-42-35741673.



**MARCH
2018**

COMMUTATIVE ALGEBRA UP TO SYMMETRY AND FI-MODULES

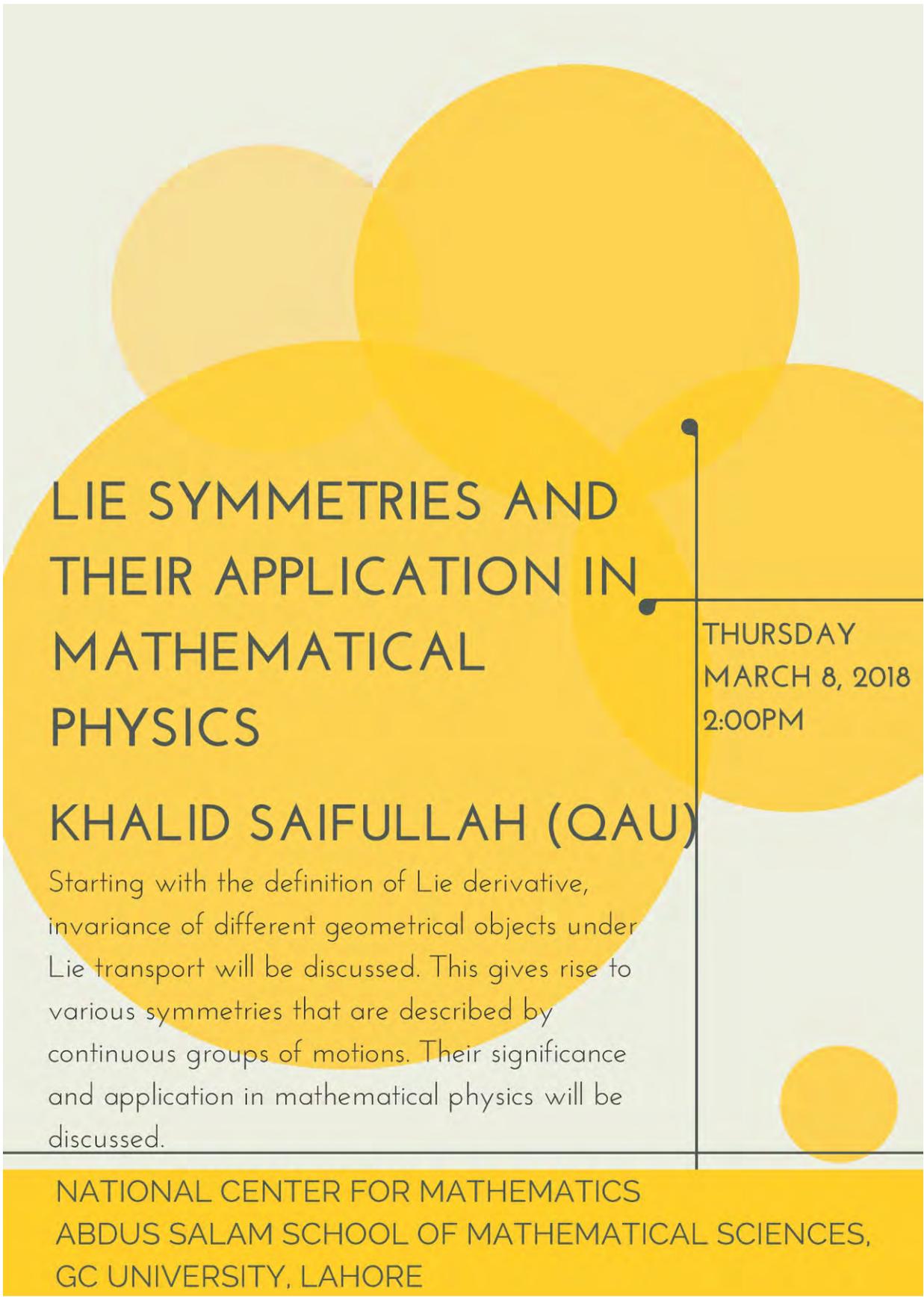
TIM RÖMER

INSTITUT FÜR MATHEMATIK, UNIVERSITÄT OSNABRÜCK

Wednesday March 7 • 2 PM

Ideal theory over a polynomial ring in countably many variables is rather complicated. In particular, motivated by results from algebraic statistics and representation theory, one is interested in ideals in such a ring which are invariant under the action of a symmetric group. These kind of ideals can be described by associated ascending chains of symmetric ideals in finitely many variables. In this talk we discuss some new results and open questions of ideals in such chains and their limits. Our approach is based on FI-modules with varying coefficients and various related techniques. This talk is based on joint work with Uwe Nagel.

THE NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE



LIE SYMMETRIES AND THEIR APPLICATION IN MATHEMATICAL PHYSICS

KHALID SAIFULLAH (QAU)

Starting with the definition of Lie derivative, invariance of different geometrical objects under Lie transport will be discussed. This gives rise to various symmetries that are described by continuous groups of motions. Their significance and application in mathematical physics will be discussed.

THURSDAY
MARCH 8, 2018
2:00PM

NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE

One Day Symposium on
**COMBINATORIAL
GRAPH THEORY AND
ITS APPLICATIONS**

Martin Baca

Technical University of Kosice
Abdus Salam School of Mathematical Sciences

Syed Ahtsham Bokhary

CASPAM - Bahauddin Zakariya University

Andrea Semaničová-Feňovčíková

Technical University of Kosice
Abdus Salam School of Mathematical Sciences

Imran Javaid

CASPAM - Bahauddin Zakariya University

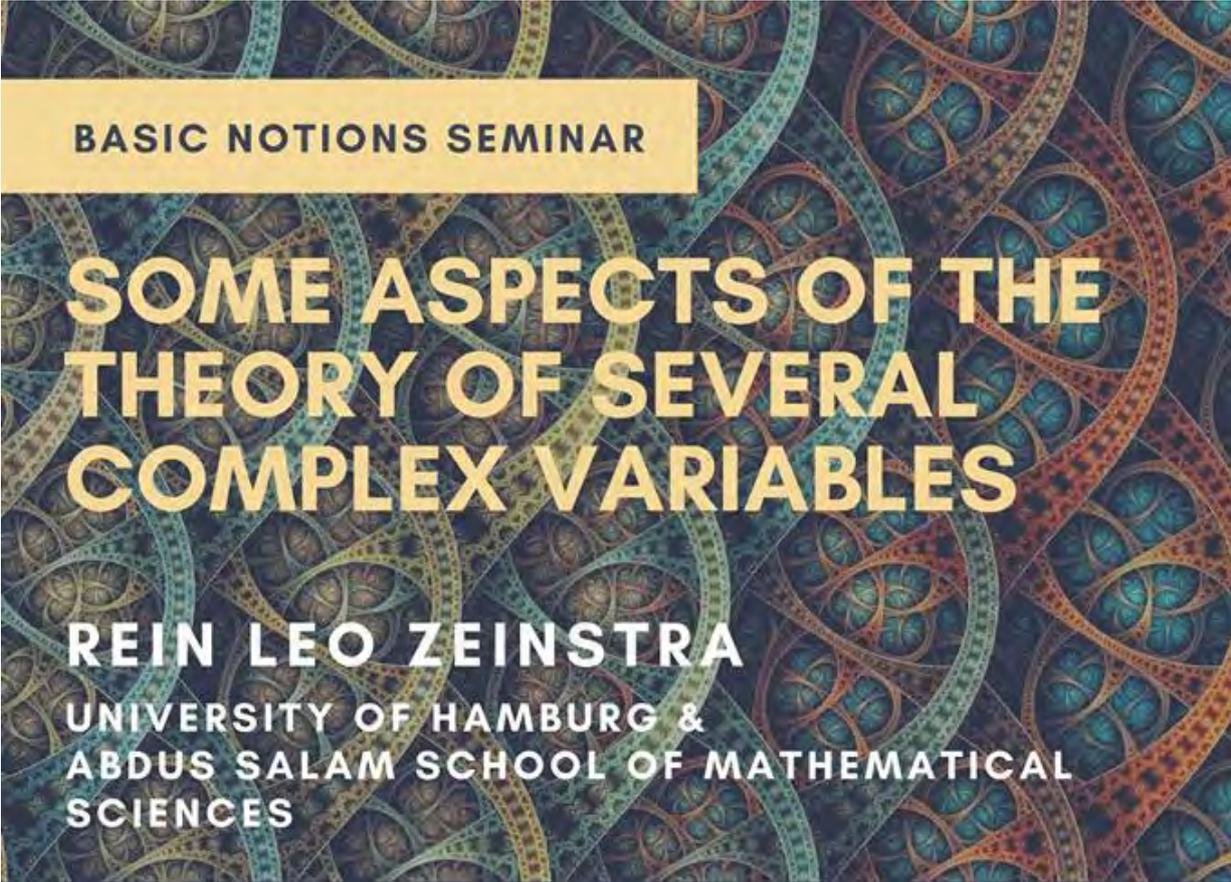
For details contact: info@sms.edu.pk

info_caspam@bzu.edu.pk

TUESDAY MARCH 13, 2018

**NATIONAL CENTER FOR MATHEMATICS,
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES, GC UNIVERSITY LAHORE**

**CENTRE FOR ADVANCED STUDIES IN PURE &
APPLIED MATHEMATICS,
BAHAUDDIN ZAKARIYA UNIVERSITY, MULTAN**



BASIC NOTIONS SEMINAR

SOME ASPECTS OF THE THEORY OF SEVERAL COMPLEX VARIABLES

REIN LEO ZEINSTR

**UNIVERSITY OF HAMBURG &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES**

SEMINAR HALL,
DEPARTMENT OF MATHEMATICS
GC UNIVERSITY, LAHORE

2:30PM WEDNESDAY MARCH 14, 2018

For details contact: dr.shahidahmad@gcu.edu.pk

**DEPARTMENT OF MATHEMATICS,
NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES
GC UNIVERSITY, LAHORE**

Basic Notions Seminar

The Theory of General Relativity

LECTURE 6: EINSTEIN'S FIELD EQUATIONS
AND THE BLACK HOLE
SOLUTION

AMER IQBAL

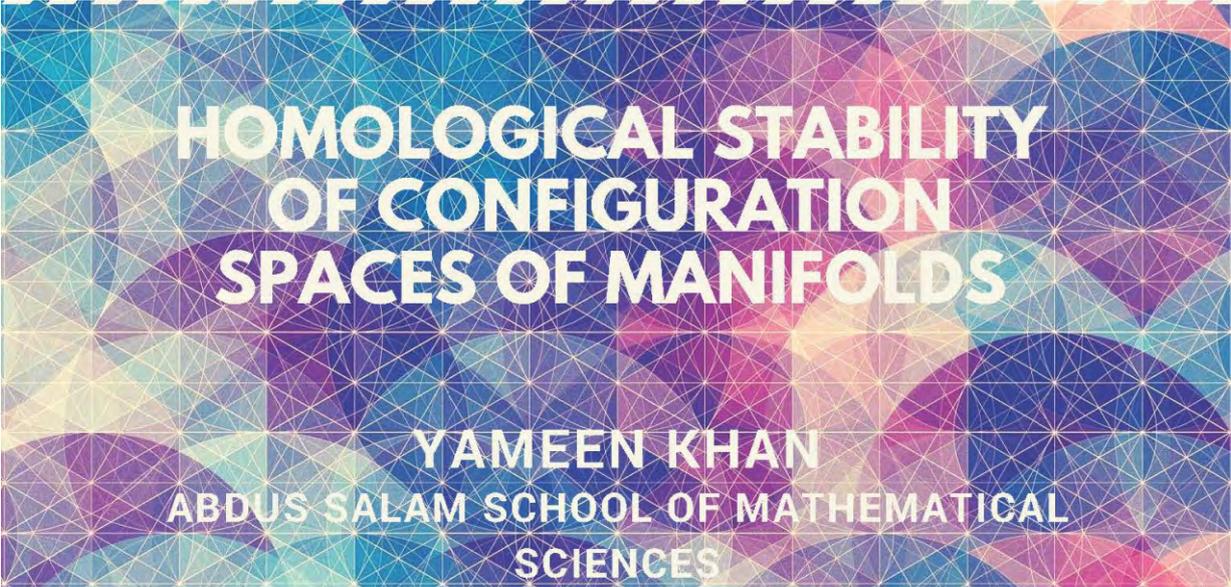
This lecture series is in preparation for the workshop *Information, Black Holes and Quantum Theory: Theoretical physics at the crossroads* (March 26 - 30, 2018).

Thursday | March 15, 2018 | 2:00-3:15pm

To attend email: info@sms.edu.pk

THE NATIONAL CENTER FOR
MATHEMATICS

ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES, G. C. UNIVERSITY, LAHORE



HOMOLOGICAL STABILITY OF CONFIGURATION SPACES OF MANIFOLDS

YAMEEN KHAN
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES

2PM TUESDAY MARCH 20, 2018

Cohomology and homology of configuration spaces in an active area of research with applications in physics and computer science. An important result about these spaces was proven by Arnold. He proved that configuration spaces of Euclidean plane are homological stable. More recently, Thomas Church proved that the configuration spaces of any connected orientable manifold of finite type are homological stable over the rational numbers. I will explain this result of Church and will prove that the sequence of configuration spaces of spheres satisfies strong homological stability.

NATIONAL CENTER FOR MATHEMATICS
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GC UNIVERSITY, LAHORE

SEMINAR SERIES MATH-X

MODELING ANTIBIOTIC RESISTANCE AND EFFECTIVE ANTIBIOTIC DOSING

Adnan Khan

Lahore University of Management Sciences

March 22, 2018 | 2 pm



NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE

INFORMATION, BLACKHOLES AND QUANTUM PHYSICS: THEORETICAL PHYSICS AT THE CROSSROADS

26-30 MARCH, 2018
AS-SMS, LAHORE

Registration and Detailed Program: www.sms.edu.pk/bhw

Deadline to register: 16 February, 2018

This workshop, through topical lectures, aims to provide an introduction to fundamental problems in black-hole physics which are the focus of intense interest in current research in quantum information theory, quantum gravity and quantum field theory. The workshop should be of interest to students and researchers alike. Financial support to attend the workshop is available for serious students.

Speakers:

Pervez Hoodbhoy (FCC)

Viqar Husain (UNB)

Amer Iqbal (AS-SMS)

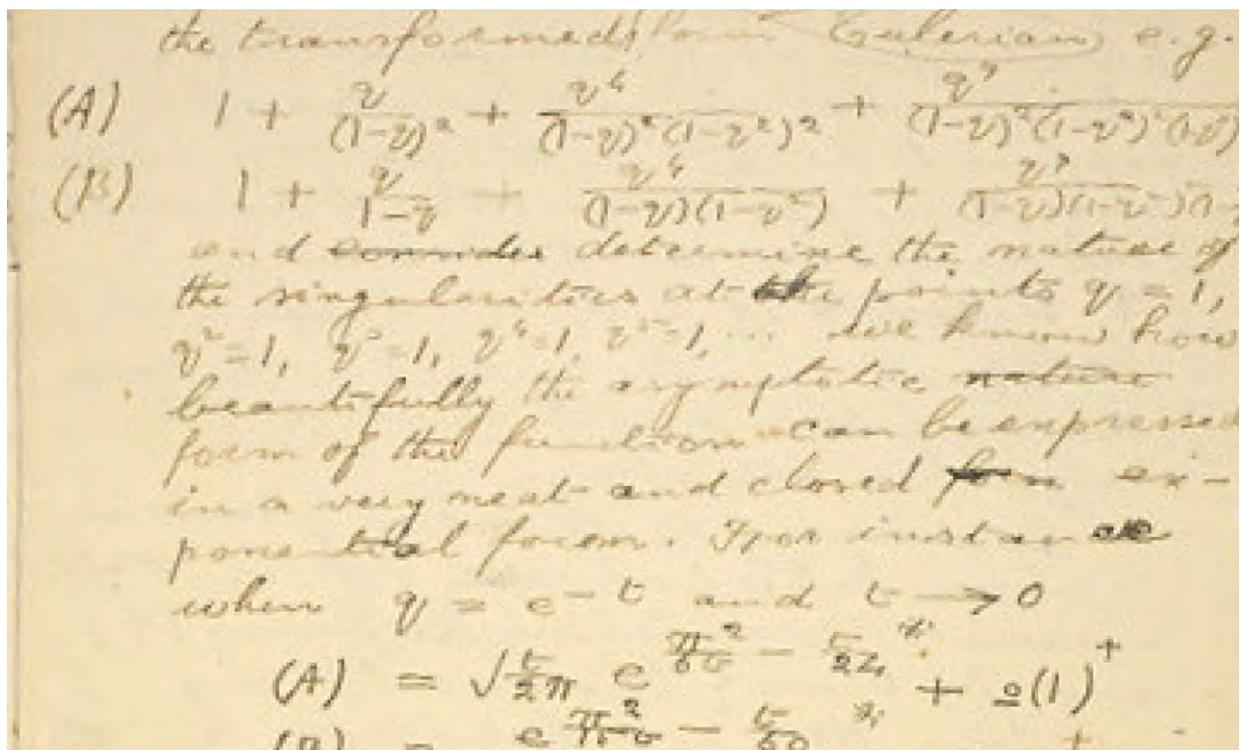
Asghar Qadir (NUST)

Babar Qureshi (MIT)

- ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
 - NATIONAL CENTER FOR MATHEMATICS, GCU, LAHORE
-



**APRIL
2018**



INTRODUCTION TO MOCK MODULAR FORMS

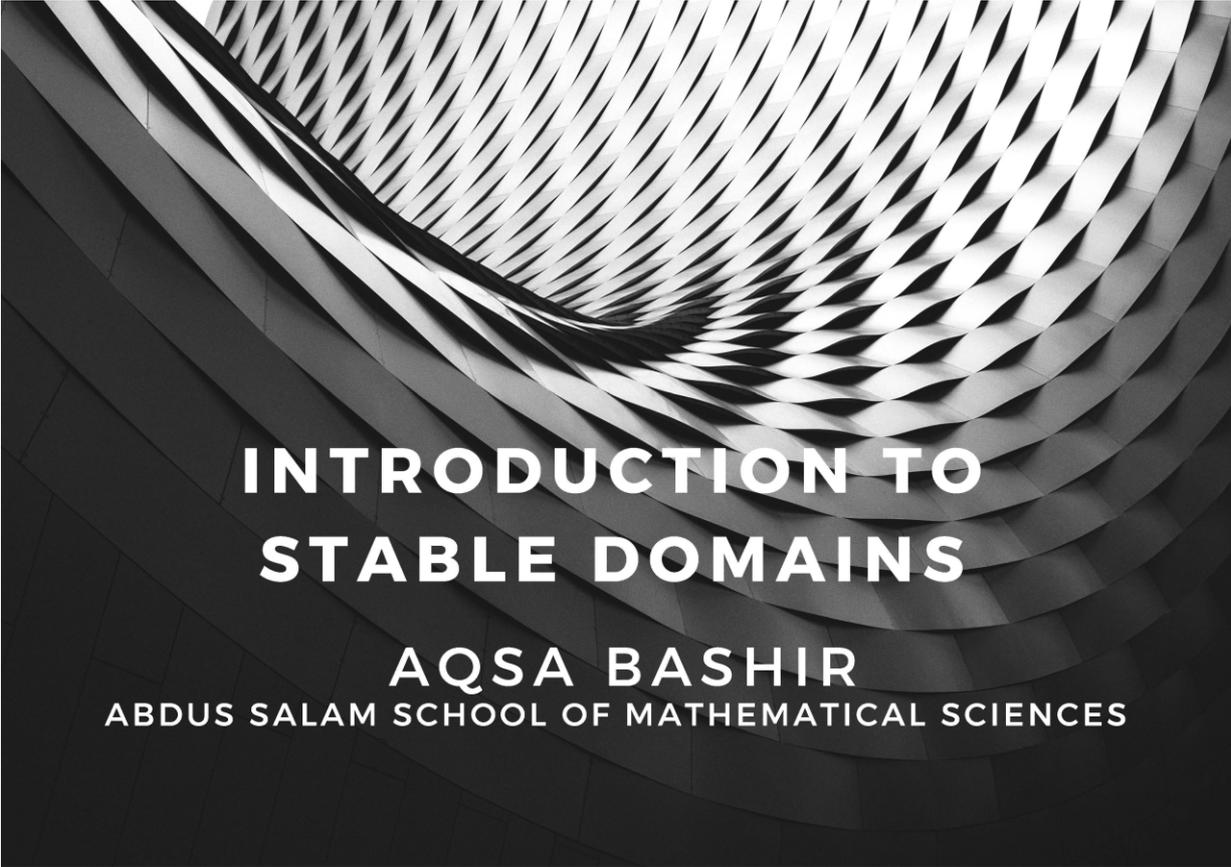
AMBREEN AHMED

Abdus Salam School of Mathematical Sciences

2PM Thursday April 26, 2018

On the 98th death anniversary of Srinivasa Ramanujan I will discuss the theory of mock modular forms which he started in his last letter to G.H. Hardy. He gave 17 examples of theta like functions which he called mock theta functions. In 2002, Zwegers related these functions to weight $\frac{1}{2}$ harmonic maass forms. In this talk, I will discuss the harmonic maass forms with some examples and will show that the mock modular forms are the holomorphic part of harmonic maass forms having nontrivial non holomorphic part.

National Center for Mathematics &
Abdus Salam School of Mathematical Sciences
GC University, Lahore



INTRODUCTION TO STABLE DOMAINS

AQSA BASHIR

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

THURSDAY APRIL 12, 2:00PM

An ideal I of a domain D is said to be a stable ideal if it is invertible in its overring $[I:I]$, consequently D is called stable if it has only stable ideals. In this talk i will explain how stability condition is weaker than the 2-generator property and invertibility via some examples and results.

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GC UNIVERSITY, LAHORE**



COHEN-MACAULAY GRAPHS

FAZAL ABBAS

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES



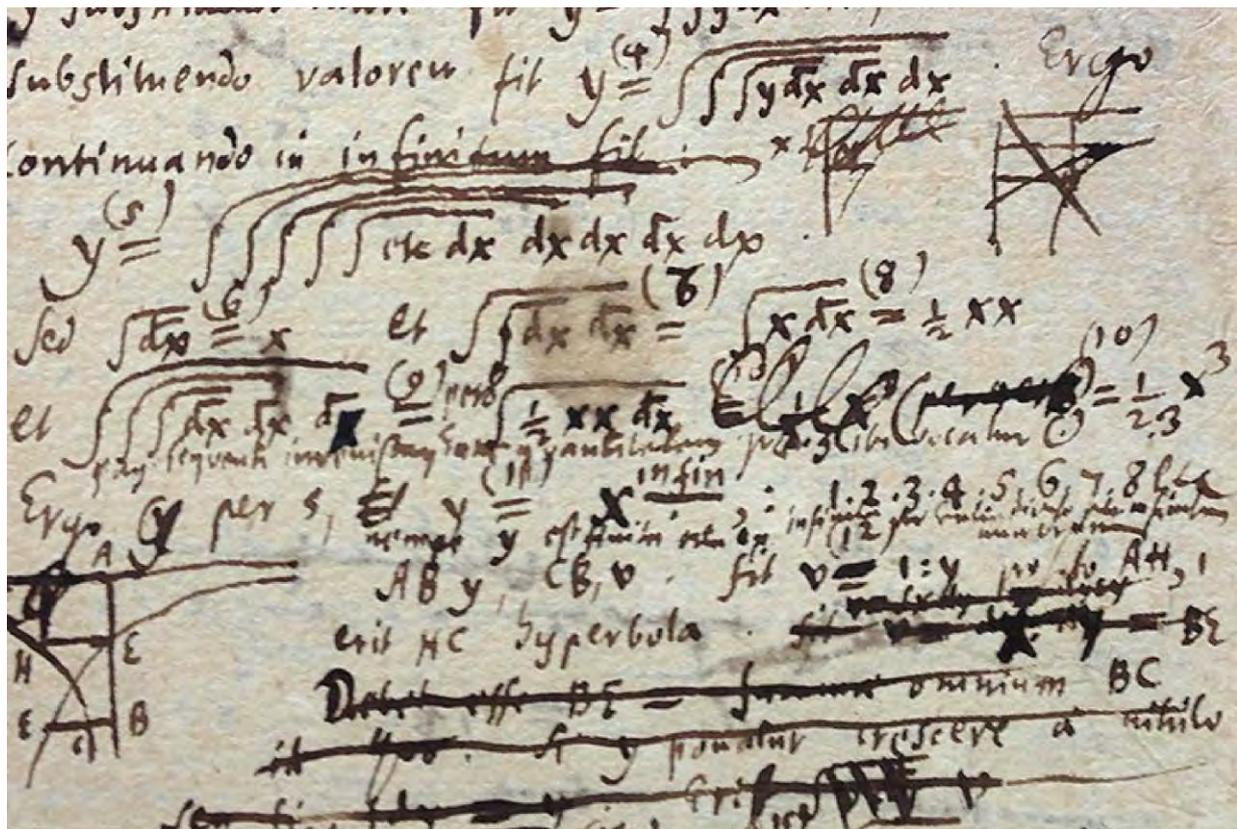
In my talk, I will give an introduction to Cohen-Macaulay rings and Cohen-Macaulay property of one-dimensional simplicial complexes or simply graphs. I will also explain the classification of Cohen-Macaulayness of graphs given by Villarreal for tree graphs and afterward by J. Herzog, T. Hibi, and X. Zheng for chordal graphs in their paper "Cohen-Macaulay Chordal Graphs". I will also discuss the main theorem in their paper for Cohen-chordal graphs.



2PM APRIL 19, 2018

**National Center for Mathematics &
Abdus Salam School of Mathematical
Sciences
GC University, Lahore**





INTRODUCTION TO THE LEBESGUE INTEGRAL AND MEASURE THEORY

REIN LEO ZEINSTR

UNIVERSITY OF HAMBURG

LECTURE 1: MONDAY APRIL 09 AT 2:30PM

LECTURE 2: MONDAY APRIL 16 AT 2:30PM

LECTURE 3: FRIDAY APRIL 20 AT 2:30PM

LECTURE 4: MONDAY APRIL 23 AT 2:30PM

NATIONAL CENTER FOR MATHEMATICS &
 ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
 GC UNIVERSITY, LAHORE

Black Holes in Quartic Quasi-Topological Gravities

JAMIL AHMED

Quaid-e-Azam University



11AM FRIDAY APRIL 20, 2018

In this talk construction of the quartic version of generalized quasi-topological gravity will be presented. This class of theories includes Lovelock gravity and a known form of quartic quasi-topological gravity as special cases and possess a number of remarkable properties. Finally, four dimensional black hole solutions to the theory will be presented.



**NATIONAL CENTER FOR MATHEMATICS &
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SCIENCES,
GC UNIVERSITY, LAHORE**

Introduction to Polyomino Ideals

Rizwan Jahangir

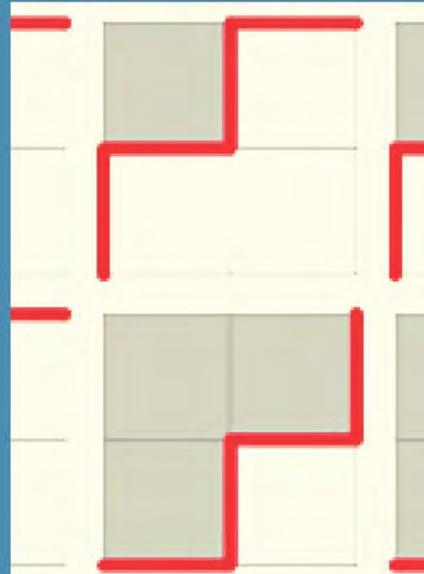
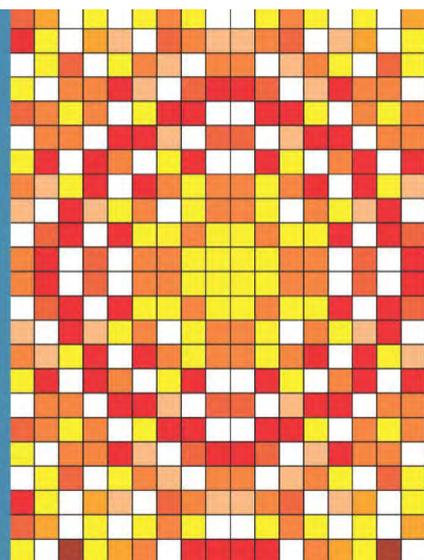
Abdus Salam School of
Mathematical Sciences

Tuesday April 10, 2018
2:00PM

Polyominoes are two dimensional shapes extensively discussed in connection with tiling of the plane. They are also of interest in recreational mathematics and combinatorics.

Polyomino ideal is the ideal of inner 2-minors of a polyomino. These were first discussed in [1]. In this talk, I will explain the algebraic properties of polyomino ideal just from the combinatorics of polyomino.

[1]. A. A. Qureshi, Ideals generated by 2-minors, collections of cells and stack polyominoes, *J. Algebra*, 357, 279{303, (2012).



National Center for Mathematics &
Abdus Salam School of Mathematical Sciences,
GC University, Lahore

NAKANO-ORLICZ SEQUENCES SPACES

Shahid Ali

Abdus Salam School of Mathematical
Sciences

In this talk I plan to discuss Nakano-Orlicz sequence spaces. These are Banach sequence spaces given by a modular, and for this reason it is also reasonable to call them variable exponent Lebesgue sequence spaces. I'll describe a number of simple statements (worked out as a preliminary part of my thesis) which will show that these spaces are different from the classical Lebesgue sequence spaces in a number of ways, however, for certain choices of the modulars they provide the scale of classical sequence spaces. At the end we will discuss the Schur property of Nakano-Orlicz sequence spaces following Nakano himself. A Banach space has Schur property if every weakly convergent sequence is normed convergent.

TUESDAY APRIL 17, 2PM

NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL
SCIENCES,
GC UNIVERSITY, LAHORE



SEMINAR SERIES

SHEAF COHOMOLOGY

AZEEM KHADAM

NOUMAN MUTEEB

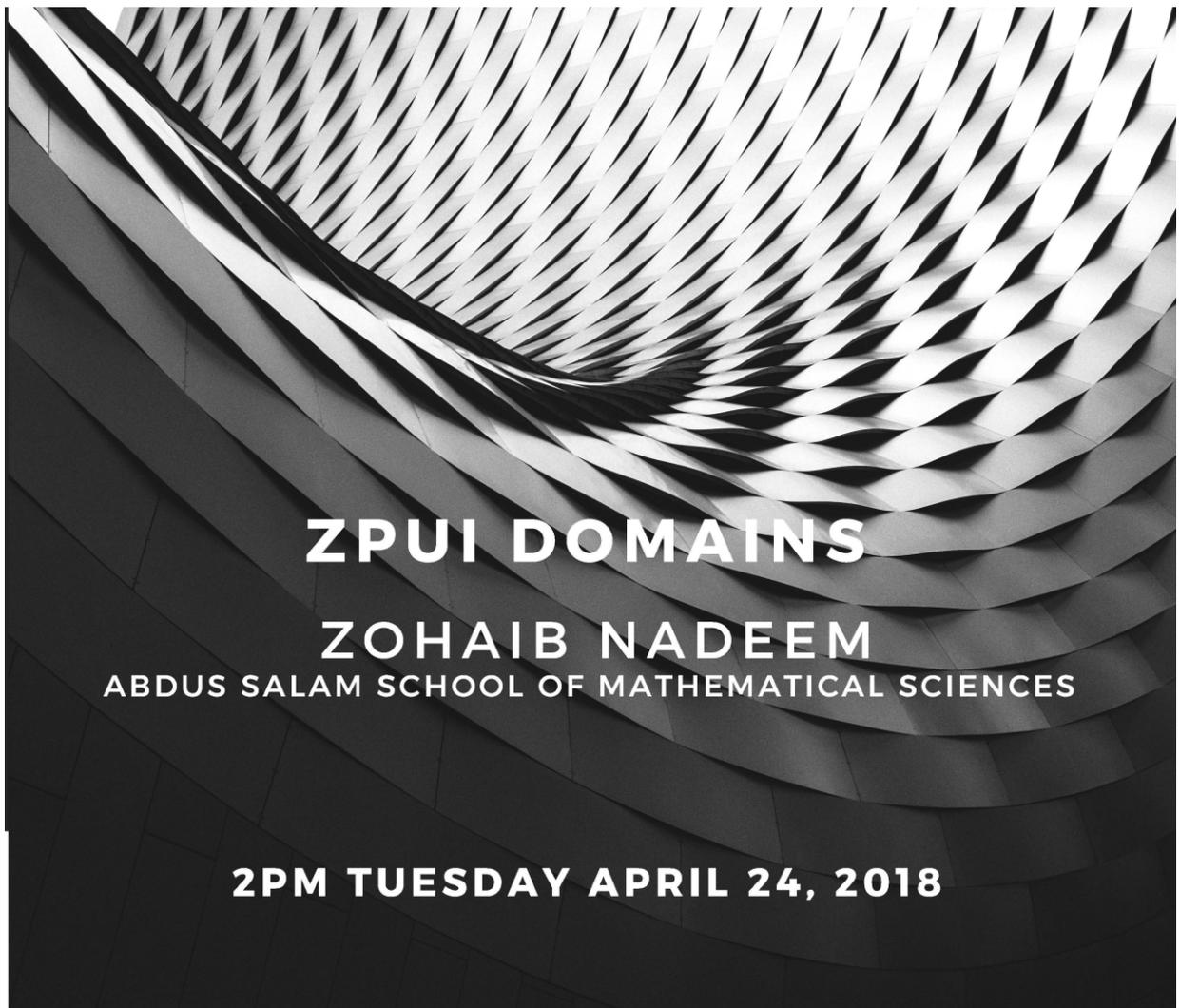
Abdus Salam School of Mathematical Sciences

Starting:

Wednesday April 25, 2018

2:30PM - 4:00PM

**NATIONAL CENTER FOR MATHEMATICS
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
GC UNIVERSITY, LAHORE**



ZPUI DOMAINS

ZOHAIB NADEEM

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

2PM TUESDAY APRIL 24, 2018

We will introduce ZPUI domains in this talk. For this, we also need to study h-local and strongly discrete Prufer domains. For reference, please look the paper of Bruce Olberding namely "Factorization into prime and invertible ideals II".

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GC UNIVERSITY, LAHORE**



**MAY
2018**



CONNECTIONS, PARALLEL TRANSPORT & GEODESICS ON K-DIMENSIONAL SURFACES KAMRAN SHAKOOR

Abdus Salam School of Mathematical Sciences

THURSDAY MAY 3, 2018

Connection generalizes directional derivatives from vector calculus and allows differentiation of vector fields on manifolds. Notions like parallel transport, geodesics and curvature can be defined using connection. The notion of Gauss curvature of a 2-dimensional surface in \mathbb{R}^3 can be generalized to any k -dimensional surface in \mathbb{R}^n using covariant derivatives. In this talk I will discuss the idea of a connection for surfaces in \mathbb{R}^n .

**NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE**



LIMIT CYCLES AND THEIR PERIOD

ADEEL AHMED

Abdus Salam School of Mathematical Sciences

FRIDAY MAY 4, 2018

In this talk I will discuss two important problems in the theory of dynamical systems. The first is Hilbert's 16th problem about the upper limit to the number of limit cycles and the second problem is to find the period of the periodic trajectories. I will discuss these two problems for a piece-wise smooth system of two linear DEs. I will show the existence of a limit cycle for this system and determine the period of the periodic trajectories.

**NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES,
GC UNIVERSITY, LAHORE**

PHD THESIS DEFENSE

MATRIX VALUED TRUNCATED TOEPLITZ OPERATORS

Rewayat Khan

Abdus Salam School of Mathematical Sciences

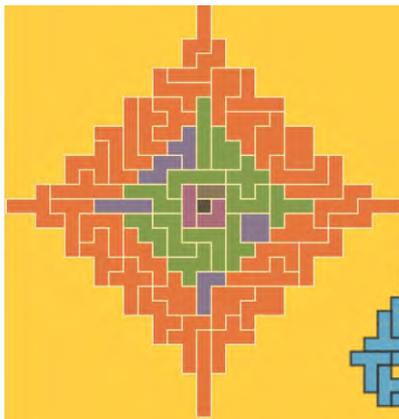
In this thesis presentation we will discuss some of the properties of model spaces corresponding to a fixed pure inner function. We will also present the most important results of "Matrix Valued Truncated Toeplitz Operators" defined on the vector valued model spaces.

Friday 11am, May 25 2018

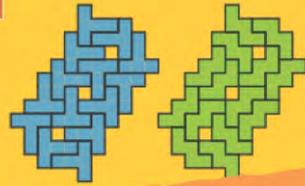
**NATIONAL CENTER FOR MATHEMATICS &
ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES
GC UNIVERSITY, LAHORE.**



**JULY
2018**



MPHIL THESIS DEFENSE



RIZWAN JAHANGIR

Theory of Polyomino Ideals

Friday, July 13, 2018

11:00 AM



Abstract

Polyominoes are two-dimensional shapes extensively discussed in connection with tiling of the plane. They are also of interest in recreational mathematics and combinatorics. Polyomino ideal is the ideal of inner 2-minors of a polyomino. These were first A. A. Qureshi in 2012.



**National Center for Mathematics,
Abdus Salam School of Mathematical Sciences, Lahore**



**OCTOBER
2018**

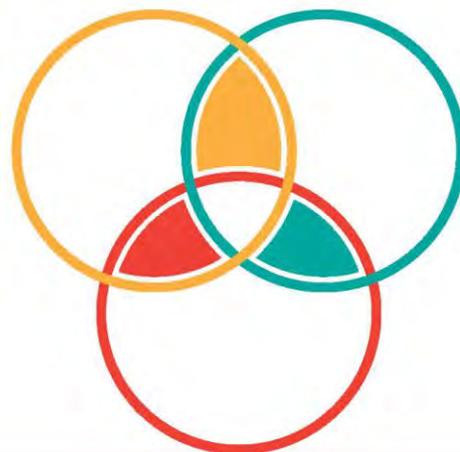
**FACE IRREGULARITY
STRENGTH OF GRAPHS
OF TYPE
(α , β , γ)**

ALI OVAIS

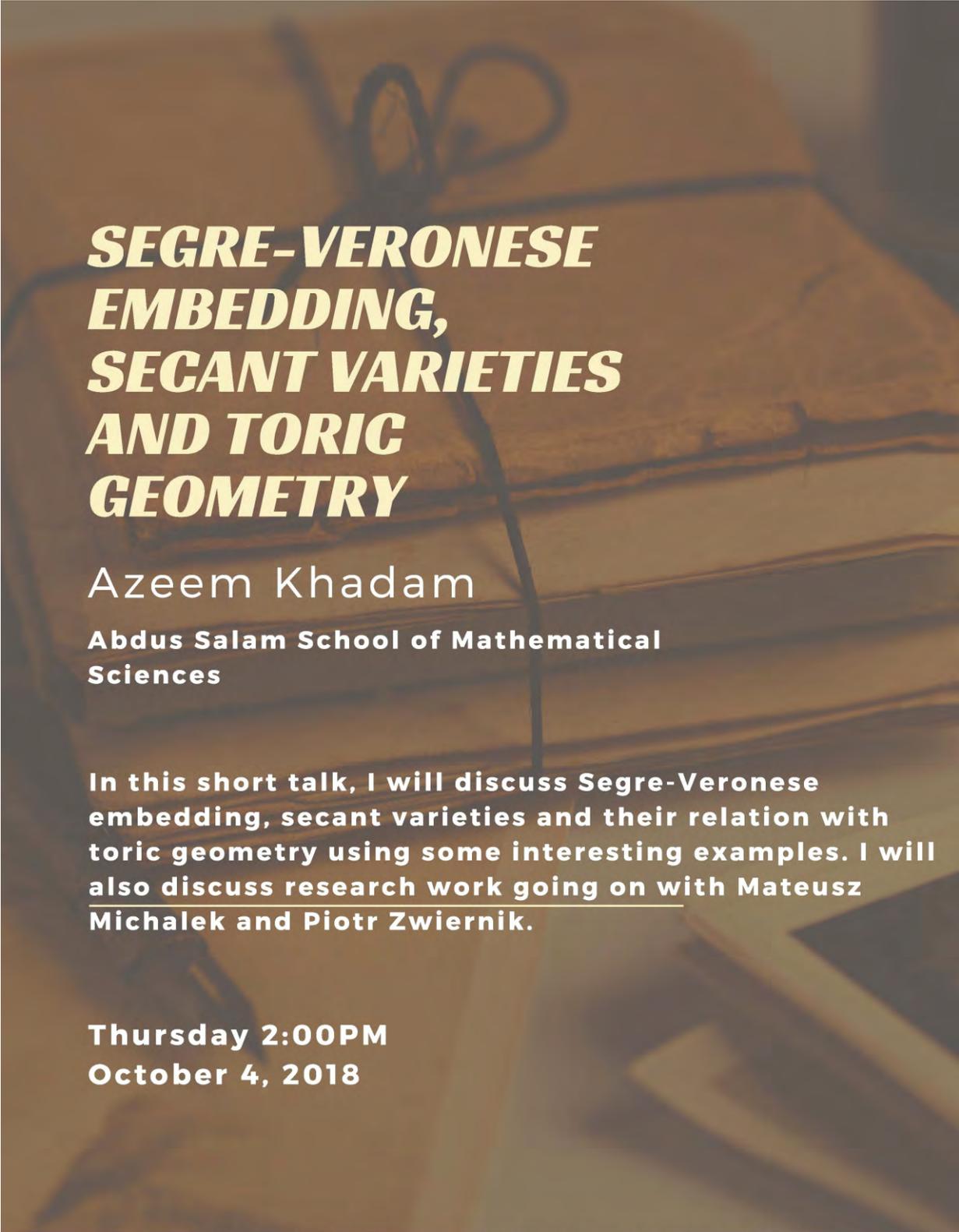
**ABDUS SALAM SCHOOL OF
MATHEMATICAL SCIENCES**

**TUESDAY OCTOBER 9, 2018
2:00PM**

We investigate face irregular labelings of plane graphs and we introduce new graph characteristics, namely face irregularity strength of type (α, β, γ) . We obtain some estimations on these parameters and determine the precise value for certain families of plane graphs that prove the sharpness of the lower bounds.



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***SEGRE-VERONESE
EMBEDDING,
SECANT VARIETIES
AND TORIC
GEOMETRY***

Azeem Khadam

**Abdus Salam School of Mathematical
Sciences**

In this short talk, I will discuss Segre-Veronese embedding, secant varieties and their relation with toric geometry using some interesting examples. I will also discuss research work going on with Mateusz Michalek and Piotr Zwiernik.

**Thursday 2:00PM
October 4, 2018**

**Abdus Salam School of Mathematical Sciences &
National Center for Mathematics
GC University, Lahore**

IDEALS IN INFINITE- DIMENSIONAL POLYNOMIAL RING

Azhar Farooq

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

2PM THURSDAY OCTOBER 11, 2018

A pervasive theme in invariant theory is that of finite generation. Recently, much attention has been drawn toward studying the invariant ideals of infinite-dimensional polynomial ring. In this talk, I will introduce equivariantly Noetherian ring and equivariant Hilbert series used for studying the intrinsic behavior of certain ideals in infinite-dimensional polynomial rings. In particular, I will discuss the equivariant Hilbert series of $\text{Inc}(N)$ -invariant monomial ideals with its connection to dimension theory.

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NON-TRIVIAL ELLIPTIC FIBRATION OVER A PAIR OF PANTS AND SUSY PARTITION FUNCTION

MUHAMMAD NOUMAN MUTEEB

TUESDAY OCTOBER 30, 2018

In this talk I will outline how to compute the partition function of $N=2$ supersymmetric gauge theory on a four dimensional space which is a torus fibered over a pair of pants. The torus fibration is taken to be degenerate on the three boundary circles of the pair of pants, in the sense that the torus gets twisted by monodromy transformation as it is transported around each of the circles. The total monodromy around the three circles taken together is identity, so that the total space is smooth. Near the end of talk I will also say a few words about the two dimensional supersymmetric partition function on the pair of pants.

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TRUNCATED TOEPLITZ OPERATORS ON HARDY HILBERT SPACES

Ahsan Khan

Abdus Salam School of Mathematical Sciences

Truncated Toeplitz operators are the compressions of multiplication operators to subspaces of Hardy Hilbert space that are invariants with respect to backward unilateral shift operator. In this talk we will find the complete characterization of maximal algebras of truncated Toeplitz operators

**Tuesday 2:00pm
October 2, 2018**

**NATIONAL CENTER FOR MATHEMATICS &
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GC UNIVERSITY, LAHORE.**

AN INTRODUCTION TO NAVIER-STOKES EQUATIONS

Najma Ahmed

Abdus Salam School of Mathematical Sciences

Thursday 2PM, October 18, 2018

In this talk, I will begin with an introduction to the basic equations of fluid mechanics including the continuity equation and the Navier-Stokes equations. I will give a complete description and derivation of the Navier-Stokes' equations.

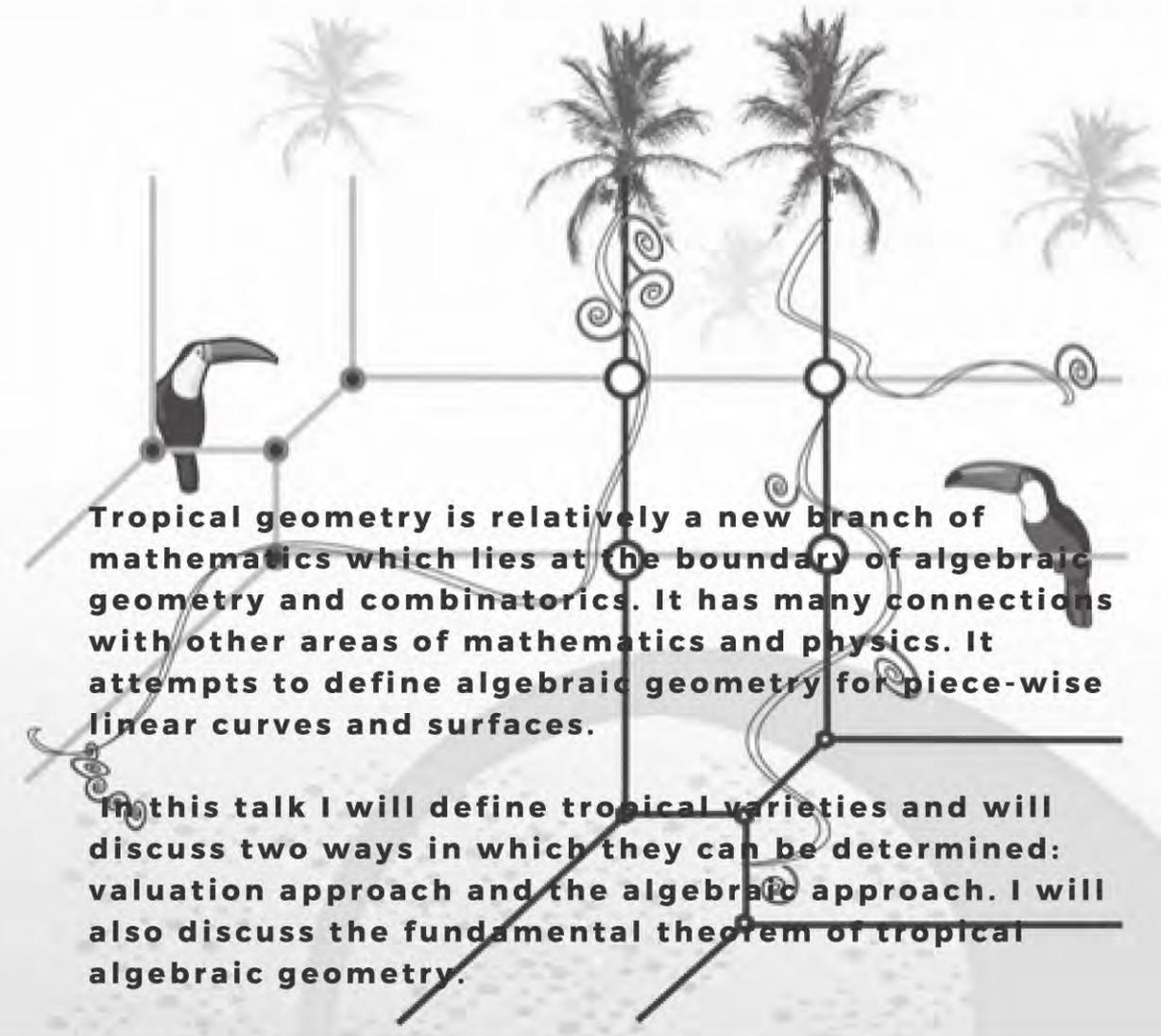
Navier-Stokes equations are important for understanding behavior of fluids in various domains and are also useful for the study of atmospheric/ocean currents. I will discuss the governing equations for the problem of magneto-hydrodynamic free convection flows with thermal memory over a moving vertical plate in porous medium.

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GC UNIVERSITY, LAHORE**

COMPUTING TROPICAL VARIETIES

NUMAN AMIN

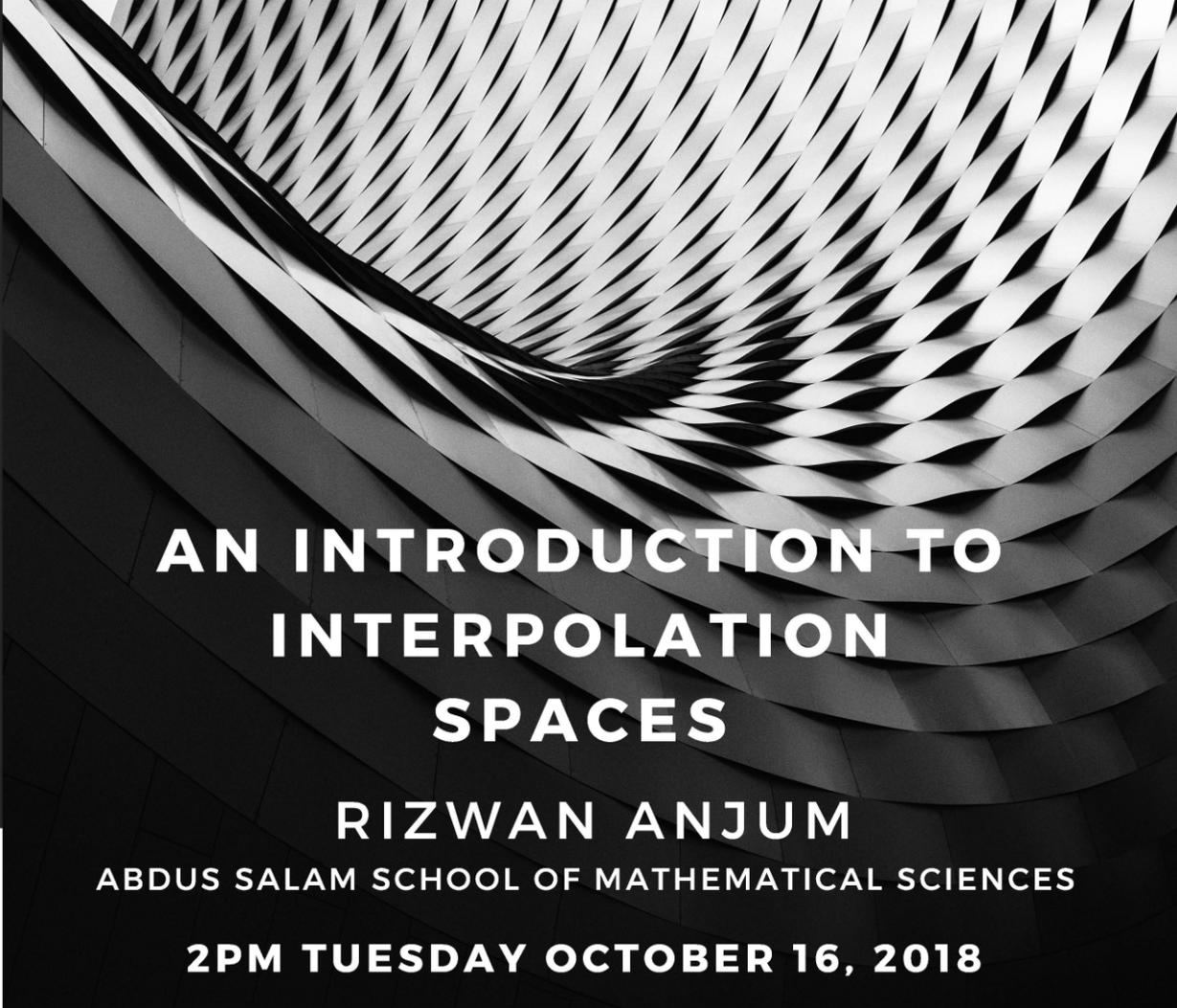
2PM TUESDAY
OCTOBER 23, 2018



Tropical geometry is relatively a new branch of mathematics which lies at the boundary of algebraic geometry and combinatorics. It has many connections with other areas of mathematics and physics. It attempts to define algebraic geometry for piece-wise linear curves and surfaces.

In this talk I will define tropical varieties and will discuss two ways in which they can be determined: valuation approach and the algebraic approach. I will also discuss the fundamental theorem of tropical algebraic geometry.

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AN INTRODUCTION TO INTERPOLATION SPACES

RIZWAN ANJUM

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

2PM TUESDAY OCTOBER 16, 2018

The theory of interpolation spaces is a relatively new area in functional analysis with applications in analysis. In the talk, I will present an introduction to interpolation theory with some examples. I will also discuss the close relation between rearrangement-invariant function spaces and interpolation spaces.

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GC UNIVERSITY, LAHORE**

Introduction to One Dimensional Dynamics

WAQAS ALI AZHAR

2PM Thursday

OCTOBER 25, 2018

The goal of this talk is to introduce many of the basic techniques from the theory of dynamical systems in a setting as simple as possible. For this reason, all the dynamics will be considered one dimensional i.e. on the real line or unit circle in the plane. We introduce topics such as hyperbolicity, topological conjugacy and structural stability. The main idea is to understand in the light of examples what it means for a dynamical system to be chaotic.

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**NOVEMBER
2018**

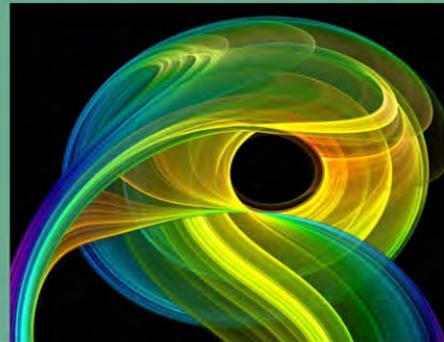
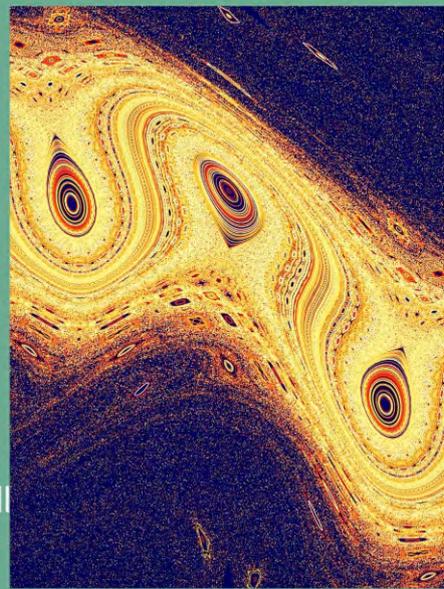
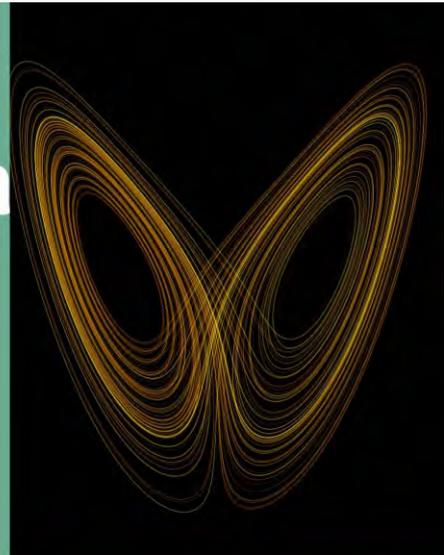
Dynamical Systems in One and Two Dimensions

Adeel Ahmad

Abdus Salam School of
Mathematical Sciences

**Thursday November 1, 2018
2:00PM**

I will first review the definition of dynamical systems and then will discuss in detail certain dynamical systems in one and two dimension along with their phase diagram. I will also discuss bifurcation in dynamical systems using some examples.



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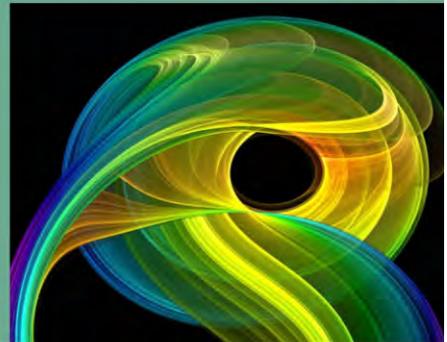
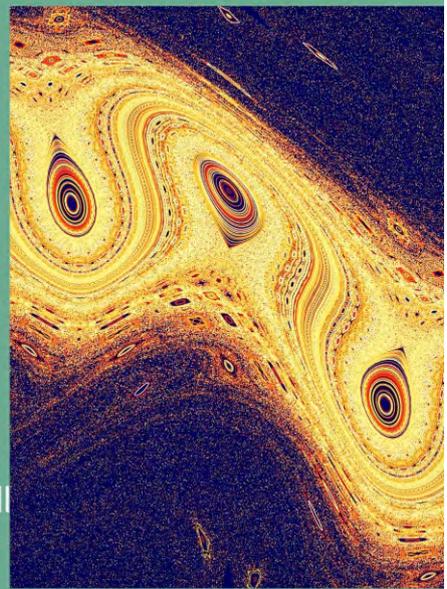
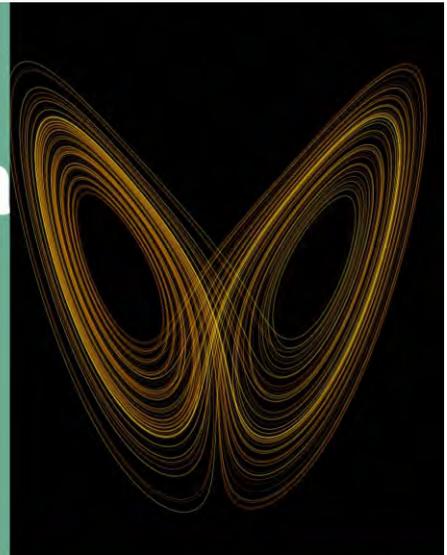
Dynamical Systems in One and Two Dimensions

Adeel Ahmad

Abdus Salam School of
Mathematical Sciences

**Tuesday November 27, 2018
2:00PM**

I will first review the definition of dynamical systems and then will discuss in detail certain dynamical systems in one and two dimension along with their phase diagram. I will also discuss bifurcation in dynamical systems using some examples.



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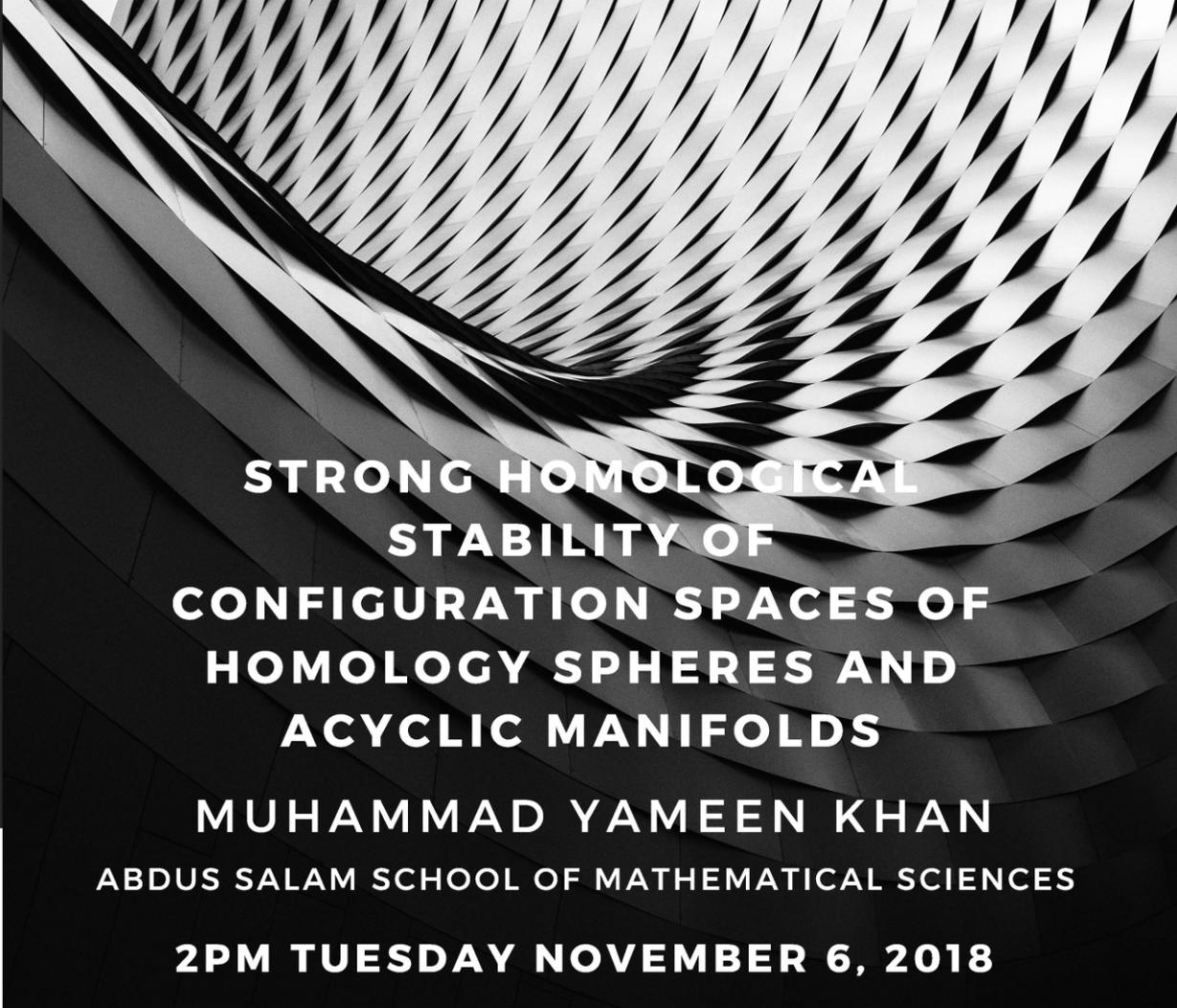
NON-TRIVIAL ELLIPTIC FIBRATION OVER A PAIR OF PANTS AND SUSY PARTITION FUNCTION

MUHAMMAD NOUMAN MUTEEB

THURSDAY, November 29, 2018

In this talk I will outline how to compute the partition function of $N=2$ supersymmetric gauge theory on a four dimensional space which is a torus fibered over a pair of pants. The torus fibration is taken to be degenerate on the three boundary circles of the pair of pants, in the sense that the torus gets twisted by monodromy transformation as it is transported around each of the circles. The total monodromy around the three circles taken together is identity, so that the total space is smooth. Near the end of talk I will also say a few words about the two dimensional supersymmetric partition function on the pair of pants.

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**STRONG HOMOLOGICAL
STABILITY OF
CONFIGURATION SPACES OF
HOMOLOGY SPHERES AND
ACYCLIC MANIFOLDS**

MUHAMMAD YAMEEN KHAN

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

2PM TUESDAY NOVEMBER 6, 2018

Integral homological stability for unordered configuration spaces of connected open manifolds was discovered by G. Segal and D. MacDuff. The rational homological stability of configuration spaces of manifolds proved by Th. Church and extended by O. Randal-Williams and B. Knudsen. We characterize the manifolds satisfying strong stability. In particular, we will discuss the strong homological stability for the unordered configuration spaces of homology spheres and acyclic manifolds.

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HIBI RINGS AND RANK BOUNDED HIBI SUBRINGS

NADIA SHOUKAT

2PM THURSDAY
NOVEMBER 15, 2018

ABDUS SALAM SCHOOL OF MATHEMATICAL SCIENCES

Let L be a distributive lattice and $R[L]$ the associated Hibi ring. We show that if L is planar, then any bounded Hibi subring of $R[L]$ has a quadratic Gröbner basis. We characterize all planar distributive lattices L for which any proper rank bounded Hibi subring of $R[L]$ has a linear resolution. Moreover, if $R[L]$ is linearly related for a lattice L , we find all the rank bounded Hibi subrings of $R[L]$ which are linearly related too.

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WHAT IS QUANDLE AND HOW IT GETS INTO ALGEBRA, GEOMETRY, TOPOLOGY AND MATHEMATICAL PHYSICS?

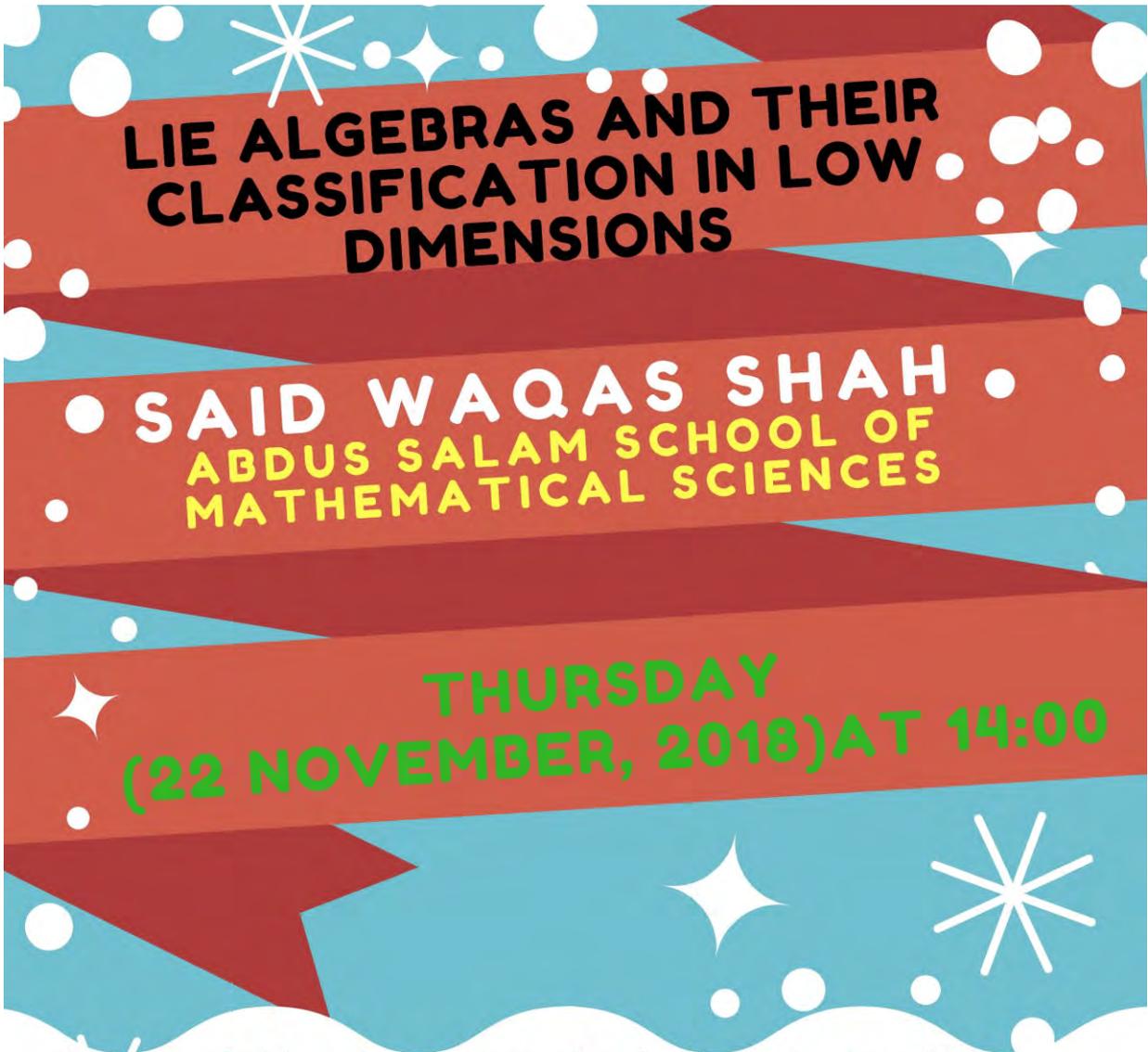
Naqeeb ur Rehman

Allama Iqbal Open University, Islamabad

2PM Monday November 12, 2018

This expository talk is about the answers to the entitled questions by defining a quandle as a set with a bijective, self-distributive and idempotent operation, and explaining how a quandle gets into algebra as a remnant (or wrack and ruin) of a group, in geometry as a set of reflections in a symmetric manifold and in topology as a knot invariant.

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**LIE ALGEBRAS AND THEIR
CLASSIFICATION IN LOW
DIMENSIONS**

SAID WAQAS SHAH
ABDUS SALAM SCHOOL OF
MATHEMATICAL SCIENCES

**THURSDAY
(22 NOVEMBER, 2018) AT 14:00**

Although Lie algebras arise in the study of Lie groups, we will talk about Lie algebras in their own right. The main purpose of this talk is to define Lie algebras in abstract way and talk about the classification of Lie algebras of dimensions one, two and three. This classification is due to Lie and Bianchi. This classification is important in topology and Physics

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NON-LOCAL M- DISSIPATIVE EVOLUTION INCLUSION IN GENERAL BANACH SPACES

Shamas Bilal

Abdus Salam School of Mathematical Sciences

2PM Thursday November 8, 2018

In this talk, we will study a class of multivalued perturbations of m -dissipative evolution inclusions with non-local initial condition in arbitrary Banach spaces. We prove the existence of solutions when the multivalued right hand side is Lipschitz and admits nonempty closed bounded values. We will present a number of illustrative examples.

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**DECEMBER
2018**

NATIONAL CENTER FOR MATHEMATICS &
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GC UNIVERSITY, LAHORE



SECOND WINTER WORKSHOP ON ADVANCED TOPICS IN MATHEMATICS: ANALYSIS AND DYNAMICS IN NUMBER THEORY

DECEMBER 13 - 19, 2018

The workshop will focus on recent developments in certain areas of number theory including diophantine approximation, modular forms and connections of number theory with dynamical systems

Speakers:

Shaun Cooper (Massey University, New Zealand)

Karl Dilcher (Dalhousie University, Canada)

Mumtaz Hussain (La Trobe University, Australia)

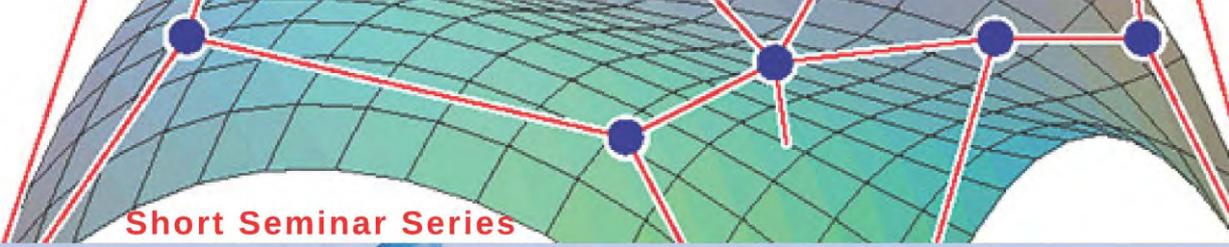
Simon Kristensen (Aarhus University, Denmark)

Last date for registration: November 23, 2018

Registration form is available at: <http://sms.edu.pk/NTW-2018>

For details contact: info@sms.edu.pk

Sponsored by the Punjab Higher Education Commission.



Short Seminar Series

ALGEBRAIC APPROACH TO THE CHORDALITY OF HYPERGRAPHS

Ali Akbar YAZDAN POUR

Institute for Advanced Studies in Basic Sciences (IASBS), IRAN

Talk-I

Friday at 14:30 (21 December, 2018)

Talk-II

Wednesday at 14:00 (26 December, 2018)

Talk-III

Thursday at 14:00 (27 December, 2018)

In the series of three lectures, first, we review the current results on the subject of chordality. Then, we introduce some operations (called reductions) on a given (hyper)graph G to obtain a smaller (hyper)graph such that the non-linear strand Betti numbers do not change under these operations. Using these operations, we introduce a new class of d -uniform clutters (called chordal clutter) which coincides with the definition of chordal graphs in the case $d = 2$, and the corresponding circuit ideal has a linear resolution over any field K . Then, the graded minimal free resolution of such hypergraphs will be investigated. It is shown that these numbers are completely characterized in terms of the combinatorics of the given clutter. Finally, we introduce the notion of decomposable clutter and we show that chordality of these clutters is indeed a generalization of Simon's conjecture on extendable shellability of d -skeletons of an n -simplex, for all d . We then prove this conjecture for $d \geq n - 3$.

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