



JACOBS  
UNIVERSITY



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# SUMMER CAMP

**MATHEMATICS**

FOR PRE-COLLEGE STUDENTS, JUNE 25 – JULY 5, 2015



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# SUMMER CAMP

**FOR PRE-COLLEGE STUDENTS, JUNE 25 – JULY 5, 2015**

Our Summer Camp introduces pre-college students with an interest in mathematics to selected topics in modern mathematics ranging from foundations of geometry to compressed sensing and applications of probability in the real world. You will meet active research mathematicians including members of the Jacobs faculty and distinguished mathematician John Conway as guest of honor – and you will meet many young people who share a keen interest in mathematics.

Activities include sightseeing and visits to science centers, mathematics discussion groups and problem solving sessions, sports, and ample opportunity to meet and make friends.

All that is required of you is a solid standing in high school mathematics and an open mind.

# ACADEMIC TOPICS

## FOUNDATIONS OF PLANE GEOMETRY FROM EUCLID TO HILBERT

- Definitions and axioms of Euclidean geometry
- Necessity of the parallel axiom; introduction to non-Euclidean geometry
- Hilbert's treatment of two-dimensional geometries

## PROBABILITY IN THE REAL WORLD

- Introduction to probability
- The expected value and variance
- Rare events, the law of large numbers, and applications in the real world

## SOLVING ALGEBRAIC EQUATIONS

- Formulas of Cardano and Ferrari for solving equations of degree three and four
- Impossibility of solving all equations of degree 4 and basic ideas of Galois theory

## GEOMETRY IN FOUR DIMENSIONS

- The idea of higher dimensional spaces
- Platonic solids in three dimensions and polytopes in four dimensions
- Minkowski's space-time

## DISCRETE DYNAMICAL SYSTEMS

- Modeling with difference equations
- Magic tricks for finding solutions
- Models for economic equilibria and instabilities
- Chaotic motion
- Random walks

## COMPRESSED SENSING

- Solving systems of linear equations
- Least square solutions
- Sparse solutions
- Basis pursuit and compressive sensing

## POSSIBLE AND IMPOSSIBLE WORLDS: PLATONIC SOLIDS, ESCHER TILINGS, AND CHAOS

- Geometry on the sphere and in the hyperbolic world
- Creating "impossible" Platonic solids in their right world
- Connections to dynamical systems and chaos

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## FACULTY AND FACILITATORS

■ **DR. KEIVAN MALLAHI-KARAI**

University Lecturer in Mathematics

■ **PROF. DR. IVAN PENKOV**

Professor of Mathematics

■ **DR. ANA-MARIA BRECAN**

Postdoctoral fellow at University of Mainz

■ **PROF. DR. DR. H.C. MULT. ALAN HUCKLEBERRY**

Wisdom Professor of Mathematics

■ **QAISAR LATIF**

Research Associate / PhD Student Mathematics

■ **PROF. DR. MARCEL OLIVER**

Professor of Mathematics

■ **PROF. DR. GÖTZ PFANDER**

Professor of Mathematics

■ **PROF. DR. DIERK SCHLEICHER**

Professor of Mathematics

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## APPLICATION FOR THE SUMMER CAMP

**Fee: € 1,200 including accommodation; € 600 (for students from Bremen, excluding accommodation)**

The full fee of € 1,200 includes tuition, full room and board in the residential colleges at Jacobs University. The campus is safe with 24-hour security. Costs for travel from Jacobs University to Bremen are also included in the fee. We also offer a reduced fee of € 600, which does not include accommodation, for participants living in the Bremen region who can commute to campus.

The fee includes tuition, full room and board in the residential colleges at Jacobs University. The campus is safe with 24-hour security. Costs for travel from Jacobs University to Bremen are included in the fee.

You need to fill out the complete application form, including a letter of reference and your latest transcript. Application deadline is **June 1, 2015**. The minimum age requirement is 16 years of age.

Please see. ■ [www.jacobs-university.de/summercamp\\_math](http://www.jacobs-university.de/summercamp_math) for the online application form and further information. Please wait until you have received a confirmation letter before making travel arrangements.



## ABOUT JACOBS UNIVERSITY

Jacobs University is a state-accredited, research-oriented, private university in Bremen, Germany, and is one of the most international academic institutions in the country, characterized by a truly intercultural community. Founded in 2001, Jacobs University attracts highly talented and open-minded students from all over the world; more than 1,200 students from over 100 nations currently live and study on our residential campus. With a broad portfolio of undergraduate and graduate programs, from the natural and social sciences to engineering and economics, all of Jacobs University's programs are taught in English. ■ [www.jacobs-university.de](http://www.jacobs-university.de)

Research and education at Jacobs University are structured in three distinct focus areas:

- **MOBILITY – OF PEOPLE, GOODS AND INFORMATION**
- **HEALTH – FOCUS ON BIOACTIVE SUBSTANCES**
- **DIVERSITY – IN MODERN SOCIETIES**

## MATHEMATICS (BSc)

Jacobs University offers a Bachelor of Science degree in Mathematics which is closely linked to applications in all three of Jacobs University's focus areas, and which also offers strong foundations in pure mathematics. Students participate in research groups together with graduate students and faculty, and many have even written research articles. One key element in our education is that we do not just teach courses to students, but accompany them as individuals throughout their education and help them identify and achieve their personal goals. ■ [www.jacobs-university.de/math](http://www.jacobs-university.de/math)

### CONTACT

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[www.jacobs-university.de/summercamp\\_math](http://www.jacobs-university.de/summercamp_math)



# SUMMER CAMP 2015 – PROGRAM

## Mathematics

June 25–July 5, 2015

### THURSDAY, JUNE 24

10:00–16:00

Arrival, registration, and welcome

18:00–21:00

Opening party with mathematical games

### FRIDAY, JUNE 26

9:15–10:30

Foundations of plane geometry from Euclid to Hilbert  
(Prof. Dr. Huckleberry)

11:00–12:15

Probability in the real world (Dr. Keivan Mallahi-Karai)

### SATURDAY, JUNE 27

9:15–10:30

Foundations of plane geometry from Euclid to Hilbert  
(Prof. Dr. Alan Huckleberry)

11:00–12:15

Geometry in four dimensions (Dr. Ana-Maria Brecan)

### SUNDAY, JUNE 28

9:15–10:30

Foundations of plane geometry from Euclid to Hilbert  
(Prof. Dr. Huckleberry)

11:00–12:15

Probability in the real world (Dr. Keivan Mallahi-Karai)

### MONDAY, JUNE 29

9:15–10:30

Geometry in four dimensions (Dr. Ana-Maria Brecan)

11:00–12:15

Probability in the real world (Dr. Keivan Mallahi-Karai)

### TUESDAY, JUNE 30

9:15–10:30

Discrete dynamical systems (Prof. Dr. Marcel Oliver)

11:00–12:15

Geometry in four dimensions (Dr. Ana-Maria Brecan)



## WEDNESDAY, JULY 1

**9:15 – 10:30**

Possible and impossible worlds: Platonic solids, Escher tilings, and chaos (Prof. Dr. Dierk Schleicher)

**11:00 – 12:15**

Compressed sensing (Prof. Dr. Götz Pfander)

## THURSDAY, JULY 2

**9:15 – 10:30**

Compressed sensing (Prof. Dr. Götz Pfander)

**11:00 – 12:15**

Solving algebraic equations (Qaisar Latif)

## FRIDAY, JULY 3

**9:15 – 10:30**

Discrete dynamical systems (Prof. Dr. Marcel Oliver)

**11:00 – 12:15**

Solving algebraic equations (Qaisar Latif)

## SATURDAY, JULY 4

**9:15 – 10:30**

Compressed sensing (Prof. Dr. Götz Pfander)

**11:00 – 12:15**

Solving algebraic equations (Qaisar Latif)

**13:00 – 17:00**

Meeting with John Conway, Professor Emeritus Mathematics, Princeton University

**18:00 – 21:00**

Closing ceremony and BBQ

A certificate will be issued for every participant, showing level of dedication and excellence.

## SUNDAY, JULY 5

### Departure

#### Afternoon Program

- Sport activities on campus
- Mathematical games and videos
- Free time with opportunity to visit historic Bremen downtown
- Problem-solving sessions
- Mathematical software labs
- Excursions in Bremen and vicinity

\* The schedule is subject to change.



## JACOBS UNIVERSITY

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