School Geoquant 2015

The focus on the **2015 Geoquant school** will be on the quantization of moduli spaces of bundles and metrics, Higgs bundles, Hitchin systems, wall crossing, hyperKähler geometry, quantum Hall effect, cluster algebras. Those topics are clearly in the center of the current interest in the field. We are happy that we could find leading experts in the field which are willing to deliver introductory lectures. The following lectures are foreseen:

- Mario Garcia-Fernandez (ICMAT, Madrid), *An introduction to Strominger systems*

  This is an overview of the theory regarding this systems of equations: existence results, moduli space, generalized geometry, T duality and more.

- Jochen Heinloth (University Duisburg-Essen), *Geometry of moduli spaces of Higgs bundles on curves*

  Moduli spaces of Higgs bundles possess a wealth of unusual geometric properties that made them appear in very different contexts: They admit a natural family of different complex structures, form an integrable system, give a geometric description of terms appearing in the trace formula, are diffeomorphic to character varieties, etc. A combination of several of these aspects led T. Hausel and F. Rodriguez-Villegas to a series of fascinating conjectures on the global geometry of these space. Although the general conjectures are still open, there has been some recent progress in this direction. In this mini course, we will try to explain some of the general conjectures and some of the methods that were used to obtain results towards them.

- Semyon Klevtsov (University of Cologne - Humboldt fellow), *Quantum Hall, Bergman kernel and Kähler metrics*

  Recently it was realized that the response of the Quantum Hall effect (QHE) to a curved geometry encodes interesting information about the theory, such as Hall conductance, anomalous viscosity of QHE liquid, its heat transport properties, etc. These lectures will be devoted to QHE, both the integer and fractional versions, on Riemann surfaces with arbitrary metric and also on higher-dimensional complex manifolds. Interestingly, relevant mathematical tools to define the theory come from Kähler geometry, especially from the study of constant scalar curvature metrics on Kähler manifolds. They include: holomorphic line bundles, Bergman kernel, energy functionals. Time permitting, I will also talk about the relation between the geometry of QHE and the random Kähler metrics program.

- Tomoki Nakanishi (Nagoya University, Japan), *Cluster algebras and applications*

  Cluster algebras were introduced by Fomin and Zelevinsky around 2000 by unifying algebraic structures appearing in Lie theory in several contexts. Nowadays, beyond the original intention and expectation, they are regarded as a common underlying algebraic/combinatorial structure broadly appears in several branches of mathematics, e.g., representation theory, Teichmüller theory, exact WKB analysis, integrable systems, and so on.

  In this series of lectures I explain the basics of cluster algebras from the scratch. Then, I focus on the application of cluster algebras to the dilogarithm identities. In particular, I explain how the cluster algebras effectively solve the long-standing periodicity and dilogarithm conjectures arising from the study of integrable systems and conformal field theory in 80ies and 90ies.

Each of these courses are planned for 5 hours. In addition to them we will allow short presentations (e.g. posters, talks by the participants). As they have been proven very effective in former schools organized in the frame of the GEOQUANT activity, regular discussion sessions are foreseen. There students can ask the lecturers additional questions in a less formal way, demand for more background information or even present by themselves certain aspects.