哈爾濱工業大學 数学研究院
Institute for Advanced Study in Mathematics of HIT

# Functional Analysis Seminar

## Integrability in random matrix theory and its applications

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## Abstract

Random matrices are widely used to model quantum systems with chaos and disorder. In such models, the observable is expressed as a quantum operator averaged over an ensemble of random matrices with a given probability measure. In my talk, I demonstrate a general approach, "the random matrix integrable theory", to the nonperturbative calculation of the random-matrix integrals. With this approach, the internal symmetries of the integration measure, expressed in terms of highly non-trivial nonlinear relations for the original integral (the Toda lattice hierarchy, the Kadomtsev-Petviashvili hierarchy) and the relations following from the deformation of the integration measure (Virasoro constraints), are used to represent the integral as a solution of differential equations, where the differentials are taken over the internal (physical) parameters of the model [1,2]. This method represents a particular implementation of results obtained within a more general theory of $\tau$-functions. In particular, the central theorem of this theory states the existence of the Toda lattice and Kadomtsev-Petviashvili hierarchies for the typical random-matrix integrals.

The particular implementation of the integrable theory will be discussed in the example of the physical problem of quantum transport in chaotic cavities [3,4]. A brief introduction to the physics of the problem and the advantage of the integrable theory method for calculation of the conductance cumulants, and of the shot-noise-conductance joint cumulants are going to be presented. In particular, we demonstrate how the conductance cumulant generation function can be expressed in terms of the solution of the Painleve V transcendent equation. In addition, the results of the integrable theory implementation to the averaged random-matrix characteristic polynomials [1], and also for the problem of the power spectrum of the eigenlevel sequences in the quantum chaotic system [2,5] will be discussed.

[1] V.Al.Osipov, E.Kanzieper, "Correlations of RMT characteristic polynomials and integrability: Random Hermitian matrices", *Annals of Physics* **325** (2010) 2251

[2] R.Riser, V.Al.Osipov, E.Kanzieper, "Nonperturbative theory of power spectrum in complex systems", *Annals of Physics* **413** (2020) 168065

[3] V.Al.Osipov, E.Kanzieper, "Integrable theory of quantum transport in chaotic cavities", *Phys.Rev.Let.* **101** (2008) 176804

[4] V.Al.Osipov, E.Kanzieper, "Statistics of thermal to shot noise crossover in chaotic cavities", *J.Phys.A:Math.Theor.* **42** (2009) 475101

[5] R.Riser, V.Al.Osipov, E.Kanzieper, "Power-spectrum of long eigenlevel sequences in quantum chaology", *Phys.Rev.Let.* **118** (2017) 204101

**Time:** Wednesday, August 31, 2022, 16:00-17:30 (UTC+8)

**Zoom ID:** 882 8540 7533 (Password: 028422)

**Link:** `https://zoom.us/j/88285407533?pwd=NFlsWlZlb2F3c3VmMHBqOXVud1NpQT09`

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`http://im.hit.edu.cn/en/2022/0414/c8931a271838/page.htm`