PIERRE DELIGNE SCHOLARSHIP REPORT. DMITRY CHELKAK, 2009.

1. Results

One of the main achievements in 2009 was the finishing of our joint with S. Smirnov paper "Universality in the 2D Ising model and conformal invariance of fermionic observables". (arXiv:0910.2045). Roughly speaking, we give a rigorous proof of the following claim: the so-called "fermionic observables" defined in a combinatorial way for the 2D Ising model sitting on any isoradial graph have a universal conformally covariant limit. Exploiting known results and ideas of O. Schramm, S. Smirnov, G.Lawler and W.Werner, one can easily deduce from here the convergence of interfaces to SLE(3) for the spin-Ising model and SLE(16/3) for the FK-Ising model in the topology given by the *convergence of driving forces*. Our proof is universal and independent of the particular structure of the underlying graphs, thus establishing the universality of the model.

Moreover, in this paper we also prove the analogue of Cardy's crossing probability formula for the FK-Ising model. Taking into account recent results of A. Kemppainen and S.Smirnov, this formula immediately gives bounds sufficient to improve the topology of convergence to the *convergence of curves* themselves. We also prepare the next paper where the convergence of curves will be shown for the spin-Ising model on the basis of the developed technique.

I also wrote a paper "An application of the fixed point theorem to the inverse Sturm-Liouville problem" (arXiv:0910.5086) for the volume dedicated to the anniversary of Nina N. Ural'tseva. In this paper the modification of Trubowitz's approach to the characterization theorems is presented. Namely, it is shown that one can check the differentiability of the mapping {potentials} $\mapsto$ {spectral data} at *only one point* in order to prove the local (and, further, global) surjectivity of the mapping. This modification simplifies the whole scheme substantially, as it shown by the example of the inverse Dirichlet problem with L^p potentials.

2. Publications

- Papers:
  (1) D. Chelkak, An application of the fixed point theorem to the inverse Sturm-Liouville problem. *Записки научных семинаров ПОМИ*, 370, 203–218, 2009. arXiv:0910.5086.
  (2) D. Chelkak, E. Korotyaev, Parametrization of the isospectral set for the vector-valued Sturm-Liouville problem, *Journal of Functional Analysis*, 257, 1546–1588.
  (this paper was submitted in 2008 and slightly changed in 2009 during the proof-reading)
  (3) Е.Л. Коротяев, Д.С. Челкак, Обратная задача Штурма-Лиувилля со смешанными краевыми условиями. *Алгебра и анализ*, 21(5), 114–137, 2009.
  (this is an old paper which was accepted in 2008)
- Preprints:
  (4) D. Chelkak, S. Smirnov, Universality in the 2D Ising model and conformal invariance of fermionic observables. 50pp., arXiv:0910.2045

3. Conferences, seminar talks etc.

- Conferences (invited talks):
  (1) *"33rd Conference on Stochastic Processes and Their Applications" (invited special session "SLE")* (Berlin, July 27–31);
  (2) *"International Conference in Spectral Theory dedicated to the memory of M.Sh.Birman"* (St.Petersburg, August 3–7);
  (3) *"Conformal Structures and Dynamics"* (Będlewo, September 21–26).
- Seminar talks, colloquia etc.:
  mini-course "Conformal invariance in the 2D Ising model" at Tel-Aviv University;
  colloquia: Moscow "Globus" Seminar, Moscow Mathematical Society Meeting;
  seminar talks: Geneva, Marseille, Paris VI;
  St.Petersburg: "Analysis and Operator Theory" and "Probability Theory" seminars.
- Workshops, schools and conferences (w/o giving a talk):
  "Random planar geometry" (Les Diablerets, February 8–14);
  "18th Summer St.Petersburg Meeting in Mathematical Analysis" (June 27 – July 2);
  "Dimer models and random tilings. 2D lattice models" (Paris, October 5–10).

4. Pedagogical activity

I taught the following courses at St.Petersburg State University (Math. & Mech. Faculty):

(1) Spring 2009: special course "Advanced Measure Theory" ("PDMI group" 2nd year students, 4th term): geometric measure theory, Hausdorff measures and dimensions, deterministic and random fractals;
(2) Fall 2009: special course "Divergent series" ("PDMI group" 2nd year students, 3rd term): summation methods and Tauberian theorems, gamma-function and asymptotic series, zeta-function and asymptotics of prime numbers;
(3) Standard calculus courses (lectures and seminars) for 2nd-3rd years students.

In June 2009 my undergraduate student Sergey Matveenko has defended his diploma paper "Inverse spectral problem for Sturm-Liouville operators with matrix potentials and separated boundary conditions". Now S. Matveenko is a 1st year graduate student at St.Petersburg University and prepares the diploma paper for publication.