Scientific report

From November 14th to 17th December, 2011, I visited the Institute Henri Poincaré and participated in the programme "Advanced Conformal Field Theory and Applications ". The purpose of the visit was to learn the state-of-the-art of the computational tools for correlation functions, Wilson loops and scattering amplitudes, the connection with integrable models and conformal bootstrap approach. Also, I pursued my work in collaboration with Jonathan Toledo from Perimeter Institute which also participated in the programme.

I had the opportunity to attend several pedagogical talks reviewing AdS/CFT duality, N=4 Super Yang-Mills and Integrability, conformal bootstrap by major experts in the field (Konstantin Zarembo, Gordon Semenoff, Slava Rychkov etc.). Also, I have attended the workshop "Higher dimensional CFT and Integrability", which highly overlapped with my research interests.

During this period, I had considerable progress on my current project of computing four point functions in N=4 Super Yang-Mills at strong coupling in collaboration with Jonathan Toledo from Perimeter Institute. Our approach is to use the AdS/CFT correspondence, which allows us to compute quantities in N=4 Syper Yang-Mills at strong coupling by using its dual string theory in AdS_5xS^5. We are focusing on correlation functions of four heavy operators, without spin in AdS and nontrivial motion in S^5. The AdS part of the correlation function in the classical limit turns out to be related with the area of the worldsheet with specific boundary conditions. Many of the techniques based on the classical integrability of the sigma model that we are using were previously applied to the problem of Wilson Loop/scattering amplitudes at strong coupling by Alday, Maldacena, Sever and Vieira and also in the computation of the three point functions by Janik and Wereszczynski. Indeed, the information about each particular problem is contained in the energy-momentum tensor. For instance, in the Wilson Loop problem the energy-momentum tensor was a polynomial, in the correlation functions turns out to be a rational function etc.: by changing its analytic properties one identifies different problems.

In all these problems, the area of the worldsheet is computed by using the Riemann bilinear identity which allows to transform an integral over a Riemann surface into integrals over some cycles in the same Riemann surface. One then relates these cycles with the solutions of the linear problem associated to the equations of motion of the string sigma model, by the WKB approximation.

During the visit, we managed to derive a set of functional equations (which we may call Y-system due to the similarity with the Wilson Loop/Scattering Amplitude problem) for the solutions of the linear problem. Once this set of equations is solved, we can compute the cycles over the Riemann surface and therefore obtain the area. Currently, we are testing our proposal numerically. We expect to expand our result in terms of conformal blocks and eventually recover some recent results on three point functions.

As a result from this grant, I expect to publish a paper on four point functions in N=4 Super Yang-Mills at strong coupling in the near future.

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