



Department of
Theoretical Physics

THE QUANTUM SPACETIME SEMINAR SERIES

Chern-Simons theories on generic three manifolds and matrix models

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Date: Mar 25, 2019

Time: 11.30 am

Venue: A-304, TIFR



We shall discuss Chern-Simons (CS) theories with rank N and level k on generic three manifold. The partition functions of such theories can be written as a function of modular transformation matrices summed over different integrable representations of affine Lie algebra $u(N)_k$. Using properties of modular transform matrices we express the partition functions of these theories as a unitary matrix model. We show that, the eigenvalues of unitary matrices are discrete and proportional to hook lengths of the corresponding integrable Young diagram. As a result, in the large N limit, the eigenvalue density develops an upper cap. We consider CS theory on $S^2 \times S^1$ coupled with fundamental matters and express the partition functions in terms of modular transformation matrices. Solving this model at large N we find the dominant integrable representations and show how large N representations are related to each other by transposition of Young diagrams as a result of level rank duality.

Next we consider $U(N)$ CS theory on S^3 and observed that in a particular framing the dominant representation is no longer an integrable representation after a critical value of 't Hooft coupling. We also show that CS on S^3 admits multiple (two-gap phase) large N phases with the same free energy.