

Geometry and large N expansion of matrix models

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Abstract

An all orders solution of Virasoro (W) constraints associated to matrix models, can be explicitly constructed in terms of algebraic geometry. The order g term in the $1/N^2$ expansion of the free energy, F_g , is the generating function for discrete surfaces of genus g . We find F_g as a residue on an algebraic curve. F_g is a symplectic invariant of the curve, and the infinite family of F_g 's form some tau function. We show how the usual integrable systems (Toda, KP, KdV), matrix integrals, Kontsevitch integral (and its generalization) fit in that framework. For instance the fact that Kontsevitch integral depends only on odd moments and satisfies KdV are straightforward in our framework.