



## MATRIX MODELS, LARGE $N$ LIMITS AND NONCOMMUTATIVE SOLITONS\*

RICHARD J. SZABO

Communicated by Martin Schlichenmaier

---

**Abstract.** A survey of the interrelationships between matrix models and field theories on the noncommutative torus is presented. The discretization of noncommutative gauge theory by twisted reduced models is described along with a rigorous definition of the large  $N$  continuum limit. The regularization of arbitrary noncommutative field theories by means of matrix quantum mechanics and its connection to noncommutative solitons is also discussed.

---

### 1. Introduction

Two of the most novel aspects of noncommutative field theories (see [7, 15] and [22] for reviews) which are not seen in ordinary quantum field theories are the properties that (a) They can be regularized and analysed by means of matrix models, and (b) In some instances they admit novel soliton solutions with no commutative counterparts. Property (a) stems from the fact that noncommutative fields are most conveniently understood and analysed as operators acting on separable Hilbert spaces. Property (b) instead is due to the fact that noncommutative field theories behave in many respects like string theory, rather than conventional quantum field theory, and noncommutative solitons correspond to *D-branes* in open string field theory of tachyon dynamics (see [13] for a review). In this survey we will describe some aspects of the interrelationship between matrix models, noncommutative solitons and field theory on the noncommutative torus. The first half of the article deals with the finite-dimensional regularization of Yang-Mills theory on a two-dimensional noncommutative torus [1] and the precise definition of the large  $N$  limit of this matrix model [16]. The second half demonstrates that the two novel properties (a) and (b) above are in fact intimately related through a regularization of noncommutative field theory by means of matrix quantum mechanics

---

\*This paper is a part of the Proceedings of the XXIV Workshop on Geometric Methods in Physics, held in Białowieża, Poland from June 26 – July 2, 2005.