*International Workshop on Noncommutative Geometry (NCG2005), Sep. 11-22, 2005, IPM, Tehran*

# Introduction to Alain Connes' Book on Noncommutative Geometry

(4 Lectures)

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Noncommutative geometry was founded by Alain Connes in late 1970's by a synthesis of several trends in mathematics and physics. The subject has strong roots in functional analysis and the theory of operator algebras on the Hilbert space in particular Von Neumann and C*-algebras, algebraic and differential topology and geometry, and the index theory of Atiyah and Singer. In fact many of the natural extensions and ramifications of the index theorem would have been impossible without noncommutative geometry. One of Connes' key insights is that extension of the classical notion of space ( i.e. a topological or measure space, possibly endowed with an extra structure like smooth or Riemannian structure, etc.) to the so called noncommutative spaces lead to natural solutions of several outstanding conjectures in topology and analysis. The passage from classical (commutative) spaces to noncommutative (quantum) spaces in many ways resemble the passage from classical to quantum mechanics. Since its inception, noncommutative geometry has evolved into a mature and elaborate body of theory with many intriguing, and often surprising connections with mainstream mathematics. It is widely believed that noncommutative geometry will be be one of the main areas of research in the 21st century. Connes' Noncommutative Geometry, published in 1994, summarized the main achievements of the theory by that time and chartered the course of the subject in coming years.

While covering the book in four lectures is certainly impossible (and that is an understatement!), my aim is to highlight a few of the basic notions germane to noncommutative geometry, as they are presented in the book.

Lecture 1: The language of noncommutative geometry; a postmodern algebra-geometry duality,

Lecture 2: Noncommutative spaces: what are they and how they are constructed,

Lecture 3: Invariants of noncommutative spaces: cyclic cohomology and K-theory,

Lecture 4: Applications.