AN INTRODUCTION TO NONCOMMUTATIVE GEOMETRY (EMS SERIES OF LECTURES IN MATHEMATICS) pdf

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geometry (ems series of lectures in, basic noncommutative geometry (ems series of lectures in mathematics) european mathematical society (december 15,) isbn: pages pdf 1 mb this book provides an introduction to.

Motivation[edit] The main motivation is to extend the commutative duality between spaces and functions to the noncommutative setting. In mathematics, spaces, which are geometric in nature, can be related to numerical functions on them. In general, such functions will form a commutative ring. For instance, one may take the ring C X of continuous complex -valued functions on a topological space X. In many cases e. In commutative algebraic geometry , algebraic schemes are locally prime spectra of commutative unital rings A. Grothendieck , and schemes can be reconstructed from the categories of quasicoherent sheaves of modules on them P. For Grothendieck topologies , the cohomological properties of a site are invariant of the corresponding category of sheaves of sets viewed abstractly as a topos A. In all these cases, a space is reconstructed from the algebra of functions or its categorified versionâ€”some category of sheaves on that space. Functions on a topological space can be multiplied and added pointwise hence they form a commutative algebra; in fact these operations are local in the topology of the base space, hence the functions form a sheaf of commutative rings over the base space. The dream of noncommutative geometry is to generalize this duality to the duality between noncommutative algebras, or sheaves of noncommutative algebras, or sheaf-like noncommutative algebraic or operator-algebraic structures, and geometric entities of certain kinds, and give an interaction between the algebraic and geometric description of those via this duality. For this reason some talk about non-commutative topology , though the term also has other meanings. Applications in mathematical physics[edit] Some applications in particle physics are described in the entries Noncommutative standard model and Noncommutative quantum field theory. The sudden rise in interest in noncommutative geometry in physics follows after the speculations of its role in M-theory made in The proposal of George Mackey to create a virtual subgroup theory, with respect to which ergodic group actions would become homogeneous spaces of an extended kind, has by now been subsumed. Noncommutative differentiable manifolds[edit] A smooth Riemannian manifold M is a topological space with a lot of extra structure. From its algebra of continuous functions C M we only recover M topologically. The algebraic invariant that recovers the Riemannian structure is a spectral triple. It is constructed from a smooth vector bundle E over M, e. A recent deep theorem [2] states that M as a Riemannian manifold can be recovered from this data. Research in spectral triples is very active, and many examples of noncommutative manifolds have been constructed. Noncommutative affine and projective schemes[edit] In analogy to the duality between affine schemes and commutative rings , we define a category of noncommutative affine schemes as the dual of the category of associative unital rings. There are certain analogues of Zariski topology in that context so that one can glue such affine schemes to more general objects. This theorem is extended as a definition of noncommutative projective geometry by Michael Artin and J. Zhang, [3] who add also some general ring-theoretic conditions e. Many properties of projective schemes extend to this context. For example, there exist an analog of the celebrated Serre duality for noncommutative projective schemes of Artin and Zhang. The theory of characteristic classes of smooth manifolds has been extended to spectral triples, employing the tools of operator K-theory and cyclic cohomology. Several generalizations of now classical index theorems allow for effective extraction of numerical invariants from spectral triples. The fundamental characteristic class in cyclic cohomology, the JLO cocycle , generalizes the classical Chern character. Examples of noncommutative spaces[edit] In the phase space formulation of quantum mechanics, the symplectic phase space of classical mechanics is deformed into a non-commutative phase space generated by the position and momentum operators. The standard model of particle physics is another example of a noncommutative geometry, cf noncommutative standard model. The noncommutative torus , deformation of the function algebra of the ordinary torus, can be given the structure of a spectral triple. This class of examples has been

studied intensively and still functions as a test case for more complicated situations. Snyder space [7] Noncommutative algebras arising from foliations. Examples related to dynamical systems arising from number theory , such as the Gauss shift on continued fractions, give rise to noncommutative algebras that appear to have interesting noncommutative geometries.

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