

High Energy Physics - Theory

Exotic smooth R^4 , noncommutative algebras and quantization

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The paper shows deep connections between exotic smoothings of small R^4 , noncommutative algebras of foliations and quantization. At first, based on the close relation of foliations and noncommutative C^* -algebras we show that cyclic cohomology invariants characterize some small exotic R^4 . Certain exotic smooth R^4 's define a generalized embedding into a space which is K-theoretic equivalent to a noncommutative Banach algebra. Furthermore, we show that a factor III von Neumann algebra is naturally related with nonstandard smoothing of a small R^4 and conjecture that this factor is the unique hyperfinite factor III₁. We also show how an exotic smoothing of a small R^4 is related to the Drinfeld-Turaev (deformation) quantization of the Poisson algebra $(X(S, SL(2, C)), \{, \})$ of complex functions on the space of flat connections $X(S, SL(2, C))$ over a surface S , and that the result of this quantization is the skein algebra $(K_t(S), [,])$ for the deformation parameter $t = \exp(\hbar/4)$. This skein algebra is retrieved as a II₁ factor of horocycle flows which is Morita equivalent to the II_∞ factor von Neumann algebra which in turn determines the unique factor III₁ as crossed product. Moreover, the structure of Casson handles determine the factor II₁ algebra too. Thus, the quantization of the Poisson algebra of closed circles in a leaf of the codimension 1 foliation of S^3 gives rise to the factor III₁ associated with exotic smoothness of R^4 . Finally, the approach to quantization via exotic 4-smoothness is considered as a fundamental question in dimension 4 and compared with the topos approach to quantum theories.

Comments: 31 pages, 6 figures, svjour style, argumentation about closed transversals modified (sec. 4.2)

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