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Deformation Quantization and Index Theory

Boris Fedosov

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In the monograph a new approach to deformation quantization on a symplectic manifold is developed. This approach gives rise to an important invariant, the so-called Weyl curvature, which is a formal deformation of the symplectic form. The isomophy classes of the deformed algebras are classified by the cohomology classes of the coefficients of the Weyl curvature. These algebras have many common features with the algebra of complete symbols of pseudodifferential operators except that in general there are no corresponding operator algebras. Nevertheless, the developed calculus allows to define the notion of an elliptic element and its index as well as to prove an index theorem similar to that of Atiyah-Singer for elliptic operators. The corresponding index formula contains the Weyl curvature and the usual ingredients entering the Atiyah-Singer formula. Applications of the index theorem are connected with the so-called asymptotic operator representation of the deformed algebra (the operator quantization), the formal deformation parameter h should be replaced by a numerical one ranging over some admissible set of the unit interval having 0 as its limit point. The fact that the index of any elliptic operator is an integer results in necessary quantization conditions: the index of any elliptic element should be asymptotically integer-valued as h tends to 0 over the admissible set. For a compact manifold a direct construction of the asymptotic operator representation shows that these conditions are also sufficient. Finally, a reduction theorem for deformation quantization is proved generalizing the classical Marsden-Weinstein theorem. In this case the index theorem gives the Bohr-Sommerfeld quantization rule and the multiplicities of eigenvalues.

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