Summary of the Main Achievements of Professor Ivan Todorov

The major contributions of Professor Ivan T. Todorov with essential use of group theory methods belong to quantum field theory and elementary particle physics.

The total number of Todorov's scientific papers exceeds 250. Todorov is the author or leading coauthor of 11 monographs in theoretical physics published by Pergamon Press, Addison-Wesley, Kluwer, Springer and others. Some of them have become an essential reading for Ph. D. students in theoretical physics.

Todorov has outstanding achievements in the study of infinite component fields and, more importantly, in the development of conformal quantum field theory (CFT), which are of lasting importance in theoretical physics, with applications to string theory, to the AdS/CFT correspondence, to quantum Hall effect, quantum computers and others.

His main contributions involving significant applications of group-theoretical methods my be split between the following research areas:

1. Axiomatic Quantum Field Theory

Todorov is a leading representative of the axiomatic approach to quantum field theory. It investigates the implications of basic symmetry principles (including energy positivity that restricts the representations of the Poincaré group) and micro-causality (or locality). The monograph [1] provides a comprehensive exposition of the foundations of the theory. A result of Todorov which still attracts attention in this domain is the invalidity of the TCP theorem for infinite component fields [OT68].

2. Conformal Field Theory

Todorov is among the pioneers (along with J. Wess, G. Mack , Abdus Salam, A. Polyakov, A. Migdal, G. Parisi, S. Ferrara) that studied conformal quantum field theory models. Conformal symmetry is essential in high energy and deep inelastic scattering processes and is becoming even more interesting nowadays in view of the experiments on the Large Hadron Collider at CERN. In its various facets this symmetry is the basis of modern string theory, and describes critical behavior of statistical systems. Monographs [2] and [3] contain new mathematical results in representation theory of the noncompact groups SO(n,1) and applications to conformally invariant quantum field theory models. The lectures [4] study and classify the coadjoint orbits of SU(2, 2). Two top cited papers of the early days of the theory belong to Mack and Todorov. In [MT69] they established irreducibility of the ladder representations of the conformal group when restricted to its Poincaré subgroup, thus anticipating the study of minimal representations in subsequent decades. In [MT73] they proved the existence of n-point conformally invariant Green functions with anomalous dimensions, free of ultraviolet divergences. To the same period belong still used results of [BT77], obtained by Todorov in collaboration with one of the first Wigner medalists, Valentin Bargmann of Princeton University.

3. Low-dimensional Field Theories and quantum groups

Todorov has important achievements in two-dimensional CFT which combine the representation theory of infinite-dimensional Lie algebras with the axioms of QFT (see, in particular [BMT]). He derived independently the celebrated Knizhnik-Zamolodchikov equation [T]. In [KT85] Wigner medalist Victor Kac and Todorov pioneered the construction of the unitary representations of the superconformal affine algebras. In [KT97] they developed the theory of general affine orbifolds. Work with a number of collaborators led by Todorov on applications of quantum groups and braid group statistics in conformal current algebra models is reviewed in [5,6]. A paper which blends together 2D CFT and quantum group methods, [MST], is co-authored by yet another Wigner medalist, Louis Michel. In recent years Todorov is actively working on extending two-dimensional CFT methods to higher dimensions.

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