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Quantum current algebra symmetry and description of Boltzmann type kinetic equations in statistical physics

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Abstract: We study a special class of dynamical systems of Boltzmann-Bogolubov and Boltzmann-Vlasov type on in◎nite dimensional functional manifolds modeling kinetic processes in many-particle media. Based on algebraic properties of the canonical quantum symmetry current algebra and its functional representations we proposed a new approach to invariant reducing the Bogolubov hierarchy on a suitably chosen correlation function constraint and deducing the related modi◎ed Boltzmann-Bogolubov kinetic equations on a ◎nite set of multiparticle distribution functions. It is well known that the classical Bogolubov-Boltzmann kinetic equations under the condition of manyparticle correlations at weak short range interaction potentials describe long waves in a dense gas medium. The same equation, called the Vlasov one, as it was shown by N. Bogolubov, describes also exact microscopic solutions of the innite Bogolubov chain or the manyparticle distribution functions, which was widely studied making use of both classical approaches and making use of the generating Bogolubov functional method and the related quantum current algebra representations. In this case the Bogolubov equation for distribution functions in some domain. Remark here that the basic kinetic equation is reversible under the time reection t-->-t, thus it is obvious that it can not describe thermodynamically stable-limiting states of the particle system in contrast to the classical Bogolubov-Boltzmann kinetic equations, being a priori time nonre-versible owing to the choice of special boundary conditions. This means that in spite of the Hamiltonicity of the Bogolubov chain for the distribution functions, the Bogolubov-Boltzmann equation a priori is not reversible. The classical Poisson bracket expression allows a slightly different Lie-algebraic interpretation, based on considering the functional space D(M_f_1) as a Poissonian manifold, related with the canonical symplectic structure on the di¤eomorphism group Diff( ) of the domain R^3, ◎first described still in 1887 by Sophus Lie. These aspects and its different consequences are analyzed in detail in our report

Keywords: kinetic equations; Bogolubov chain; multi-particle distribution functions; current algebra; Wigner representation; functional equations; reduction theory; Lie-Poisson bracckets; invariant functional submanifolds

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