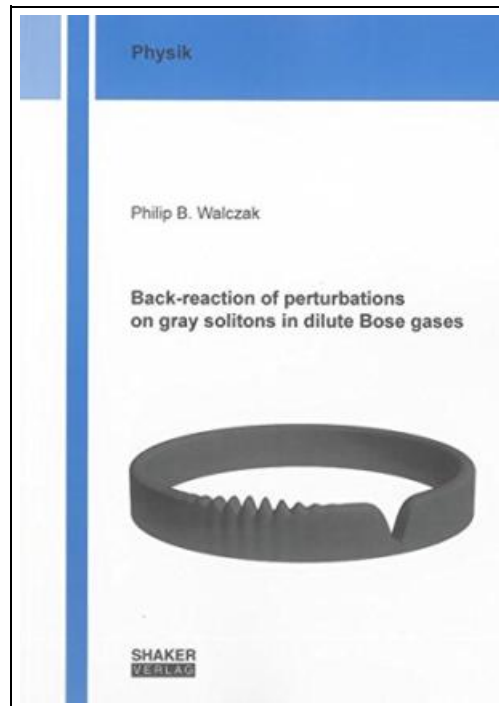


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BACK-REACTION OF PERTURBATIONS ON GRAY SOLITONS IN DILUTE BOSE GASES



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Shaker Verlag Aug 2012, 2012. Buch. Condition: Neu. Neuware - The main topic of this work is the back-reaction from perturbations of small amplitude on gray solitons in weakly interacting quasi-one-dimensional dilute Bose gases. These systems are of special interest, since they raise physical questions connected with the emergence of collective degrees of freedom. An essential part of the present work constitutes the result of a linearization of the Gross-Pitaevskii equation (GPE) about a gray-soliton background solution. The linearization corresponds to a systematic expansion of the Heisenberg equation of motion in the dilute gas parameter up to and including first order. The solutions to the linearized equation of motion are derived with a method similar to the factorization from scattering theory. To this end the field amplitude is expanded with respect to normal modes with real amplitude and harmonic time evolution, which represent the elementary excitations of the system. The results are exact for the infinite system without boundary conditions, but may be transferred to finite systems with periodic boundary conditions up to exponentially small errors. Furthermore it is confirmed that the normal mode solutions indeed form a complete and orthonormal set of functions. The advantage of the real amplitude representation is that the modes with natural frequency zero, the so-called zero modes, are straightforwardly found from the quadratic Hamilton function, and they join at the bottom of a (quasi-)continuous spectrum of normal modes with finite frequency. In particular, a discrete zero mode with negative mass is obtained, which is associated with a spatial translation of the soliton. However, it is clarified that this assignment is not as unambiguous as commonly assumed, since a mixture of the zero modes is allowed by canonical transformation although their masses have different signs. From the analytical form of the normal mode solutions one...



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