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COLLECTIVE PHENOMENA AND CLUSTERING: FROM NUCLEAR SYSTEMS TO FUSION PLASMAS

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Abstract. *The present work aims at presenting new theoretical contributions to the understanding of physical systems whose strongly nonlinear intrinsic character leads to a rich variety of complex manifestations, interesting from both theoretical and practical points of view. The main theoretical difficulty is the correct identification of the degrees of freedom for each physical system under scrutiny, supplemented by the need to develop the suitable theoretical framework, or to create it where needed. It is remarkable that this enterprise has been possible both in the field of nuclear structure and in the study of the evolution of the fusion plasma turbulence. In the first part of this work, we study the interplay of collectivity and clustering within nuclear structure, where a central role is played by the two and four body correlations. In the second part, we are interested in the nonlinear processes due to the collective unstable modes in the magnetically confined plasmas. In this context, the competition between order and chaos is manifest through the generation of cuasicoherent structures on the turbulent background* which have a significant influence on the transport of particles and energy.

Keywords: Clustering, coherence, correlations, alpha decay, plasma turbulence

1. Introduction

The theoretical description of proton rich or neutron rich atomic nuclei has become an important part of modern nuclear physics, especially due to the experimental advances in the study of highly unstable nuclei.

The main investigation tool is represented by the radioactive decays, which include the phenomena induced by the strong interaction like the emission of individual particles (protons or neutrons), two-proton emission, alpha decay, heavy cluster emission and also binary and ternary fission.

There can also occur processes which are induced by the electromagnetic or weak interactions, but in what follows we will address those of nuclear origin, due to their importance in the study of exotic nuclei [1].

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