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The Compression-Mode Giant Resonances and Nuclear Incompressibility

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Abstract

The compression-mode giant resonances, namely the isoscalar giant monopole and isoscalar giant dipole modes, are examples of collective nuclear motion. Their main interest stems from the fact that one hopes to extrapolate from their properties the incompressibility of uniform nuclear matter, which is a key parameter of the nuclear Equation of State (EoS). Our understanding of these issues has undergone two major jumps, one in the late 1970s when the Isoscalar Giant Monopole Resonance (ISGMR) was experimentally identified, and another around the turn of the millennium since when theory has been able to start giving reliable error bars to the incompressibility. However, mainly magic nuclei have been involved in the deduction of the incompressibility from the vibrations of finite nuclei.

The present review deals with the developments beyond all this. Experimental techniques have been improved, and new open-shell, and deformed, nuclei have been investigated. The associated changes in our understanding of the problem of the nuclear incompressibility are discussed. New theoretical models, decay measurements, and the search for the evolution of compressional modes in exotic nuclei are also discussed.

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1 Introduction

Giant resonances (GRs) are the clearest manifestation of nuclear collective motion. The domain of GRs is a mature field, in which the basic issues have been established quite some time ago. Monographs exist that review the classification of these collective modes and illustrate the findings obtained up to the turn of the century [1, 2]. We do not intend to restart from scratch but, in a way, this review paper aims to be a supplement to the book by M. Harakeh and A. Van Der Woude [2]; consequently, the results presented here have all been obtained after the years 2000-2001, with only a few exceptions.

There are essentially three new and interesting lines of research in the current physics of GRs: use well-established experimental data as a benchmark for new theories; identify GRs in neutron-rich,