IDENTIFICATION OF CHARACTERISTIC ENERGY SCALES IN NUCLEAR ISOSCALAR GIANT QUADRUPOLE RESONANCES: FOURIER TRANSFORMS AND WAVELET ANALYSIS

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ABSTRACT

The identification of energy scales in the region of Isoscalar Giant Quadrupole Resonance (ISGQR) is motivated by their potential use in understanding how an ordered collective motion transforms into a disordered motion of intrinsic single-particle degrees-of-freedom in many-body quantum systems. High energy-resolution measurements of the ISGQR were obtained by proton inelastic scattering at E_p= 200 MeV using the K600 magnetic Spectrometer at iThemba LABS. The nuclei ^{58}Ni, ^{90}Zr, ^{120}Sn and ^{208}Pb, associated with closed shells, were investigated. Both the Fourier transform and Wavelet analysis were used to extract characteristic energy scales and were later compared with the results from the theoretical microscopic Quasi-particle Phonon Model (QPM), including contributions from collective and non-collective states. The scales found in the experimental data were in good agreement with the QPM. This provides a strong argument that the observed energy scales result from the decay of the collective modes into 2p-2h states. The different scale regions were tested directly by reconstruction of measured energy spectra using the Inverse Fourier Transform and the Continuous Wavelet Transform (CWT), together with a comparison to a previously available reconstruction using the Discrete Wavelet Transform (DWT).

I declare that this research report is my own unaided work; the Matlab programme code was provided by Prof. G.R.J. Cooper of the Geophysics Department. It is been submitted for the partial fulfillment of the requirements for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Signature:

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This work is dedicated to my lovely daughters: Maryam and Mardiyath

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TABLE OF CONTENTS

CONTENTS **Page**

LIST OF FIGURES

LIST OF TABLES