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INELASTIC SCATTERING OF POLARIZED PROTONS AND CLUSTER STRUCTURE IN 2s-1d SHELL NUCLEI

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INELASTIC SCATTERING OF POLARIZED PROTONS AND CLUSTER STRUCTURE IN 2s-1d SHELL NUCLEI

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ABSTRACT

It is shown that inelastic scattering using polarized protons is superior to other inelastic scattering experiments using unpolarized beam to get precise multipole deformations in light nuclei. Such knowledge of correct multipole deformations is of great importance since they are directly connected with cluster structure configuration in these nuclei.

The existence of deformed structures in light nuclei of 2s-1d shell has long be recognized.
Most of the Hartree-Fock (HF) calculations characterize this region as a region [1] of permanent ground state deformations. Most of these HF calculations like for instance the most recent one by P. Quentin [2] using a Skyrme III interaction indicates the presence in these nuclei of hexadecopole ($\beta 4$) as well as quadrupole ($\beta 2$) deformations.

The existence of such multipole deformations in several nuclei of the 2s-1d shell has been confirmed by several inelastic scattering experiments using various projectiles [3] including polarized protons [4]. Nevertheless the absolute values of $\beta 2$ and $\beta 4$ deformations extracted from these data, generally analyzed with a coupled - channels program, were very different depending on the type of particles used as probes.
The deformed structures of the nuclei N = Z (4n type) in the 2s-1d shell hsve also been considered through the α-particle cluster configuration.

Recent heavy ions and α-tranafer reactions suggest the existence of α clusters in light nuclei [5]. The existence of some α nucleus structure in ^{20}Ne has, for example, first been succesfully considered using the model of Brink and Bloch [6].

Recently the simple microscopic α cluster model of Brink and Margenau was used to study several light 4n nuclei [7].

This model gave for ^{20}Ne the following deformations ($\beta 2 = 0.55$, $\beta 4 = 0.32$) and for ^{28}Si ($\beta 2 = - 0.43$, $\beta 4 = + 0.18$). When compared to

all available results from inelastic scattering experiments only the one coming from inelastic scattering of polarized protons experiments on these nuclei [4] were in very good agreement with these results (these experimental results were $\beta 2 = 0.47$, $\beta 4 = 0.28$ for ^{20}Ne and $\beta 2 = -0.50$, $\beta 4 = +0.15$ for ^{28}Si) values which are generally accepted now. This is just a simple example to show the superiority of polarized protons over other particles used in inelastic scattering experiment to get precise multipole deformations which therefore may more correctly be related to possible cluster structure configurations. Indeed analyzing powers data are much more sensitive than cross section to the values of $\beta 4$ deformations and in fact to the shape of the nuclei or its mass distribution.

Using polarized protons may therefore be a good additional tool to study clustering in nuclei. The existence of a large $\beta 4$ deformation such as in ^{20}Ne and ^{28}Si can probably definitely be related with the presence of α aggregates in these nuclei. It would be worthwile to point out therefore the need for precise protons polarizations data (analyzing power and cross section) to get values for $\beta 2$ and $\beta 4$ at the beginning and at the end of this 2s-1d shell to make definite description of nuclei in this mass region in terms of a possible α cluster configuration.

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