Gamma-ray spectroscopy of deformed states in light nuclei and cluster emission

by

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Zusammenfassung

Im Rahmen dieser Arbeit wurde nach γ-Übergängen möglicher Cluster- Strukturen in leichten Kernen gesucht. Dazu wurden Experimente mit dem γ- Detektorball GASP am Laboratori Nazionali di Legnaro (LNL) in Italien durchgeführt. Um eine bessere Kannaltrenung und Selektivität zu erreichen wurde zusätzlich der Detektorball ISIS (zum Nachweiss leichter Teilchen) verwendet. Mit der Hilfe von γ-Teichen-Koinzidenzen wurden detaillierte Niveau-Schemata für die Übergänge unter der Teilchenschwelle in ^{10}Be extrahiert. Außerdem wurde die Bevölkerung der γ-Übergänge durch Direkte- und Compoundkern- Reaktionmechanismen für die Neon-Isotope studiert. Das beobachtete γ-Spektrum für ^{21}Ne wurde als starker Hinweis auf eine reflexionsasymetrische Struktur gedeutet. Neue Spinzuordnungen, die einer DCO (Directional Correlations de-exciting Oriented states) Analyse folgen, sind für einige der Niveaus in ^{21}Ne getrofen worden. Neue Übergänge in ^{22}Ne wurden gefunden. Durch Vergleich der von uns gemessenen Daten mit theoretischen Vorhersagen konnten zusätzlich vorläufige Spinzuordnungen für ^{23}Ne extrahiert werden.

Eine quantitative Analyse der Emission von ^{8}Be und ^{12}C* wurde durch geführt und aus den Energiespektren wurden Informationen über das Verhält- nis zwischen den gleichzeitig eintreffenden unkorellierten α-Teilchen sowie die den realen ^{8}Be-Clustern extrahiert. Zusätzlich wurden die Unterschiede zwischen den registrierten γ-Spektren in Koinzidenz mit zwei α-Teilchen in unterschiedlichen Detektoren, und den γ-Spektren in Koinzidenz mit den '^{8}Be' Ereignisse analysiert.

Es wurde experimentell nachgewiesen, daß die Restkerne nach der Cluster-Emission in einem höheren Anregungszustand sind, als die gleiche Kerne, die aus der aufeinanderfolgenden Emission der α-Teichen enstanden sind. Deshalb ist bei Restkerne, die aus der Cluster-Emission herforgeganden sind, die Emission weitere leichte Teilchen bevorzugt. Dieses Phänomen ist diskutiert und eine mögliche Erklärung wurde gegeben.

Abstract

Gamma-ray decays from possible nuclear cluster structures in light deformed nuclei have been investigated using the GASP array of high purity germanium detectors. In order to achieve the required experimental sensitivity, a special device was used, namely a highly efficient array of silicon-detector telescopes for the detection of charged particles. Using γ-particle coincidences, a detailed level scheme for the γ-ray transitions in ^{10}Be beneath the particle threshold was obtained and new γ-ray transitions identified. Furthermore, the γ-ray populations in the direct and compound reaction mechanisms were studied for neon-isotopes. The γ-ray spectra obtained for ^{21}Ne were interpreted as indicating a reflection asymmetric structure. New spin assignments have been made for some of the levels in ^{21}Ne following a DCO (Directional Correlations de-exciting Oriented states) analysis. New transitions in ^{22}Ne were found. In addition, tentative spin assignments for ^{23}Ne were extracted after comparing the current experimental data with theoretical predictions.

A quantitative analysis of the emission of ^{8}Be and ^{12}C* clusters was made and information about the ratio between the coincident uncorrelated α-particles as well as the real cluster events was extracted from the energy spectra. In addition, the differences between the γ-ray spectra in coincidence with two α-particles registered in different detectors and the '^{8}Be' events were analysed. The results show the enhanced sequential emission of α-particles. Here, it has been experimentally observed that the residual nuclei, after cluster emission, are in a state of higher excitation energy than the same compound nuclei following the sequential emission of α-particles. This phenomenon is discussed and an explanation proposed.

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"The only thing to do with good advice is to pass it on. It is never of any use to oneself"

by Oscar Wilde.

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