Producing Huge Spin Alignment in Inelastic Excitations of Clustered Nuclei

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Introduction
In most nuclear reactions (fusion, quasi-elastic and deeply inelastic scattering) the total angular momentum is dominated by the large reservoir contained in orbital motion. It is not surprising, then, that the exit channel fragments tend to acquire an aligned spin \textit{perpendicular} to the beam-axis.

After analyzing a previous experiment with $^7$Be at MSU a huge spin alignment (∼50%) \textit{parallel} to the beam-axis was found for inelastically excited $^7$Be$^*$. We performed an analogous experiment at TAMU using $^7$Li which also exhibited a large longitudinal spin alignment. In particular we studied the reactions:

$^7$Li($J' = 3/2$) + Be/C/AI $\rightarrow$ $^7$Li($J' = 7/2$) + Be/C/AI (all remaining in GS) and observed a large spin-orientation \textit{parallel} to the beam-axis in all cases.

The experiment was conducted in the MARS beam line at Texas A&M in August 2015. The K500 was used to provide a primary 24 MeV/A $^7$Li beam.

We used two Si-Csl(Tl) telescopes mounted on a rail system. One telescope array was placed at 15 cm from the target and the other at 35 cm.

This dual-annular telescope system provided nearly complete azimuthal coverage and polar angular coverage of 1.8° to 16°, with a small gap at 5.7°.

Alignment Mechanism

The entrance and exit L-waves are the same but the projection has changed, i.e. the reaction plane has \textit{tilt}.

The large beam energy and small excitation energy forces the reaction plane to \textit{tilt} ($\Delta L = 0$, $M = \pm 2$) because of angular momentum and excitation energy matching.

Additional findings suggest coherent L-wave mixing washes out the oscillations of alignment in angle expected for a single L-wave.