Three-body breakup of $^{11}\text{Li}$ with the eikonal method

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Three-body model

The $^{11}\text{Li}$ breakup on a $^{208}\text{Pb}$ target 70 MeV/nucleon is studied in the eikonal approximation by using a $^{11}\text{Li}+\text{n}+\text{n}$ three-body description in hyperspherical coordinates. The breakup cross sections show a peak at low energies in correspondence with the experimental data. The calculated breakup cross section and angular distribution are in good agreement with the experimental data.

### Abstract

The idea is to solve the four-body Schrödinger equation $H_{AB}\psi = E\psi$, for $E < 0 \rightarrow$ Bound state, $E > 0 \rightarrow$ Scattering states, with the Hamiltonian $H_{AB} = \frac{\hbar^2}{2m}\left(\Delta_x + \Delta_y\right) + V_{\text{coul}} + V_{\text{cent}} + V_{\text{R}}$. We make the partial wave expansion $\psi^{(l)} = \rho^{-l/2} \sum_{\ell=0}^{\infty} \sum_{J=0}^{\infty} j_{\ell}(\rho)Y_{\ell}^{(l)}(\Omega)\psi_{\ell J}(\Omega)$, where $j_{\ell}(\rho)$ are the spherical Bessel functions (known functions) and $Y_{\ell}^{(l)}(\Omega)$ are the spherical harmonics (unknown functions).

### R-matrix

It allows to calculate continuum states with the correct asymptotic behavior. The unknown hyperradial wave function is found from the matching of the internal wave function with the external wave function in $r$.

### Breakup cross section

**Fig. 2.** Total (solid line) and partial wave decomposition (dashed lines).

**Fig. 3.** Elastic scattering of $^{11}\text{Li}$ (solid line) and $^{4}\text{He}$ (dashed line) on $^{208}\text{Pb}$.

Non negligible contributions of $0^+$ and $2^+$ off resonance.

Reduction of $^{11}\text{Li}+^{208}\text{Pb}$ elastic scattering that may due to flux going to the breakup channel.

### Eigenphases

**Fig. 4.** Total (full line) and $1^+$ contribution (dashed line).

Peak at low energies

Very good agreement with the experimental data

### Conclusions and Remarks

- Our prediction strongly suggests the existence of a $1^+$ resonance in correspondence with the experimental data.
- The present model allows to introduce other contributions in addition to $1^+$ that are far from negligible.
- We introduce an accurate 3B description of the continuum wave functions through the R-matrix method.
- Accurate projectile wave functions are needed for a precise description of the breakup.