Magnetic Feshbach resonances in ultracold collisions between Rb(^{2}S) and AlF($^1\Sigma^+$)

Masato Morita[1], **Sangami Ganesan-Santhi**[1], **Marcin Gronowski**[1], **Michał Tomza**[1 †]

[1]Faculty of Physics, University of Warsaw, ul. Pasteura 5, 02-093 Warszawa, Poland

†corresponding author's emails: michal.tomza@fuw.edu.pl

Feshbach resonance is a key concept in the research and engineering of ultracold atoms and molecules. In recent studies, Feshbach resonances are supposed to play a crucial role in the fast loss of ground state polar molecules from optical dipole traps when their two-body collisions are non-reactive. However, several discussions exist regarding the origin of the fast loss as well as the characteristics of the resonance states for atom-molecule and molecule-molecule collisions, including the distribution of the resonances [1, 2, 3, 4].

In this study, we explore magnetic Feshbach resonances for the ultracold s-wave collisions between Rb(^{2}S) and AlF($^1\Sigma^+$) on an *ab initio* potential energy surface by solving the coupled-channel equations with the converged basis set. As in the collisions between alkali atoms (^{2}S) and alkaline-earth atoms (^{1}S) [5, 6], geometry dependence of the hyperfine coupling parameters in the short range of the collision complex is essential for causing resonances.

All the resonances obtained by the present calculations are attributed to bound states whose energies and wavefunctions are highly sensitive to the coupling with various rotational states via the short-range anisotropy of the interaction potential. As a result, clusters of resonances associated with hyperfine couplings of three atoms are observed repetitively while sweeping the magnetic field, and the spacing between the clusters serves as the fingerprint of the short-range anisotropy of the potential. The critical importance of the coupling between rotational states in the short range for describing Feshbach resonances is consistent with the previous calculation results for Rb(^{2}S)+SrF($^2\Sigma^+$) [4].

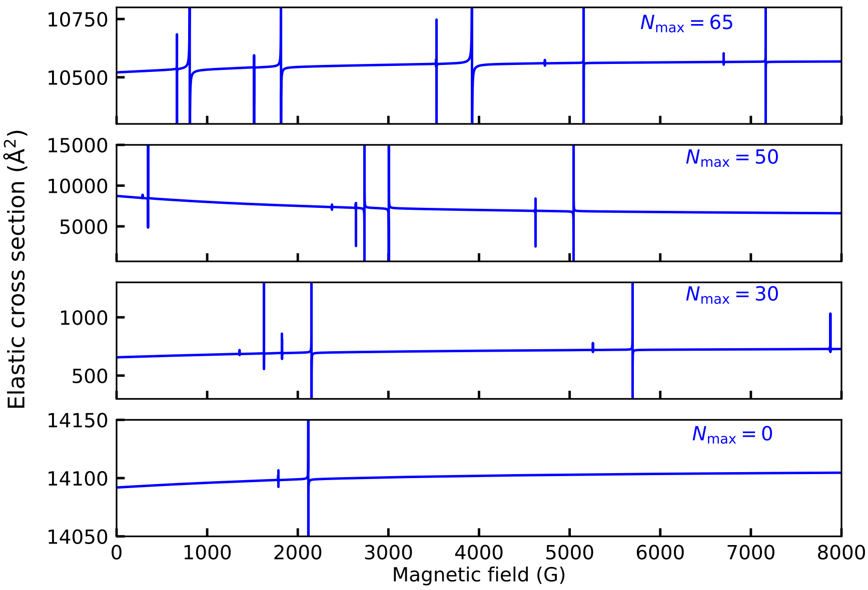

Figure 1: Elastic cross section as a function of magnetic field for the collisions between Rb and SrF(N = 0) in their lowest internal states. For the convergence, it is necessary to include the rotational states up to N_{max} = 65. The collision energy is $E_c = 0.1\mu$K. Grid interval of magnetic field is ΔB = 0.1 G.

Acknowledgments

We performed coupled-channel calculations by extending the code originally developed by Timur V. Tscherbul [7].

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