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Two-body description for the radiative capture reaction 6Li (p,gamma)7Be

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The 6Li abundance measured in the atmosphere of metal-poor stars is three orders of magnitude larger than predicted by the theory of Standard Big Bang Nucleosynthesis (SBBN) predictions [1]. Even if the results of the astronomical measurements are still under debate [2-4], the knowledge of the cross section (or astrophysical S-factor) of the reactions that contribute to determine the 6Li abundance is fundamental in order to distinguish between different explanations. Among these reactions, the radiative capture 6Li(p,gamma)7Be plays an important role.
Although this reaction was extensively studied experimentally [5-8],
very large uncertainties in the S-factor in the BBN energies (50-400 keV) are still present. A recent work [9] pointed out the presence of a possible resonance in the BBN energy window, that reduces the S-factor at zero energy. In order to solve this puzzle, a new campaign of measurement was performed by the LUNA collaboration. From the theoretical side many studies were performed using different approaches and inputs, like a two-body a phenomenological potential [10], an optical potential [11], a cluster model [12] and the Gamow shell model [13].
In this work, we try to improve the model used in Ref. [10].
We treat the problem as a two-body problem, using phenomenological
potentials to predict the S-factor. We fit the parameters of our potentials in order to reproduce the elastic scattering data of 6Li(p,p)6Li and the bound states properties of the 7Be. Solving the two-body Schroedinger equation, we evaluate the wave functions for the scattering and the bound states, which we use to predict the S-factor of the radiative capture reaction. The calculated S-factor can reproduce the energy behavior, but in order to agree with the experimental data we need to multiply the results by a spectroscopic factor. This is not surprisingly, since in this simple study we have neglected the internal structure of both 6Li and 7Be. The final results are in nice agreement with the available experimental data at stellar energies.

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