ROLE OF FUNDAMENTAL CONSTANTS IN BBN: WHAT CAN WE LEARN FROM NUCLEAR MODELS?

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Variations of fundamental constants, such as the fine structure constant or the quark masses, can be linked to variations of the deuteron binding energy B_D [1]. In nuclear physics, this quantity directly depends on the nucleon-nucleon (NN) interaction. Slight modifications of the NN interaction may significantly affect some reactions, in particular those presenting a low-energy resonance. In that case, the reaction rate is strongly sensitive to the resonance energy.

We focus here on the triple-α process, which essentially depends on the energy of the Hoyle state [2] (0^+_2 located 0.38 MeV above the 3α threshold). The ^{12}C nucleus is described by a microscopic three-cluster model [3], by using the Minnesota NN interaction [4]. This potential reproduces the experimental binding energy of the deuteron (B_D=2.22 MeV). By slightly renormalizing the NN interaction, we get simultaneous variations of B_D and of the $^{12}C(0^+_2)$ energy. Then we can analyse the triple-α reaction rate as a function of B_D. From a study of He burning in 15 solar mass stars, we conclude that physical variations of B_D should be in the interval $-0.023<\Delta B_D/B_D<+0.011$ [5].

Similar calculations have been performed on A=5 and A=8 nuclei [6]. An investigation of the $^{14}N(p,\gamma)^{15}O$ reaction rate is in progress.

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