Evaluation of Production Cross Sections of Li, Be, B in CR

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Abstract

Accurate evaluation of production cross sections of light elements is important for models of CR propagation, galactic chemical evolution, and cosmological studies. However, experimental spallation cross section data are scarce and often unavailable to CR community while semi-empirical systematics are frequently wrong by a significant factor. We use all available data from LANL nuclear database together with modern nuclear codes to produce evaluated production cross sections of isotopes of Li, Be, B suitable for astrophysical applications.

1. Introduction

The accuracy of the nuclear cross section calculations used in astrophysics is far behind the accuracy of recent CR measurements and clearly becomes a factor restraining further progress (see [4,5] for a discussion). Scarce cross section measurements alone can not be used to produce a reliable evaluation of the cross sections, while current nuclear codes and semi-empirical parametrizations also fall short of predicting cross section behavior for the whole range of target nuclei and incident energies. We use all available data (including cumulative and isobaric reactions, and reactions on natural samples of elements) together with modern nuclear codes to produce evaluated production cross sections of isotopes of Li, Be, B. Examples of using evaluated cross sections are given in [3,6].

2. Results

Figs. 1-3 show production cross sections of isotopes of Li, Be, B for most important channels where, at least, several data points are available. Our evaluated cross sections are shown together with data and results of frequently used semi-empirical systematics [10,14]. The individual cross section evaluations were tested against isobaric (A = 7, 10) and cumulative data where available. The low-energy part of production cross sections is often resonance-shaped, which may be important in case of reacceleration models [11]; this is usually ignored in propa-

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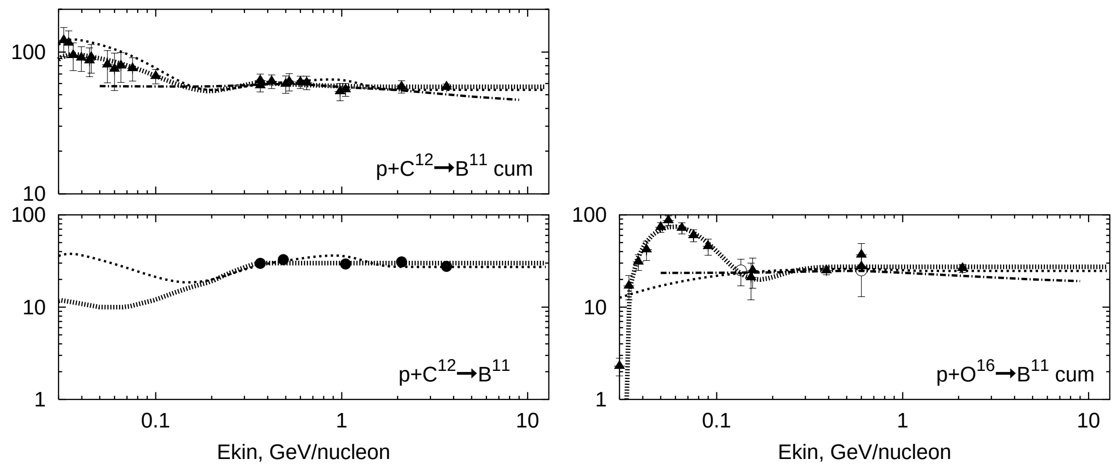

Fig. 1. The individual and cumulative production cross sections (mbarn) of B^{11} vs. kinetic energy. Lines: ||||| – evaluated cross sections, ••• – [10], -•- – [14]. Data: ▲ – isobaric cross section [9], ○ – cross section on a natural sample (compilation [2]), ● – individual cross section [1,7-9,12,13].

gation calculations. Some data on production of Li, Be, B in reactions with other nuclei can be found in [8,9,12,13] and in compilation [2].

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3. References

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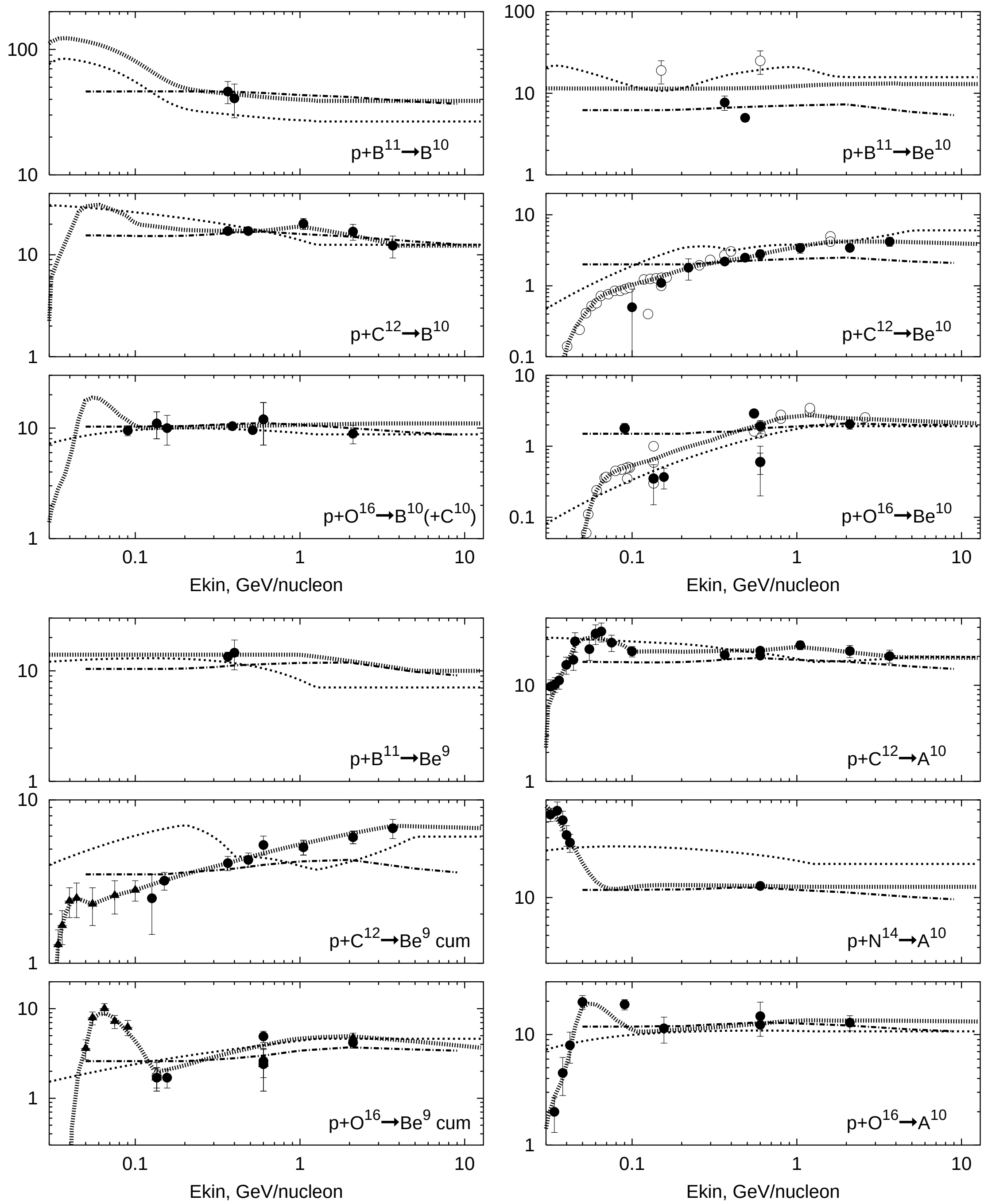

Fig. 2. The production cross sections (mbarn) of B^{10}, $Be^{9,10}$, and isobaric cross section A^{10}=C^{10}+B^{10}+Be^{10}. Lines and data symbols are coded as in Fig. 1.

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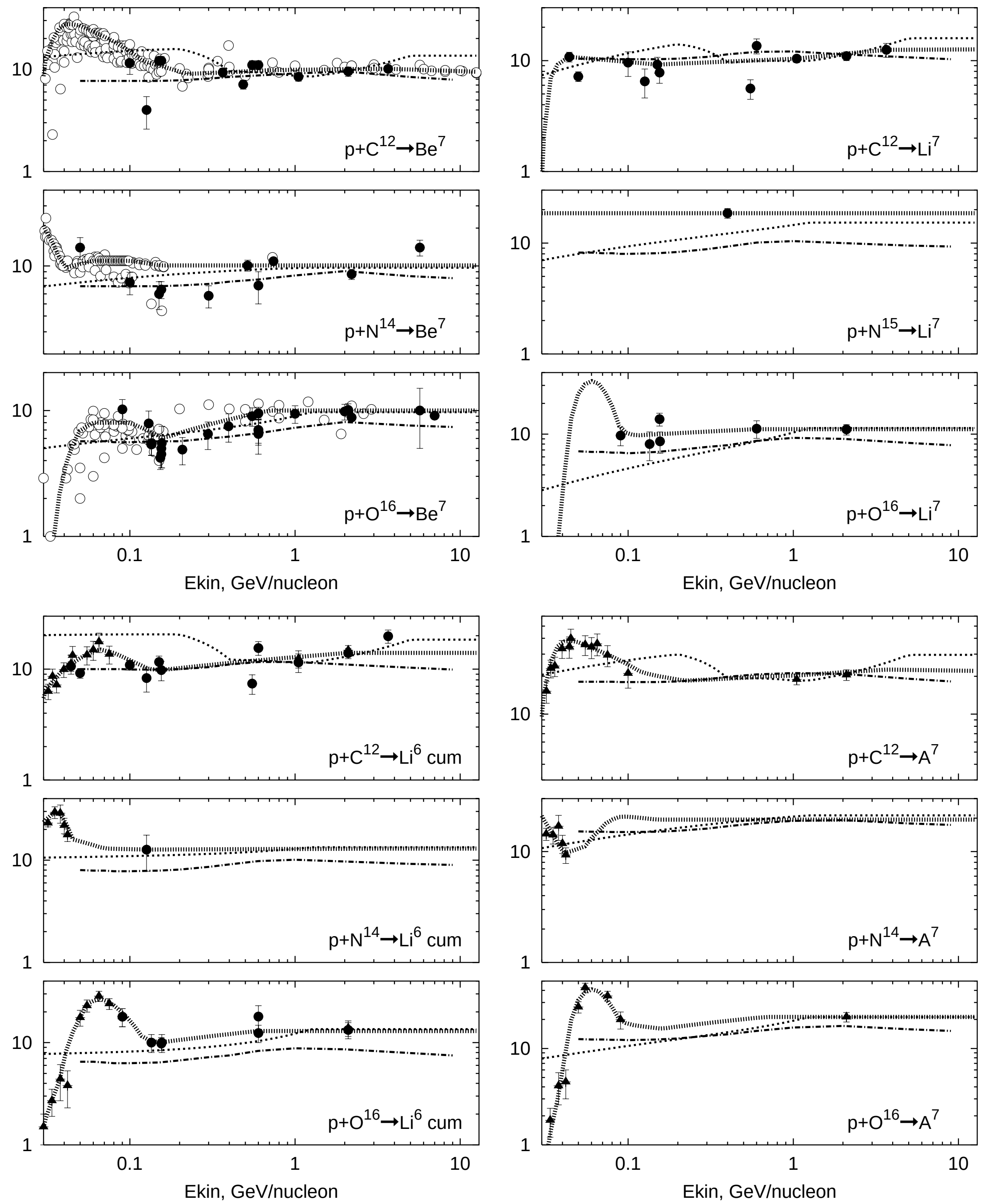

Fig. 3. The production cross sections (mbarn) of Be^7, $Li^{6,7}$, and isobaric cross section A^7=Be^7+Li^7+He^7. Lines and data symbols are coded as in Fig. 1.