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Nuclear Astrophysics with MINIBALL

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The origin in the cosmos of the so-called p nuclei is one of the most puzzling tasks to be solved by any model of heavy-element nucleosynthesis. These nuclei are by-passed by the s- and r-process pathways. To date, these nuclei have been observed only in the solar system. Understanding the synthesis of these p-process nuclei on the basis of astrophysical processes occurring outside the solar system, like e.g. in exploding supernovae (SNII) or on He-accreting white dwarves with sub-Chandrasekhar mass, which are both thought to be the most possible p-process sites, will enable us not only to understand the nuclidic composition of the solar system but also to further elucidate our fundamental picture of its creation.

Abundance calculations of the p nuclei make an extensive use of the nuclear statistical model for the calculation of the rates of an extended reaction network. Comparison with (p,gamma) and/or (n,gamma) cross section indicate that these rates can be predicted within a factor of two. However, some very scarce (alpha,gamma) data show that the reaction rates calculated using phenomenological alpha-particle optical potentials can be wrong by a factor of ten or more. These uncertainties might be reduced substantially by putting constraints on the alpha-particle optical potentials that are so far poorly known at such low energies (E<12 MeV). In order to achieve this goal, there exist different approaches, amongst which the (alpha,gamma) measurements at sub-Coulomb energies in inverse kinematics using state-of-the art detectors is the most transparent. The energies available at ISOLDE (<3 MeV/u) in combination with the MINIBALL array and radioactive beams may provide the most suitable experimental conditions to launch a nuclear astrophysics program aiming at the study of the alpha potential. In this direction some first ideas as well as first tests of the response of MINIBALL to capture events will be presented.

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