Contribution ID: **13** Type: **not specified**

In-flight beta-decay of light exotic nuclei

Monday 29 October 2012 11:30 (30 minutes)

The peculiar properties of light exotic nuclei have been investigated using nuclear reaction at high and intermediate energies. The extraction of reliable information on their structure, however, depends on reaction models; beta-decay studies can be seen as complementary in this context. The beta-decay process has the advantage of being well understood. The decay probability directly relates to the overlap between mother and daughter states. In light nuclei, especially close to the drip lines, beta-decay is characterized by large Q-values and low breakup thresholds in the daughter nuclei, so that feeding to unbound resonances and delayed emission of light ions becomes possible. In the case of halo nuclei, the same phenomenon could lead to direct decays to the continuum. The detection of the emitted particles serves at once for the identification of the decay paths, and to collect additional information about the structure of the populated states. Recent results include the study of the decays 6He [1], 11Li [2], 8B [3], and to states of astrophysical relevance on 12C [4].
The light-ion emission channels are characterised by a small relative momentum of the fragments, because of the small Q-values. This represents a challenge for conventional setups where the rare, low-energy signals of the ions are drowned in an overwhelming beta-background. In the Storage Ring at HIE-ISOLDE the nuclei would circulate at high velocity and decay in-flight. The light ions emitted in the exotic channels of interest would remain in a narrow cone around the beam axis, keeping a large forward momentum. They could then be identified in a charged-particle detection setup placed after a bend, where they would separate from the beam because of the different magnetic rigidity. Cases of interest at HIE-ISOLDE are 6He, 8He, the proton-emission decay of 11Be [5], the alpha-emission decay of 16N [6].

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