



Fourth International Conference on

SUPERSTRONG FIELDS IN PLASMAS

October 2010, Sunday 3 to Saturday 9
Villa Monastero, Varenna, Italy

Nuclear Physics experiments with high energy lasers

F.Hannachi, C.Plaisir, MM.Aléonard, F.Gobet, M.Tarisien

Centre d'Etudes Nucléaires de Bordeaux Gradignan, Université Bordeaux1, CNRS-
IN2P3 Route du solarium 33175 Gradignan France

V.Méot, G Gosselin and P.Morel

CEA, SPN, BP12 91680 Bruyères-le-Châtel, France

hannachi@cenbg.in2p3.fr, www.cenbg.in2p3.fr

Abstract

In the last decade, the development of high intensity lasers has opened up new opportunities for nuclear physics studies. Lasers are unique tools to produce hot and dense plasma and very high fluxes of photon or particle bunches in very short duration pulses. The possibility to combine in the same reaction chamber a moderate energy, short pulse high intensity laser with a high energy, long pulse laser makes it possible to study nuclear properties in extreme conditions which cannot be reached with conventional particle accelerators. It is then possible to create nuclei in isomeric states (IS) and investigate their decay properties in such hot and dense plasmas. In these new media, the interaction between the nuclei and their electronic cloud may modify nuclear properties such as apparent decay lifetimes. This is of prime importance in particular for the issue of energy storage in nuclei.

In the plasma, new decay modes appear such as induced photon emission, bound internal conversion. Other exotics decay modes are predicted which have not yet been observed. Furthermore, indirect decay channels may be opened for nuclear states with lifetimes longer than those of their neighbouring states (IS). If there exists a nuclear level lying above the isomeric level that may be excited from the isomeric state, and then decay down to the ground state, one may expect that this indirect decay mode may become significant when the plasma temperature is around the energy difference between the isomeric level and the upper level. However, if the multipolarity of the excitation transition of the intermediate level and of its decay are more favourable than that of the isomeric transition (the transition through which the IS decays), one may expect that the indirect decay mode becomes predominant at a lower temperature.

This indirect process would be a valuable tool to investigate nuclear excitations in plasmas and to test the predictions of the nuclear transition rate models. A physics case for such studies, based on the theoretical predictions of Gosselin et al, will be discussed together with the required experimental conditions.

