Probing α-clusters in medium/heavy nuclei by strong electromagnetic fields

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1) We investigate the influence of a strong laser electromagnetic field on the α-decay rate by using the Hennenberger frame of reference [1]. We introduce an adimensional parameter $D = S_0/R_0$, where R_0 is the geometrical nuclear radius and $S_0 \sim I^{1/2}\omega^{-2}$ a length parameter depending on the laser beam intensity I and frequency ω. The barrier penetrability has a strong increase for intensities corresponding to $D > D_{crit} = 1$, due to the fact that the resulting Coulomb potential becomes strongly anisotropic even for spherical nuclei. As a consequence, the contribution of the monopole term increases the barrier penetrability by two orders of magnitude, while the total contribution has an effect of six orders of magnitude at $D \sim 3D_{crit}$. In the case of deformed nuclei, the electromagnetic field increases the penetrability by an additional order of magnitude for a quadrupole deformation $\beta_2 \sim 0.3$. The influence of the electromagnetic field can be expressed in terms of a shifted Geiger-Nuttal law by a term depending on S_0 and deformation.

2) Alpha clusters are born in nuclei at low densities, the wave function being a Gaussian peaked on the nuclear surface and therefore corresponding to a local pocket-like potential. The α-particle formation probability reaches the largest value in the "α-decay island" above ^{100}Sn for $N \sim Z$ nuclei [2] and therefore the clusters can be easier detected. We show that the shape of the α-cluster can be determined by exciting it to the first resonant state inside the pocket-like potential, using a quasi-monochromatic γ-beam. The position and width of this "alpha-like pygmy" resonant state [3] can be predicted by using the α-decay systematics to ground and excited states [4]. As a consequence, the half life from this excited state becomes shorter by several orders of magnitude.

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[2] V.V. Baran and D.S. Delion, *Proton-neutron versus alpha-like correlations above ^{100}Sn*, Phys. Rev. C **94**, 034319 (2016).

[3] V.V. Baran and D.S. Delion, *Alpha-like resonances in nuclei*, J. Phys. G (in press). http://iopscience.iop.org/article/10.1088/1361-6471/aa98c7

[4] D.S. Delion, *Universal decay rule for reduced widths*, Phys. Rev. C **80**, 024310 (2009).