Signatures of α-condensation in N=Z nuclei and coherent emission of 2α- and 3α-clusters from excited compound nuclei

W. von Oertzen[1,2]
[1] *Helmholtz-Zentrum Berlin, Glienicker Strasse 100, D-14109 Berlin, Germany and*
[2] *Freie Universität Berlin, Fachbereich Physik,*

Conditions for a phase change in N=Z nuclei with the formation of an α-particle condensate, a dilute Bose-Gas in excited states, are discussed for excitation energies with $E_{B\alpha}/N_\alpha = 0$, i.e. at and above the thresholds [1, 2]. This phase transition is of second order in a mixture of fermions and α-particles. The de-Broglie wavelength of relative motion for these α-particles is much larger then the nuclear radii. The condensed states appear at the mentioned thresholds, which correspond to excitation energies of 80-100 MeV. Such states can also be defined for α-particles surounding a strongly bound core with N=Z, eg. ^{16}O and ^{40}Ca, in these cases the thresholds are slightly lower. The experimental observation of the decay of such condensed α-particle states is proposed, with the coherent emission of several correlated α-particles, a decay not described by the Hauser-Feshbach approach for compound nucleus decay. These features imply the favoured emission into the same angle and the formation of the resonances of ^{8}Be and ^{12}C$^{*}(0_2^+)$. Because of the large diffuseness of the condensed states the compound decay will occur through lower emission barriers as compared to the normal compound nucleus. Examples of such observations with the enhanced emission of the unbound resonances in the form of ^{8}Be and ^{12}C$^{*}(0_2^+)$ - clusters will be given. The experiments involved the ISIS-GASP-detection systems at Laboratorii Nationale di Legnaro, [1, 3], ^{32}S + ^{24}Mg reactions with ^{56}Ni at E$_{ex}$ = 75 - 80 MeV. Based on these observations the planning of future experiments can be formulated. The optimum experiment involves a highly granulated particle ball with $\Delta E - E$ detectors combined with a highly efficient gamma-detection array.

---

[1] Y. Funaki *et al.*, Phys. Rev. **80**, 064326 (2009)
[2] W. von Oertzen, Eur. Phys. J. A **29**, 133 (2006).
[3] Tz. Kokalova, W. von Oertzen, *et al.*, Eur. Phys. J. A **23**, 19 (2005).

.

PACS numbers: