

## Role of $\alpha$ -clustering in nuclear fission

**G.G. Adamian**

Joint Institute for Nuclear Research, 141980 Dubna, Russia

### Abstract

Using the scission-point fission model, we demonstrate the influence of the  $\alpha$ -clustering mechanism on the formation of mass, charge, total kinetic energy (TKE), and neutron multiplicity distributions in the spontaneous fission (SF) of  $^{256}\text{Fm}$  and  $^{258}\text{Fm}$  nuclei which exhibit completely different SF characteristics [1, 2]. The  $\alpha$ -particle seems to act as a catalyst in these nuclear reactions. For example, we show that taking into account  $\alpha$ -clustering in the scission configuration results in a strong broadening of the TKE distribution of fission fragments and a significant change in the mass distribution near symmetry. This leads to a substantial improvement in describing experimental data. The unusually narrow symmetric mass distribution of  $^{258}\text{Fm}(\text{sf})$  is related to  $\alpha$ -clustering of heavy fragment in the dinuclear system  $\text{Cd}+\text{Te}$  and formation of the trinuclear system  $\text{Cd}+\alpha+\text{Sn}$  and their binary decays leading to the formation of  $\text{Sn}$  fragments. The large variation of the TKE distribution is also explained by existence of fission pathway through the binary scission of trinuclear systems. Predictions for some observables are presented that may be experimentally verified. For  $^{258}\text{Fm}(\text{sf})$ , the TKE and neutron multiplicity distributions are decomposed into three components corresponding to the super-long, asymmetric short, and symmetric super-short modes. By utilizing the TKE and neutron multiplicity distributions for  $^{258}\text{Fm}(\text{sf})$ , the super-long mode can be distinguished from the symmetric super-short and asymmetric short modes. It can be suggested that the super-long mode has an  $\alpha$ -cluster nature. Since the super-long mode has also been observed in the induced fission of actinides, it can be concluded that  $\alpha$ -clustering is a universal phenomenon in the fission process.

### References

- [1] H. Paşca, G.G. Adamian, and N.V. Antonenko, Phys. Lett. B **870** (2025) 139943.
- [2] H. Paşca, G.G. Adamian, and N.V. Antonenko, Phys. Rev. C **114**, (2026) *in print*.