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Original Article

# Neuro-fuzzy modeling of deformation parameters for fusion-barriers

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## Abstract

The fusion-barrier distribution is very sensitive to the structure of the colliding nuclei such as nuclear quadrupole and hexadecapole deformation parameters and their signs. If the nuclei that enter the fusion reaction are deformed, the barrier problem becomes complicated. Therefore the deformation parameters are taken into account in the calculations. In this study, Neuro-Fuzzy approach, ANFIS, method has been used for the estimation of ground-state quadrupole ($\varepsilon_2$) and hexadecapole ($\varepsilon_4$) deformation parameters for the nuclei. According to the results, the method is suitable for this task and one can confidently use it to obtain the data that is not available in the literature.



## Keywords

Deformation deformation; Nilsson parameters; Artificial intelligence; ANFIS

## 1. Introduction

In the fusion process [1], a compound nucleus is formed after overcoming a fusion barrier created between nuclei from repulsive Coulomb and attractive nuclear forces. The fusion barrier distribution [2] which is important for the understanding of fusion mechanism is sensitive to the data related to some nuclear properties such as the nuclear shapes, deformations, multiple excitations and the nuclear surface vibrations [3]. This distribution not only depends on the static quadrupole deformation but also on the hexadecapole deformation [4]. Furthermore, the fusion cross-section depends on the ground-state shapes of the nuclei related to the deformation parameters [5]. Fusion cross-sections have been increased in energies around the Coulomb barrier compared to the estimation of a simple potential model as a result of Coulomb barrier distribution depending on the deformed target nucleus orientation [6,7]. By using spherical projectile and target nuclei, the fusion-barrier penetration problem is easy whereas if the nuclei are deformed, the problem becomes complex [8]. For the detailed information about the effect of the shapes on the fusion-barrier distributions and the fusion-cross section, we refer the reader to Iwamoto [9].