2004 Vol.42 No.4 pp.594-598 DOI:

Fusion Barrier of Super-heavy Elements in a Generalized Liquid Drop Model

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(Received: 2004-3-3; Revised:)

Abstract: The macroscopic deformed potential energies for super-heavy elements Z=110,112,114,116,118 are determined within a generalized liquid drop model (GLDM). A quasi-molecular mechanism is introduced to describe the deformation of a nucleus in the GLDM and the shell model simultaneously. The macroscopic energy of a two-center nuclear system in the GLDM includes the volume-, surface-, and Coulomb-energies, the proximity effect at each mass asymmetry, and accurate nuclear radius. The shell correction is calculated by the Strutinsky method and the microscopic single particle energies are derived from a shell model in an axially deformed Woods-Saxon potential with the quasi-molecular shape. The total potential energy of a nucleus can be calculated by the macro-microscopic method as the summation of the liquid-drop energy and the Strutinsky shell correction. The theory is applied to predict the fusion barriers of the cold reactions ^{64}Ni+^{208}Pb\rightarrow ^{272}110*, ^{70}Zn+^{208}Pb\rightarrow ^{278}112*, ^{76}Ge+^{208}Pb\rightarrow ^{284}114*, ^{82}Se+^{208}Pb\rightarrow ^{290}116*, ^{86}Kr+^{208}Pb\rightarrow ^{294}118*. It is found that the neck in the quasi-molecular shape is responsible for the deep valley of the fusion barrier. In the cold fusion path, double-hump fusion barriers could be predicted by the shell corrections and complete fusion events may occur.

PACS: 25.60.Pj, 25.70.Jj, 27.90.+b,

Key words: generalized liquid drop model, super-heavy elements, fusion barrier