

SPONTANEOUS SYMMETRY BREAKING AS A LAW OF NATURE

Isaac Bersuker 

Institute of Chemistry, Moldova State University, 3, Academiei str., Chisinau MD-2028, Republic of Moldova
Oden Institute, The University of Texas at Austin, Austin TX, USA
e-mail: bersuker@cm.utexas.edu

Abstract. In a semi-review paper, it was discussed the notion of symmetry of polyatomic systems defined as invariance under transformations, and show that this important property of atomic matter is extremely vulnerable, and may undergo internal breakdown, subject to the presence of electronic degeneracy or pseudodegeneracy. First formulated by Landau, L. in 1934, later proved and published by Jahn and Teller, this Jahn-Teller effect (JTE) underwent tremendous developments with important applications in physics, chemistry, biology, and materials science. Less attention was paid to the roots of this phenomenon and its correct interpretation in the sense of its influence on observable properties. It is shown that electronic degeneracy and its extended form, called pseudodegeneracy, are actually the only source of spontaneous symmetry breaking (SSB) in nature, including all forms of matter, beginning with elementary particles, via nuclei, atoms, molecules, and solids. Theoretically, the vulnerability of the notion of symmetry is due to the fact that, following quantum mechanics, the separation of the motion of electrons and nuclei (and, similarly, the separation of motions of elementary particles) is approximate, and hence the classical notion of polyatomic space configuration is approximate too, with SSB as one of its main violation.

Keywords: adiabatic potential, electronic degeneracy, Jahn-Teller effect, pseudo Jahn-Teller effect, spontaneous symmetry breaking.

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