Numerical simulation of microscopic plasticity

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The Lecture studies the numerical model for microscopic simulation of plasticity. The isotropic homogeneous elastic medium is subjected transition from Euclidean to Riemann-Cartan internal geometry. The deformation of elastic medium without defects is based on Euclidean geometry in three dimensional space. The deformation of elastic medium with defects is based on Riemann-Cartan geometry and is interpreted in this Article, as different phase state. In this article, the expression for the free energy leading is equal to a volume integral of the scalar function (the Lagrangian) that depends on metric and Ricci tensors only. In the linear elastic isotropic case the elastic potential is a quadratic function of the first and second invariants of strain and warp tensors with two Lame, two mixed and two bending constants. The conditions of stability of media are derived using expressions of free energy in two alternative phases. Initially the defect-free phase is stable and remains stable, when the strain is considerably small. With the increasing strain the stability conditions could be violated. If the strain in material attains the critical value, the pure geometric instability occurs. In other words, the medium undergoes the spontaneous symmetry breaking in form of emerging topological defects and transition to plastic flow. The results of numerical modeling of plastic transitions are delivered for different initial strain states