Contribution ID: **27** Type: **not specified**

On reduction of general three-body Newtonian problem and curved geometry

The general three-body problem is a typical example of a dynamic system with non-trivial behavior and its study is topical up to now in the celestial mechanics and in other fields of physics and chemistry. After the foundation by Newton of classical mechanics, for the past several centuries a huge number of theoretical and numerical studies of this problem have been carried out. In particular, it has been proved theoretically that the general three-body problem is characterized by 12 integrals of motion, using which the initial 18-th order system is reduced to an autonomous 8-th order system. Moreover, till now, there is no strict proof that the general three-body problem can be reduced up to the autonomous 8-th order system, nor any proof that this problem cannot be reduced to 6-th order. In considering this problem, we put the question: can we by changing the geometry of the problem disclose any hidden additional symmetry in the problem? Obviously, this would allow to bypass the problem when there is no involution between certain integrals of motion and do a more complete reducing of the problem, that is reduce the dimensionality of the problem as much as is the number of integrals of motion.

In the present work the dimensionality reduction of the general three-body classical problem is considered in the framework of the ideas of separation of the internal and external motions of the body-system. We have proved that for a Hamiltonian system in the general case there exists equivalence between phase trajectories and geodesics ones on the Riemannian manifold M (the energy hypersurface of the three-body system). This allowed to formulate the classical three-body problem as a geodesic flow on the manifold M, in the framework of six ordinary differential equations (ODEs) of the second order. It is shown that when the total potential of a body-system depends on the relative distances between particles, the system of geodesic equations conditionally splits into two subgroups of symmetric equations to which only the total angular momentum of the system belongs. The latter is a result of introducing of curved geometry and, correspondingly, the local coordinate frame, and solves the problem of noninvolution of some integrals of motion. However, the main achievement of the approach is that it enables in the general case to solve exactly three nonlinear equations, describing rotational motion of a triangle formed by three bodies, from six ones. The remaining three nonlinear equations describe the internal motion of the three-body system and are easily transformed to a system of Riccati equations. Thus, it is proved that the general three-body classical problem can be reduced to a system of three nonlinear ODEs that in phase space is equivalent to autonomous system of the sixth-order. The developed approach forces to consider from another angle the problems of curved geometry in the theory of gravitation, and in physics in general.

Author: Prof. GEVORKYAN, Ashot (Joint Institute for Nuclear Research)

Presenter: Prof. GEVORKYAN, Ashot (Joint Institute for Nuclear Research)