GEOMETRY AND DYNAMICS OF NONHOLONOMIC SYSTEMS

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In mechanics, a nonholonomic constraint is a restriction on the possible velocities of the system without restricting its possible configurations. An example of this is the possibility to manoeuvre a car into parallel parking despite the nonholonomic constraint that prohibits the lateral displacement of its wheels. These type of constraints have important applications in control theory and robotics.

The study of nonholonomic systems is challenging because their equations of motion do not come from a variational principle and, as a consequence, do not possess a Hamiltonian structure. Therefore, many of the properties of the solutions remain poorly understood and the subject remains an active field of research.

The course will begin by describing the underlying physical principles of the theory and the structure of the equations of motion.

I will then present a survey of known results on the existence of first integrals, the existence of smooth invariant measures, integrability, and the process of Hamiltonization that refers to the possibility of formulating of the equations of motion in Hamiltonian form in a symmetry reduced phase space.

The material of the course will be motivated and illustrated with a large number of examples.