Contribution ID: **43** Type: **not specified**

Poncelet property and quasi-periodicity of the integrable Boltzmann system

Thursday, July 1, 2021 10:20 AM (40 minutes)

The integrable Boltzmann system describes the motion of a particle in a plane subject to an attractive central force with inverse-square law on one side of a wall at which the particle is reflected elastically. This model is a special case of a class of systems, involving also an inverse-cube law centrifugal force, considered by L. Boltzmann to illustrate his ergodic hypothesis. The system without centrifugal force was recently shown by G. Gallavotti and I. Jauslin to admit a second integral of motion additionally to the energy. By recording the subsequent positions and momenta of the particle as it hits the wall, we obtain a three-dimensional discrete-time dynamical system. We show that this system has the Poncelet property: if for given generic values of the integrals one orbit is periodic, then all orbits for these values are periodic and have the same period. We also prove a conjecture of Gallavotti and Jauslin on the quasi-periodicity of the integrable Boltzmann system, implying the applicability of Kolmogorov-Arnold-Moser perturbation theory to the Boltzmann system with weak centrifugal force. As in the analogous case of the Poncelet porism, which I will review, the results rely on the theory of elliptic curves.

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