Dynamics of a Homogeneous Ball on a Rotating Cylinder

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In this work we consider the problem of a homogeneous ball rolling on the inner surface of a circular cylinder. The system is placed in a gravity field parallel to the axis of the cylinder. The cylinder's axis moves with plane-parallel motion along a fixed circle, while the cylinder does not rotate about its own axis.

The equations of motion of the system considered are integrated by quadratures, and the possibility of the ball moving downward or upward along the cylinder's axis is examined in detail.

It turns out that, by making the supporting cylinder execute circular motions, it is impossible to achieve an unbounded elevation of the ball along the cylinder. In the general case, the ball will execute quasi-periodic motions without drifting in the vertical direction either upward or downward (see Fig. 1, left). However, in contrast to a fixed (or rotating) cylinder, there exist resonances at which the ball moves on average downward with constant acceleration (see Fig. 1, right).
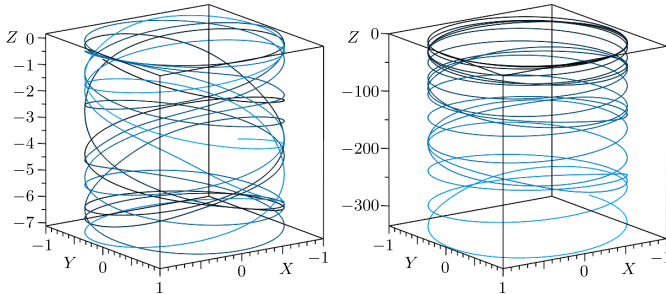

Figure 1. An example of the trajectory of the center of the ball in the general case (left) and in the resonant case (right).

The results of the work were published in [1].
This is a joint work with Alexander Kilin.

References

[1] Kilin A. A., Pivovarova E. N., Ivanova T. B., Rolling of a Homogeneous Ball on a Moving Cylinder, *Regul. Chaotic Dyn.*, 2025, vol. 30, no. 4, pp. 628–638.