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Multiplicity of periodic solutions for the forced conservative pendulum under relativistic effects

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Abstract

In this talk we will show that the periodic problem for the relativistic forced pendulum equation with a derivative dependent coefficient

$$\left(\frac{u'}{\sqrt{1-u'^2}}\right)' + \frac{a}{\sqrt{1-u'^2}} \sin u = f(t), \quad u(0) = u(T), \quad u'(0) = u'(T),$$

has at least two geometrically distinct solutions when f has mean value zero. Surprisingly, in spite of its apparent lack of variational structure, we will show that the unforced equation ($f = 0$) is conservative and that that the forced one does, in fact, admit a proper Lagrangian formulation: we find a functional \mathcal{I}_R defined on the Sobolev space H_T^1 whose critical points are periodic solutions of the problem. Then, a multiplicity theorem based on Lusternik–Schnirelman category, [2], will allow us to obtain the existence of two geometrically distinct critical points of \mathcal{I}_R .

This talk is based on joint work with Pablo Amster and Jean Mawhin, [1].

References

- [1] P. Amster, J. Á. Cid and J. Mawhin, Periodic solutions of the forced conservative pendulum with relativistic acceleration and derivative dependent coefficient, *J. Differ. Equ.* **454** (2026), 113965.
- [2] J. Mawhin and M. Willem, *Critical Point Theory and Hamiltonian Systems*, Springer, New York, 1988.

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