Applications of Computer Algebra – ACA 2025
July 14-18, 2025
Session on *"Computer Algebra Modeling in Physics, Classical and Celestial Mechanics, and Engineering"*

An overview of averaging methods in Hamiltonian perturbation theory, using a CAS

José A. Vallejo[1] [jvallejo@mat.uned.es]

[1] Fundamental Mathematics Department, Universidad Nacional de Educación a Distancia, Madrid, Spain

The Hamiltonian formalism is particularly well-suited for employing perturbation techniques. A widely used procedure involves transforming the system under consideration into its normal form [1], followed by the application of an averaging method to derive an approximate dynamics [2]. The computations in this latter stage can become quite cumbersome to perform manually, making it an ideal context to leverage the capabilities of a Computer Algebra System (CAS). In this talk, I will describe several examples illustrating the existence of stable closed orbits within seemingly chaotic systems, using these concepts and the free CAS Maxima [3,4].

Keywords
Normal forms, Averaging methods, Closed orbits

References
[1] M. Avendaño-Camacho, J. A. Vallejo, Yu. Vorobiev: A simple global representation for second-order normal forms of Hamiltonian systems relative to periodic flows. Journal of Physics A: Mathematical and Theoretical 2013 DOI: 10.1088/1751-8113/46/39/395201
[2] M. Avendaño-Camacho, J. A. Vallejo, Yu. Vorobiev: Higher order corrections to adiabatic invariants of generalized slow-fast Hamiltonian systems. Journal of Mathematical Physics 2013 DOI: 10.1063/1.4817863
[3] M. Avendaño-Camacho, J. A. Vallejo, Yu. Vorobiev: A perturbation theory approach to the stability of the Pais-Uhlenbeck oscillator. Journal of Mathematical Physics 2017 DOI: 10.1063/1.5000382
[4] M. Avendaño-Camacho, M. A. Manotas, J. A. Vallejo: Closed stable orbits in a strongly coupled resonant Wilberforce pendulum. Journal of Vibration and Control. 2022-04 DOI: 10.1177/1077546320986023