COHEN Romain
RENAUD Jules
Spring 2026

Sorbonne Université – Bachelor Project

Chaotic Bouncing Ball

1) Experimental Study
2) Numerical Study

Supervising professors – Lionel FORET, Benoît FORGET

Experimental Study
a) Set Up

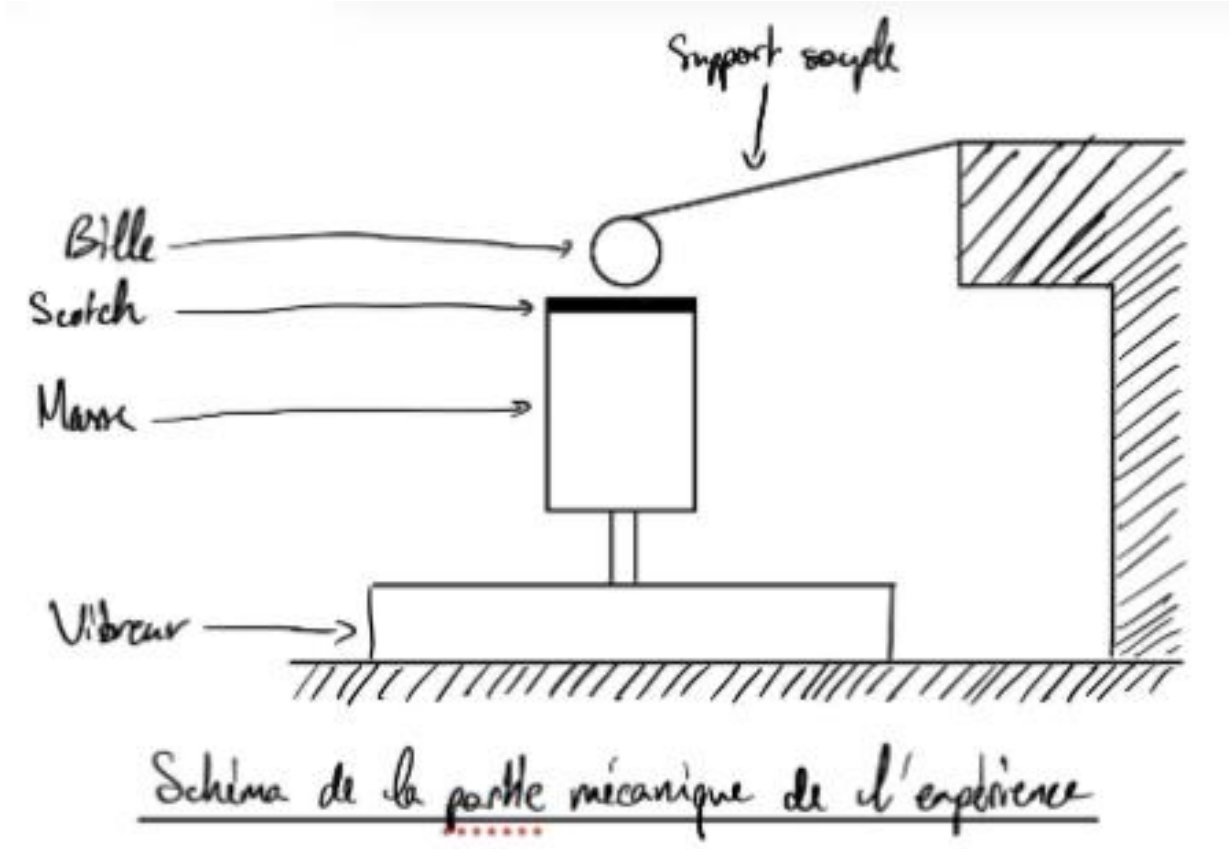
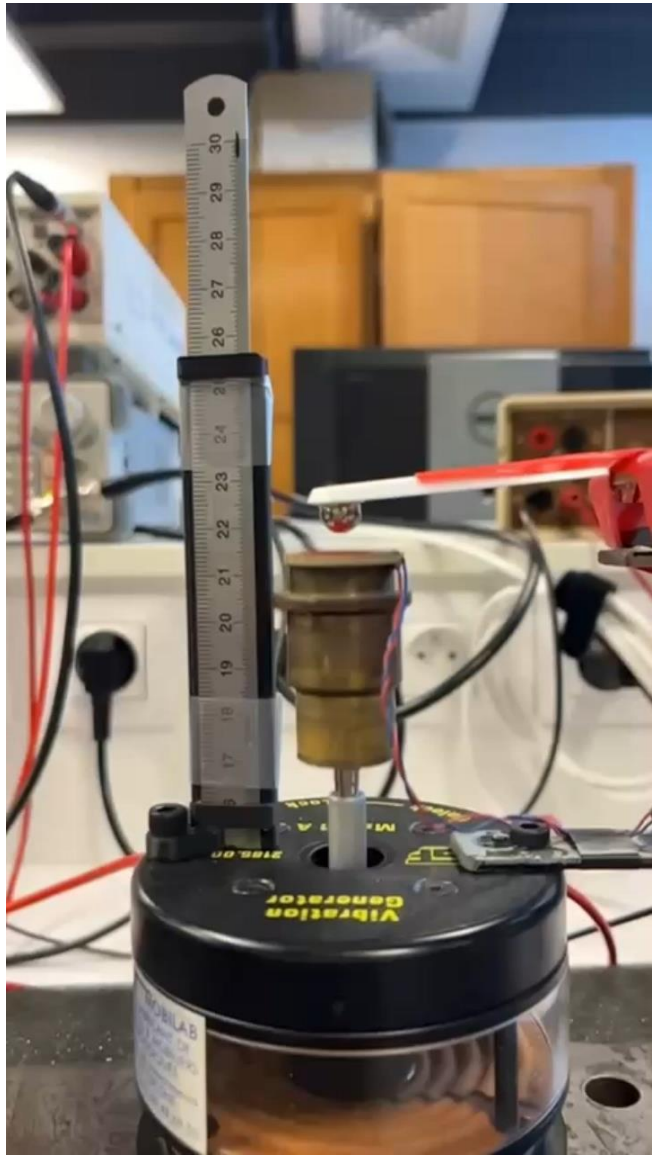


Schéma de la partie mécanique de l'expérience



Experimental Study
b) Bifurcation Diagram

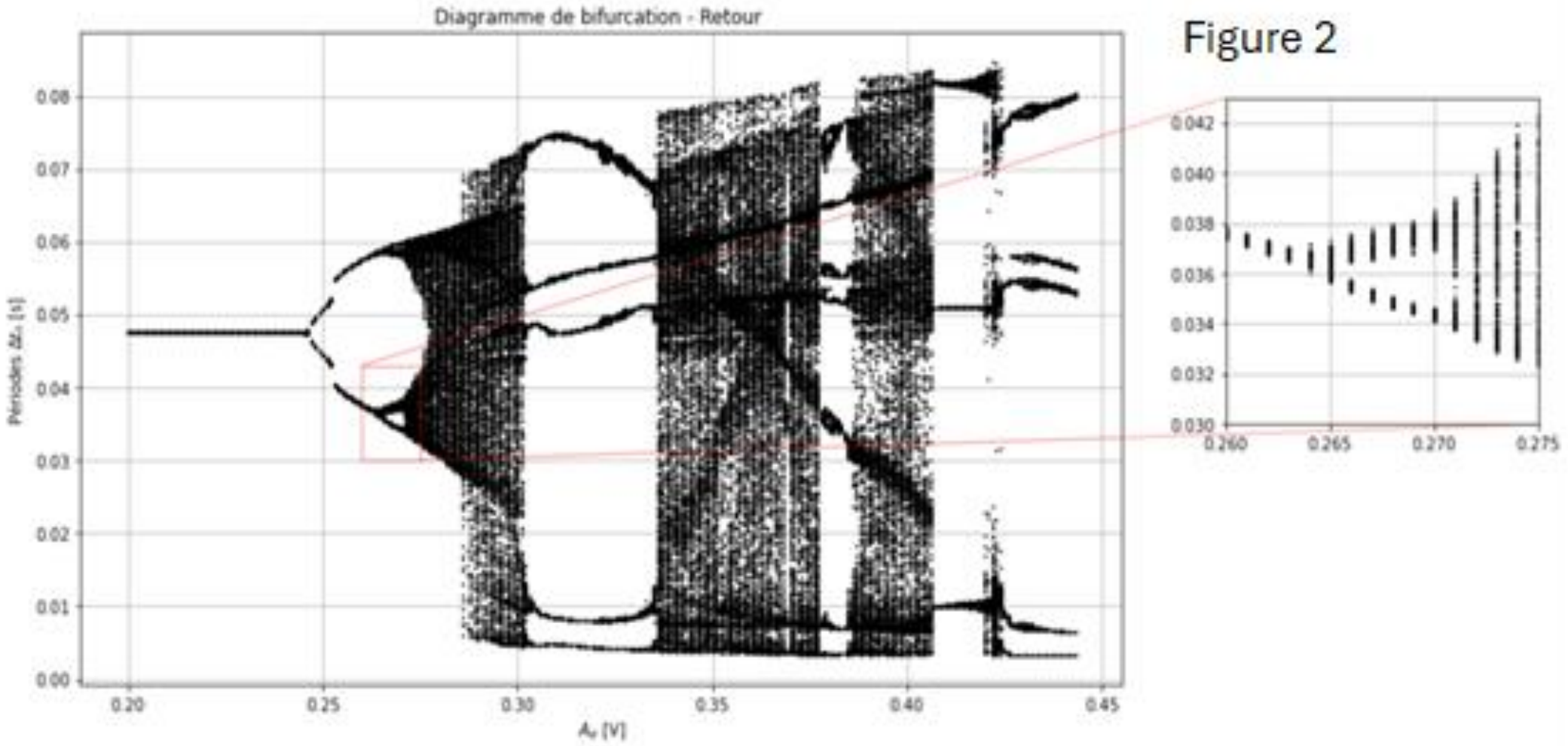


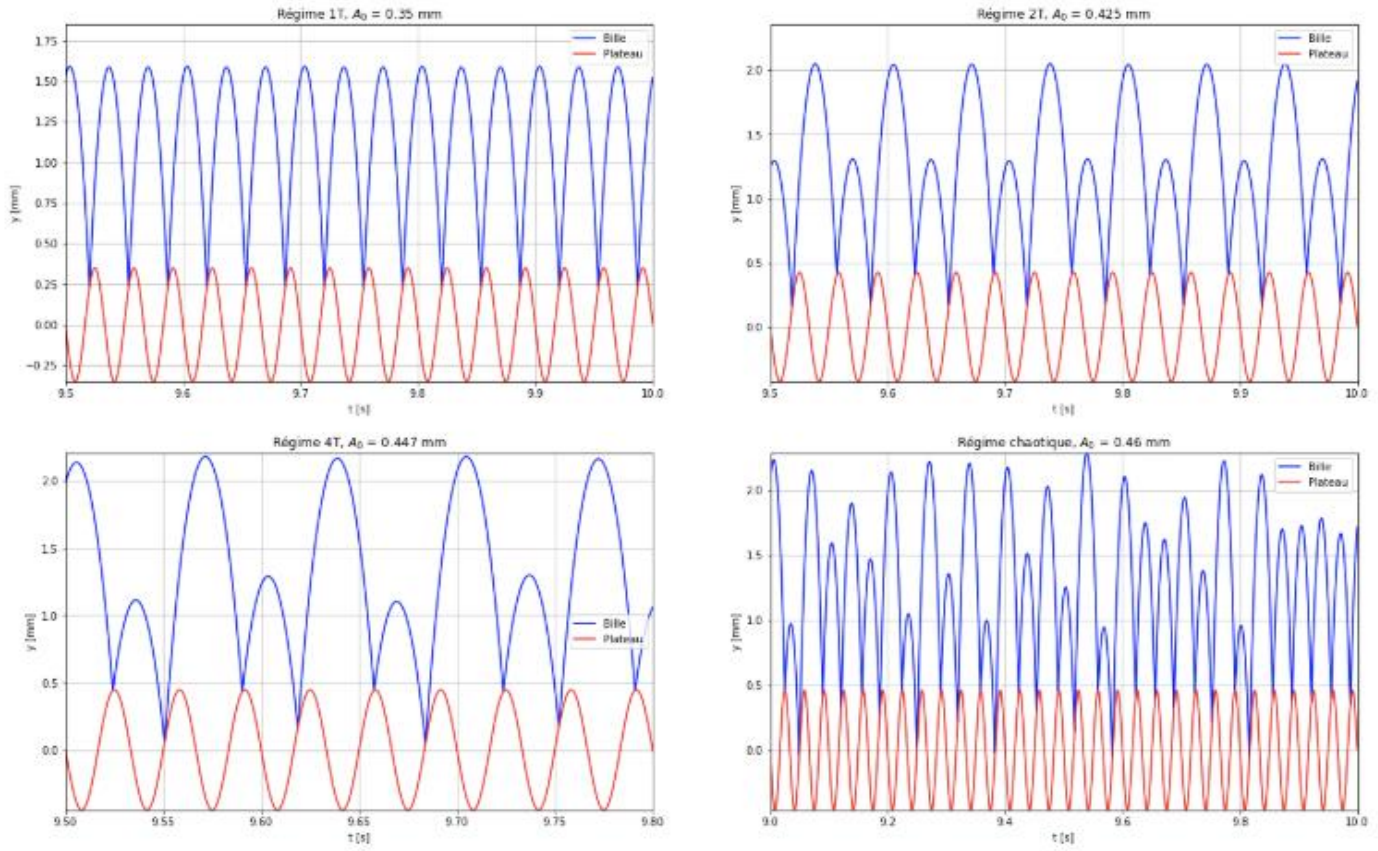
Figure 2

Numerical Study
a) Python Model

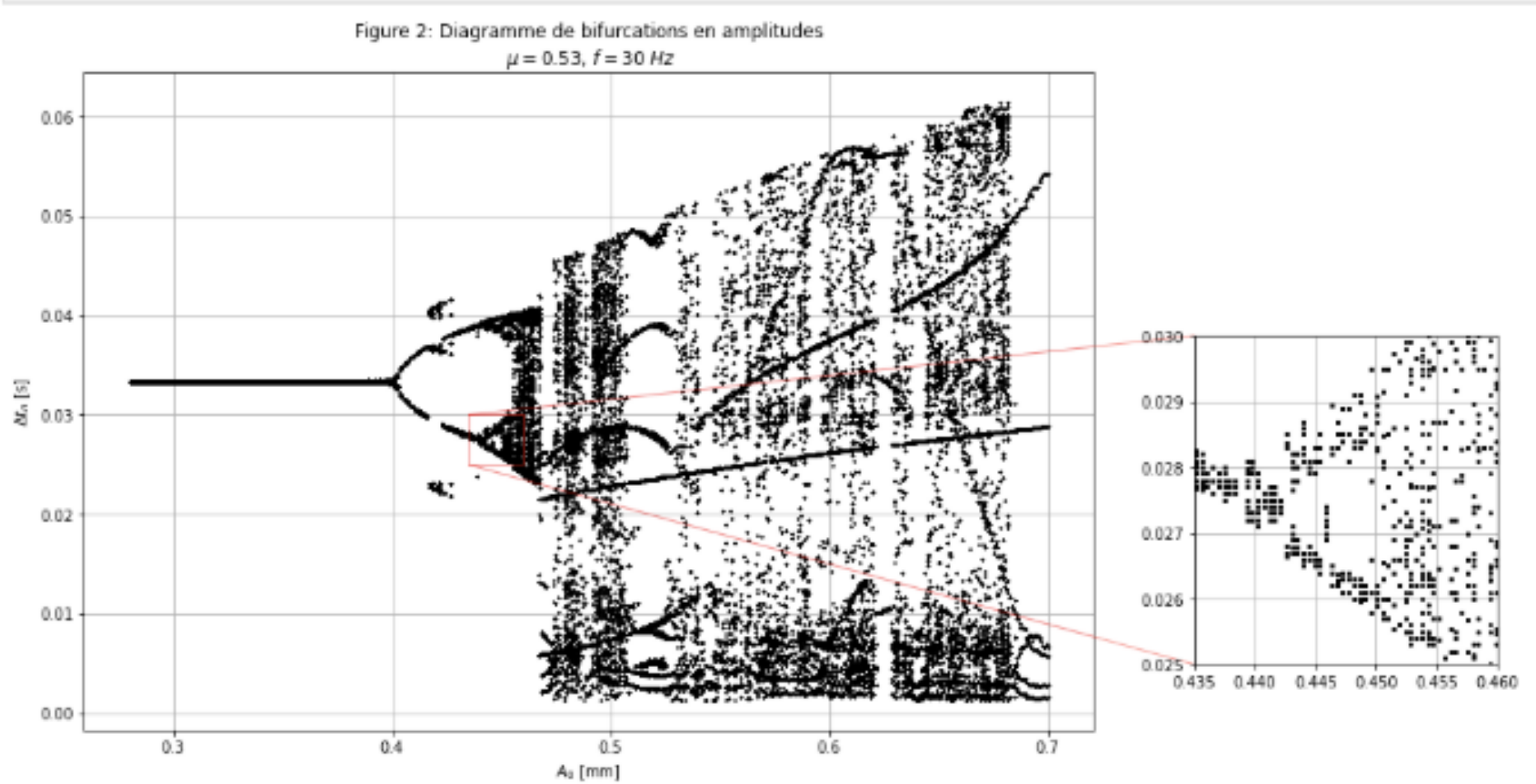
Collision equation :

$$v_n - v_P(t_n) = -\mu\left(v_{B,n-1}(t_n) - v_P(t_n)\right)$$

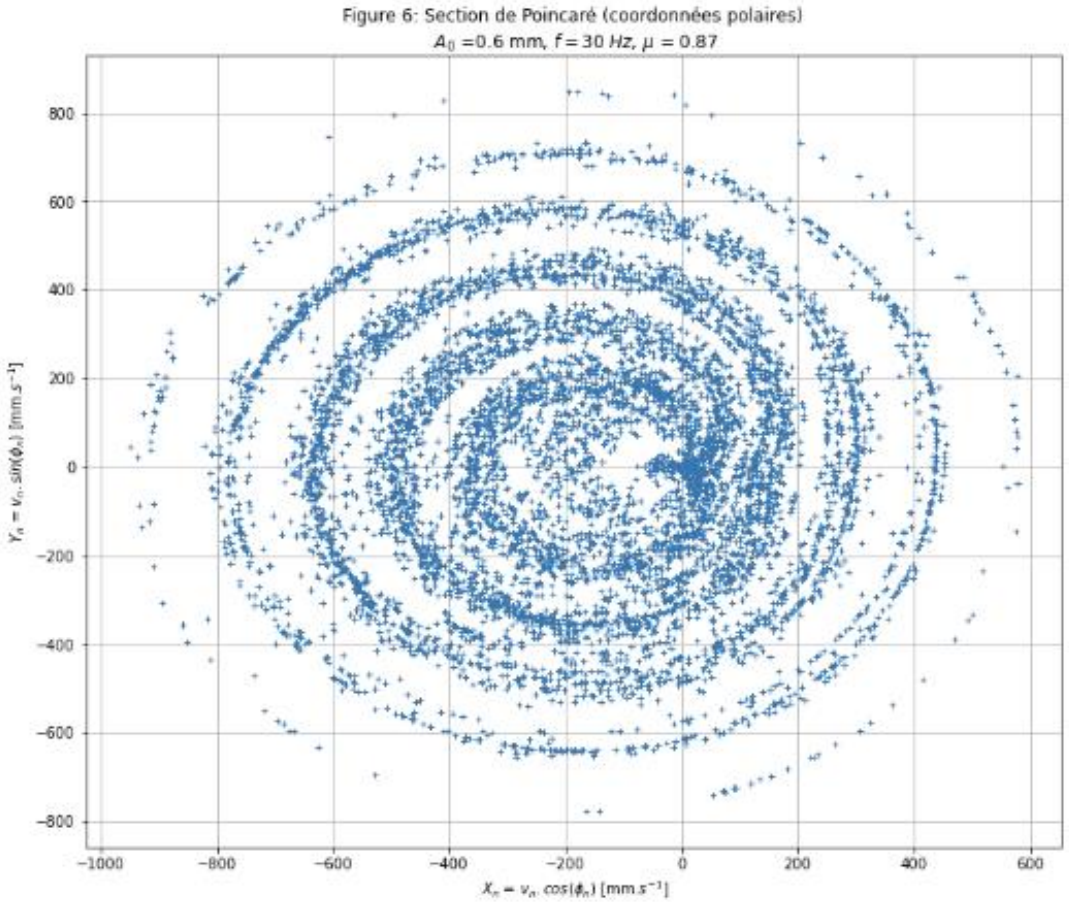
Figure 1: Exemples de dynamiques de la bille en régime permanent

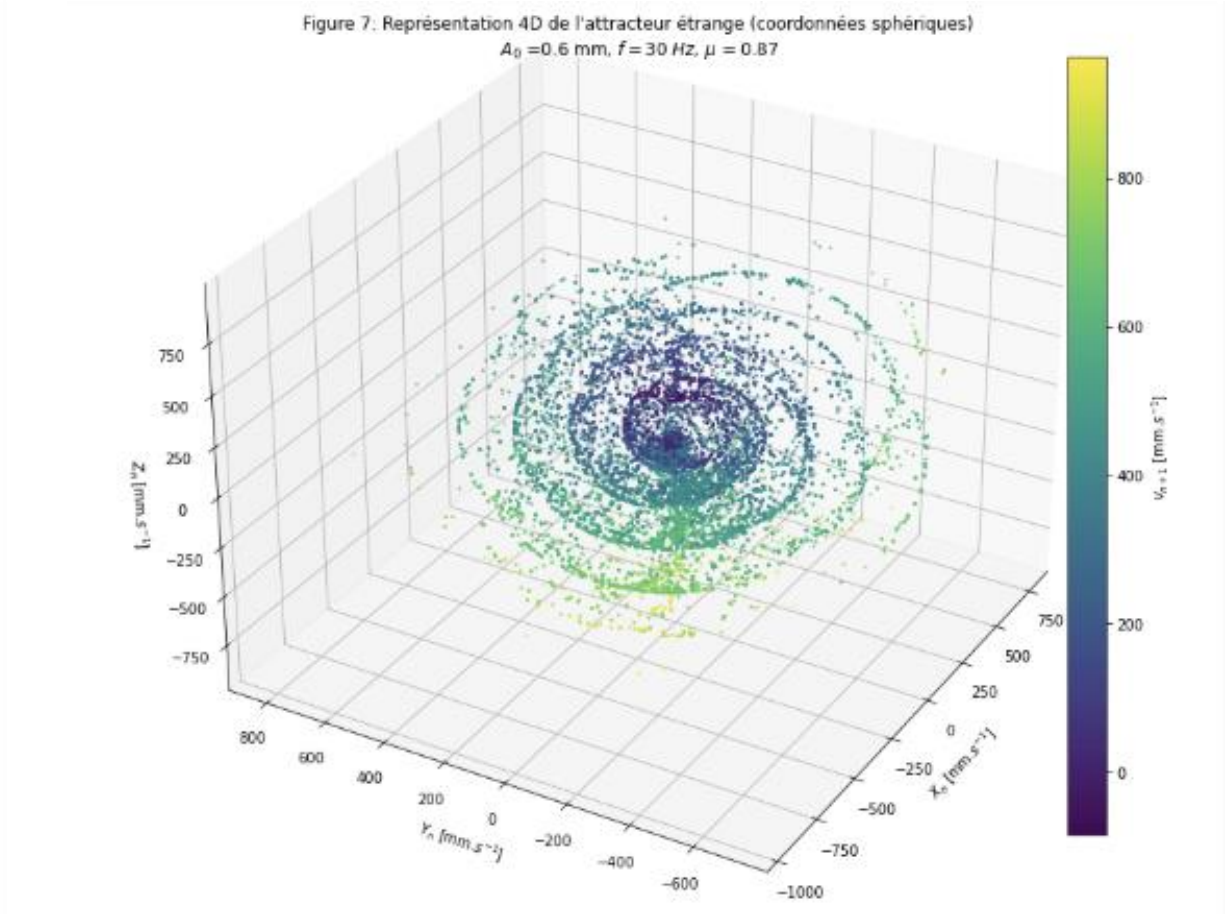


Numerical Study
b) Bifurcation Diagram



Numerical Study
c) Strange Attractor

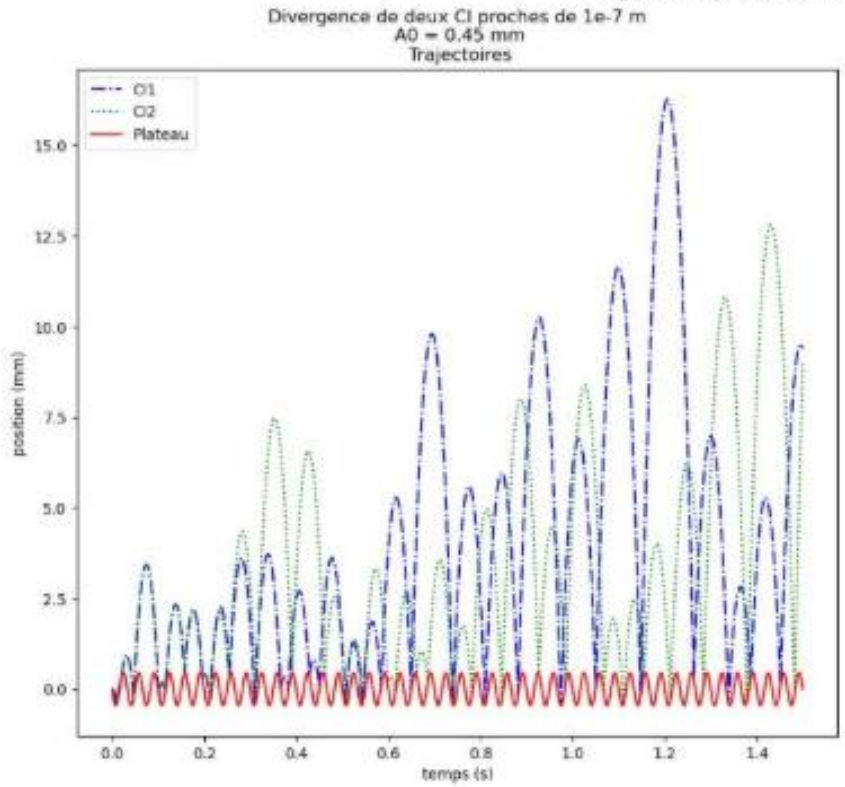


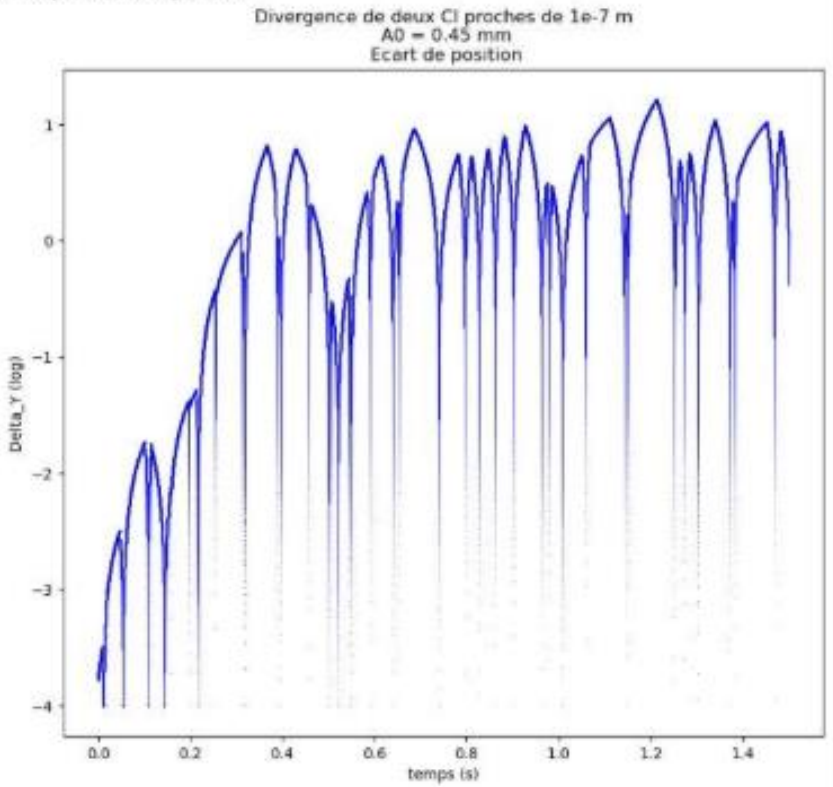


Numerical Study
d) Lyapunov Exponant

$$|y_1(t) - y_2(t)| = d_0 \exp(\lambda t)$$

Figure 8: Trajectoires et écart de position pour deux CI proches





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Thank you for listening

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References

[1] *La bille qui rebondit : une expérience simple pour aborder la physique du chaos*, Pierre Boissel, 1992
[2] *The dynamics of repeated impacts with a sinusoidally vibrating table*, P. J. Holmes, 1981
[3] *Fractal dimension of the strange attractor of the bouncing ball circui*t, B. K. Clark and al., 1993