SCHOOL OF
PHYSICAL SCIENCES
AND NANOTECHNOLOGY

UNIVERSIDAD
YACHAY
TECH

Learning Physics - Aware Surrogates

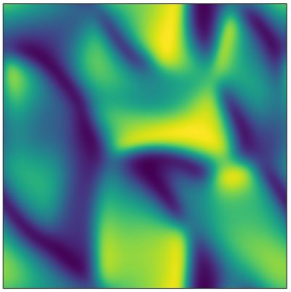
Villaruel-Yánez Daniel, Limaico Franklin

Machine Learning and Data Science

Introduction

Physical system: **active suspension**

Kinetic theories → **Smoluchowski equation**
Distribution function
$\Psi(\mathbf{x},\mathbf{p},t)$



+ Coupling to the **Stokes flow** = Self-organized system

Dataset details:

Name: `active_matter`
File type: **HDF5**

Precision: **fp32**
Libraries: **PyTorch** and **Numpy**

Fields: **concentration, velocity, orientation tensor and strain-rate tensor** (moments of Ψ)

Goal of the project

Problem:

Forecasting from surrogates model

non-physical **artifacts**, **instabilities** and poor **generalization** to new parameter regimes

General objective:

improvement for surrogates models for **Physical dynamics prediction**

Implementation:

Physics-informed model

Project plan

Global plan:

1. Input: Few snapshots
2. Data normalization
3. Data-driven surrogates implementation
4. Loss function evaluation
5. Physical constraints integration
6. Modified baseline implementation
7. Outputs: Snapshots for the next time step. Loss function evaluation between actual data, baseline forecast and physics-informed baseline forecast

Plan for the next week:

1. Data normalization
2. Understanding of ConvNext block baseline

Questions?