


UNIVERSITÀ DEGLI STUDI
DI TRENTO
Dipartimento di Fisica

# Prof. Jani Joan

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**Tuesday 20th October 2026 – 10:30**
**Aula Seminari Fisica Teorica – PovoZero**

## Unlocking the Chaos: Transition Dynamics, Computational Methods, and Secure Communication Applications

**Abstract:**

Chaos theory provides a profound framework for understanding complex, non-linear, and non-deterministic behaviour in deterministic systems. This lecture explores the presence of chaos across physical and computational domains, tracing the critical transition from order to chaos through routes such as period-doubling bifurcations and quasi-periodicity. To bridge theoretical concepts with concrete implementation, we examine the computational practice of constructing bifurcation diagrams and Poincaré sections. These diagnostic tools are applied across classic non-linear systems—such as the Lorenz attractor, the Duffing oscillator, and the Logistic map—to visualize phase space trajectories and quantify sensitivity to initial conditions.

Furthermore, we bridge the gap between numerical simulation and practical physical engineering by analysing the manifestation of chaos in electronic systems, specifically focusing on Chua's circuit and non-linear oscillators. Building on these electronic dynamics, we showcase the operational potential of chaotic behaviour in modern technology, highlighting its application in secure communication protocols. Techniques such as chaotic synchronization, signal masking, and chaotic parameter modulation are demonstrated as powerful paradigms for encrypting data against eavesdropping. This lecture equips attendees with both the theoretical foundation and practical computational tools required to model, observe, and harness chaos in real-world engineering contexts.

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