

INTERNSHIP-PhD PROPOSAL

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Internship location: ENS de Lyon

Thesis possibility after internship: YES

Funding: TBD

Dense Crowds as Active Matter

Watch a dense crowd from a balcony and you see a single body: an active material that deforms and flows as thousands of people move together. Our field measurements in Pamplona, Spain, have revealed spontaneous collective oscillations involving hundreds of people [1]. Combining these observations with theory, we have explained how such oscillations emerge. We now want to understand how this material responds when it is pushed.

How does a local push travel through a crowd? Under what conditions can it trigger a crowd surge? When does the crowd recover, and when does it fracture, leaving lasting breaks in its network of neighbours? Answering these questions requires connecting the crowd's structure and motion to its mechanical response.

The project will combine quantitative analysis of existing data with new field measurements at the San Fermín festival in Pamplona. Planned measurements will track both the dynamics of the crowds and of their boundaries. Through a combination of data analysis and modelling, we aim to identify the continuum laws governing how dense crowds transmit disturbances and fracture.



Picture of the crowd that formed at the opening of the San Fermín festival in 2023. Locally the density reached 10 persons/m²

Depending on your interests and skills, your PhD internship will focus on quantitative data analysis, theoretical modelling or numerical simulations, with opportunities to contribute to field observations.

[1] Emergence of collective oscillations in massive human crowds

F. Gu, B. Guiselin, N. Bain, I. Zuriguel, and D. Bartolo, *Nature* 638 112 (2025) [PDF]