

INTERNSHIP-PhD PROPOSAL

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Internship location: ENS de Lyon

Thesis possibility after internship: YES

Funding: YES

If YES, which type of funding: Europe

CROWDS AS ACTIVE MATTER

Our goal will be to quantitatively describe dense crowds as active condensed matter.

Mesmerizing impressions of virtually all patterns observed in bird flocks, fish schools, and even human crowds are rendered in silico by simple algorithms. However, going beyond visual impressions and predicting the collective dynamics of massive crowds in response to physical, social, or biological imperatives remains a formidable challenge.

We will address this challenge by combining experimental observations on massive crowds and theory. We will elucidate the dynamics of crowds gathering thousands of people and where the density can exceed 8 people per square meters, see Fig. 1. Our primary goal will be to explain their spontaneous fluctuations and response to boundary perturbations. To gain some intuition about the type of questions we will address and the type of concepts and tools we will use, you can take a look at our first description of human crowds as active fluids in [1].



Fig. 1. Close view on the massive crowd gathered in Pamplona on the day of the opening of the San Fermin festival . Images N. Bain, F. Gu, B. Guiselin and D. Bartolo,

We will perform a novel series of experiments on crowds gathering the participants of festivals in Spain, and on other massive gathering events in the world. Depending on your taste and skills your Master project and PhD work could include a combination of numerical simulations and theory, in addition to experimental observations and quantitative data analysis,

[1] Nicolas Bain and Denis Bartolo, *Science* (2019) [PDF]