Title: Active anomalous stochastic search
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Background: Biological dynamics are characterised by *activity* in the sense that energy is taken up from the environment and converted into motion [1]. Examples of self-propelled motion range from human movement, to foraging marine predators, to crawling biological cells. Active dynamics are very different from passive Brownian motion, where a tracer particle is driven by collisions with the surrounding fluid particles. Biological processes furthermore often exhibit *anomalous* dynamics characterised by long-term diffusion that is, again, very different from Brownian motion [2]. This reflects the spatio-temporal complexity of biological systems. Mathematically both active and anomalous dynamics are modeled in terms of advanced (persistent, non-Markovian, non-Gaussian) stochastic processes [1,2]. This project will cross-link these two very recent, new fields of research for understanding the search of targets like, e.g., food sources in a foraging process [3].
Project description: The warm-up will be to learn about Lévy walks, a famous fundamental class of anomalous stochastic processes [4]. Their diffusive properties should be understood analytically and explored numerically in simple search scenarios, formulated mathematically as first passage and first arrival problems. While much is known about these dynamics in one dimension, higher dimensional settings are at the forefront of research. This knowledge should be applied to understand new experimental data by G.Volpe (London) and V.Trianni (Rome) on biological and robotic Lévy walkers. The impact of biological activity and interactions between single particles on search efficiency should be explored by developing and analysing new stochastic models.

References:

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