



Dipartimento
di Fisica
e Astronomia
Galileo Galilei

1222·2022
800
ANNI



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Thursday 11th November 2021,

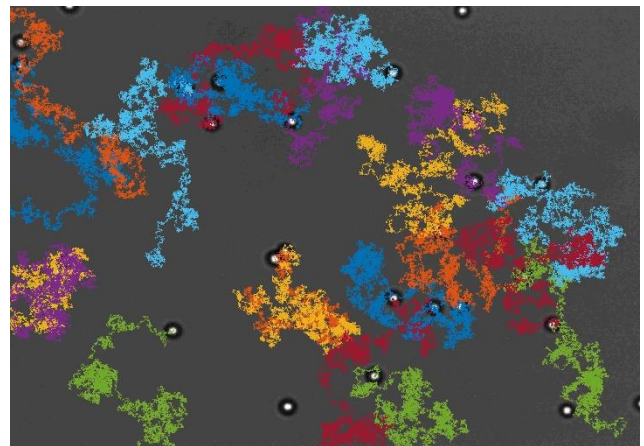
11.30 am, Room R, 3rd floor building via Marzolo 8

Antonio Ciarlo, PhD

University of Naples “Federico II”, Italy

Experimental study of Fickian yet-non Gaussian Diffusion in an optical speckle field

Brownian diffusion process has two fundamentals characteristics: Fickianity, i.e. the Mean Squared Displacement (MSD) increases linearly in time, and Gaussianity, i.e. the displacements distribution (DD) is Gaussian. Even if Fickianity not implies Gaussianity, this implication was thought to be universal since there were no evidences about a breaking of its validity. In 2009 [1], a new stochastic process has experimentally emerged that demonstrates that Fickianity can be not followed by Gaussianity. For



this reason, this stochastic process is known as Fickian yet non-Gaussian diffusion (FnGD) and it is typical of many phenomena. In our recent paper [2], we demonstrate that it is possible to reproduce this phenomenon experimentally and in a controlled way by exploiting the optical forces produced by a speckles optical field: the motion of silica microspheres immersed in a Newtonian fluid illuminated by a speckles field has the characteristics of a FnGD process. A spatial light modulator (SLM), controlled by a computer, allows to produce systematically the speckles field and we can vary its parameters, such as the optical power and the grains average size. In this way, we did a parametric study of FnGD free from uncontrolled phenomena: this is the great difference between this apparatus and those proposed in the literature. Tracking the microspheres, we have obtained the MSDs and the DDs of the diffusion process at different speckle field optical powers. For each power, when the MSDs are linear, the DDs are not gaussian, demonstrating that the optical forces produced by a speckles field reproduce the FnGD in a controlled way.

[1] Bo Wang, Stephen M Anthony, Sung Chul Bae, and Steve Granick. Anomalous yet brownian. *Proceedings of the National Academy of Sciences*, 106(36):15160–15164, 2009.

[2] Raffaele Pastore, Antonio Ciarlo, Giuseppe Pesce, Francesco Greco, and Antonio Sasso. Rapid fickian yet non-gaussian diffusion after subdiffusion. *Physical Review Letters*, 126:158003, Apr 2021.