

PRIN Grant 2022NTKXCX
“Stochastic properties of dynamical systems”
Project for *Assegno di Ricerca* in the Bologna Unit

The successful candidate will hold a PhD in Mathematics, Physics or other scientific disciplines, provided their CV shows a strong mathematical background. They will be expected to carry on research on the ergodic and stochastic properties of chaotic dynamical systems, within the general framework of the research grant “*Stochastic properties of dynamical systems*” and to work closely with the scientific staff of the Bologna Unit. The main topics of interest of the unit are listed below, but the postdoctoral associate will be allowed, and in fact encouraged, to have a certain degree of autonomy in choosing their specific problems within or around the listed topics and/or integrating them with their own personal lines of research.

Non-compact and infinite-measure preserving dynamical systems. The interest here is both in developing new general ideas and techniques in infinite ergodic theory and deriving stochastic properties of specific systems. Questions in the first group include: limit theorems for Birkhoff sums of global (non-integrable) observables, notions of infinite mixing and their applications (quantitative mixing, decay of correlations, limit theorems), sufficient conditions for the K-property in general systems, etc. Questions in the second group include: ergodic and stochastic properties of aperiodic Lorentz gases (applications of ergodicity, mixing, K-property, decay of correlations, limit theorems) and similar systems, such as expanding/hyperbolic maps on non-compact and/or homogeneous space, possibly with quenched disorder.

Dynamical systems with holes and extreme events. Since the study of dynamical systems with holes/leaks is essentially in its infancy, even basic problems in the field are of interest, e.g., escape rates for general expanding maps, dependence of the escape rate on the position of the hole, the problem of the maximal escape rate, perturbation of holes, etc. Related to this, a direction of interest is that of large deviations in Extreme Value Theory for chaotic dynamical systems (and stochastic processes as well).

Transfer operator and spectral methods. A key mathematical tool for many of the above problems is the transfer operator, in its various forms. However, the study of fine properties of the spectrum of the transfer operator is at its very beginning, see, e.g., the question of locating its eigenvalues in the unit disc, or studying how the spectral gap changes as a function of relevant parameters of the dynamics. Any progress in this direction is of value to the project.

Applications to systems of physical interest. The group is especially interested in the following applications of techniques from dynamical systems: “internal-wave billiards”, that is, point-particle systems which approximate the motion of internal or inertial waves in fluid dynamics (main mathematical technique: homeomorphisms of the circle); use of Koopman and/or transfer operators for questions of assimilation, interpretation and forecast of data in climate-related problems. Numerical work will also be considered.

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Activity plan for *Assegno di Ricerca* in the Bologna Unit

The detailed activity plan of the postdoctoral fellowship will largely depend on the specific problem the postdoctoral associate will work on. In any event, on top of regular meetings with the local PI at the Department of Physics and Astronomy the University of Bologna, the associate will interact with the other research units of the PRIN Grant (Roma Tor Vergata and Pisa) and will travel to national/international conferences to stay updated in the research field and to disseminate their results. Scientific visits to experts in the topic of interest will be encouraged.