My name is Francesco Cellarosi (pronouns: he/him/his) and I am an Associate Professor in the Department of Mathematics and Statistics at Queen's University.

My research focuses on dynamical methods to answer probabilistic questions, especially arising from number theory. Roughly speaking, I try to understand to what extent certain number-theoretical objects behave as if they were *random*. Classical probability rarely applies to such questions, but tools from the theory of dynamical systems or ergodic theory often save the day!

Some problems from mathematical physics and quantum mechanics also fit my research agenda.

Problem 1 Temporal Central Limit Theorems (TCLT) are known for some dynamical system with very low complexity, such as badly approximable rotations of the circle. The randomness of k-free integers in long intervals can be characterized in terms of an ergodic rotation on a compact abelian group. I am interested in extending TCLTs to this context, and explore their number theoretical consequences.

Problem 2 Jacobi theta functions are special functions of two complex variables that play a fundamental role in the construction of elliptic functions. Their behaviour near the natural boundary, along certain random affine lines, can be studied using an automorphic function along the geodesic flow defined on a certain Lie group. The limiting distributions arising this way are either compactly supported or heavy-tailed. The bulk of these distribution are poorly understood. Preliminary explorations reveal interesting concentration phenomena that need to be investigated. Tools from hyperbolic geometry, representation theory, and homogeneous dynamics can be useful in this project, although careful numerical simulations can be performed with minimal background.

Problem 3 The study of the dynamics generated by the geodesic flow on the unit tangent bundle to a hyperbolic surface naturally leads to the equidistribution of unstable horocycles. Some quantitative results are known in this context, allowing to obtain explicit error terms in the convergence of measures supported on the unstable horocycles, provided some regularity assumptions on the test functions.
The goal is to extend these results to higher dimensional homogeneous spaces, especially when we cannot afford too much regularity (as it is the case in several applications) and when the horocycle lifts are non-generic.

If you find any of these problems interesting or would like to hear more about my research, do not hesitate to contact me at fc19@queensu.ca