

In last years there have been appeared lots of intriguing mathematical questions coming from mathematical finance, actuarial science, queueing theory, random evolution of matrices, population dynamics, statistical and mathematical physics and many others research fields related with exit times of stochastic process from some given set. Within this project we plan to focus mainly on two families processes: Markov additive processes and branching Lévy processes. Both processes have similar affine structure and could be treated by similar martingale techniques and potential theory tools. The fluctuation theory of Markov additive processes plays also a crucial role in this proposal.

Within the proposed project we plan to:

- A.** Investigate some optimal stopping problems related with state-dependent discounting;
- B.** Study distributional properties of a maximal displacement of a Lévy branching process and a maximum of a perturbed random walk on tree;
- C.** Analyze the quasi-stationary measures for some Lévy processes and exit sets.

The proposed research is based on: techniques of fluctuation theory for Lévy processes, analytical estimates of the density of α -stable processes, theory of branching random walks and Lévy branching processes, potential theory and martingale methods.