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Spectral theory of extreme statistics in birth-death systems[1]

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Statistics of rare events, or large deviations, in chemical reactions and systems of birth-death type have attracted a great deal of interest in many areas of science including cell biochemistry, astrochemistry, epidemiology, population biology, *etc.* Large deviations become of vital importance when discrete (non-continuum) nature of a population of "particles" (molecules, bacteria, cells, animals or even humans) and stochastic character of interactions can drive the population to extinction. I will briefly review the novel *spectral method* [1-3] for calculating the extreme statistics of a broad class of birth-death processes and reactions involving a single species. The spectral method combines the probability generating function formalism with the Sturm-Liouville theory of linear differential operators. It involves a controlled perturbative treatment based on a natural large parameter of the problem: the average number of particles/individuals in a stationary or metastable state. For extinction (the first passage) problems the method yields accurate results for the extinction statistics and for the quasi-stationary probability distribution, including the tails, of metastable states. I will demonstrate the power of the method on the example of a branching and annihilation reaction, $A \to 2A$, $2A \to \emptyset$, representative of a rather general class of processes.

1. M. Assaf and B. Meerson, Phys. Rev. Lett. **97**, 200602 (2006).

2. M. Assaf and B. Meerson, Phys. Rev. E **74**, 041115 (2006).

3. M. Assaf and B. Meerson, Phys. Rev. E **75**, 031122 (2007).

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