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Long-time Behavior of Random Processes with Rare Big Jumps

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We study additive functionals of the type $\xi^\varepsilon(t) = \xi_0^\varepsilon + \int_0^t \eta^\varepsilon(ds; x(s/\varepsilon))$ on $\mathbb{R}^d$ in the series scheme with small series parameter $\varepsilon \to 0$, $(\varepsilon > 0)$. The family of the Markov jump processes with *locally independent increments* $\eta^\varepsilon(t;x)$, $t \geq 0, x \in E$ on $\mathbb{R}^d$, is defined by the generators on the test-functions $\varphi(u) \in C^1(\mathbb{R}^d)$: $\widetilde{\Gamma}^\varepsilon(x)\varphi(u) = \varepsilon^{-1} \int_{\mathbb{R}^d} [\varphi(u+v) - \varphi(u)]\Gamma^\varepsilon(u, dv; x)$. Such processes include as particular cases: birth-and-death processes, dynamical systems, additive functionals, compound Poisson process, increment process in random environment, they are also important in reliability applications as for example in shock and degradation.

Conditions of Lévy (or Poisson) approximation mean that the jump values of the stochastic system are split into two parts: a small jump taking values with probabilities close to one and a big jump taken values with probabilities tending to zero together with the series parameter $\varepsilon > 0$. For $\varepsilon \to 0$ (that means $t/\varepsilon \to \infty$ - large time interval) we show weak convergence of the processes studied to the process that contains deterministic drift, diffusion part and Lévy jumps.