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Characteristic Functions of Feller Processes and Their Applications

We present uniform upper and lower bounds for the characteristic function of a Feller process, which yield sufficient conditions for the ultracontractivity of the associated Feller semigroup, the transience and recurrence of the Feller process and the existence of local times for the Feller process. These conditions are optimal for symmetric Lévy processes, and they apply to a large class of Feller processes. As a byproduct, we obtain that for a stable-like process on \mathbb{R}^d with smooth variable index $\alpha(x) \in (0, 2)$, if $d \geq 2$ or $\sup_{|x| \geq K} \alpha(x) \in (0, 1)$ for some constant $K > 0$, then the process is transient; while if $d = 1$ and $\inf_{|x| \geq K} \alpha(x) \in [1, 2)$ for some constant $K > 0$, then it is Harris recurrent; moreover, if $d = 1$ and $\inf_{x \in \mathbb{R}} \alpha(x) \in (1, 2)$, then the associated process has local times. The work is based on a joint work with René L. Schilling.