The Space-Fractional Poisson Process

Enzo Orsingher, Federico Polito

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In this paper we introduce the space-fractional Poisson process whose state probabilities $p_k^\alpha(t)$, $t>0$, $\alpha \in (0,1]$, are governed by the equations $(\mathrm d/\mathrm dt) p_k(t) = -\lambda^\alpha (1-B)p_k^\alpha(t)$, where $(1-B)^\alpha$ is the fractional difference operator found in the study of time series analysis. We explicitly obtain the distributions $p_k^\alpha(t)$, the probability generating functions $G_\alpha(u,t)$, which are also expressed as distributions of the minimum of i.i.d.\ uniform random variables. The comparison with the time-fractional Poisson process is investigated and finally, we arrive at the more general space-time fractional Poisson process of which we give the explicit distribution.

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