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On conditional mean ergodic semigroups of random linear operators

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Abstract

In this article, we prove two forms of conditional mean ergodic theorem for a strongly continuous semigroup of random isometric linear operators generated by a semigroup of measure-preserving measurable isomorphisms, one of which generalizes and improves several known important results.

1 Introduction and the main results

The notion of a random normed module (briefly, an RN module), which was first introduced in [1] and subsequently elaborated in [2], is a random generalization of that of a normed space. In the last 10 years, the theory of RN modules together with their random conjugate spaces have undergone a systematic and deep development [3–9], in particular the random reflexivity based on the theory of random conjugate spaces and the study of semigroups of random linear operators have also obtained some substantial advances in [6, 8, 10–12].

It is well known that the (ε, λ) -topology induced by the L^p -norm on an RN module is exactly the topology of convergence in probability P . Actually, it is Mostari and Taylor that earlier observed the essence of the (ε, λ) -topology, studied probability theory in Banach spaces and did many excellent works [13, 14] under the framework of the special RN module $L^0(\mathcal{E}, X)$, where $L^0(\mathcal{E}, X)$ is the RN module of equivalence classes of X -valued random variables defined on a probability space (Ω, \mathcal{E}, P) , see [4] or Section 2 for the construction of $L^0(\mathcal{E}, X)$. Motivated by these works, we have recently begun to study the mean ergodic theorem under the framework of RN modules to obtain the mean ergodic theorem in the sense of convergence in probability, in particular we proved a mean ergodic theorem for a strongly continuous semigroup of random unitary operators defined on complete random inner product modules in [8] and further investigated the mean ergodicity for an almost surely bounded strongly continuous semigroup of random linear operators on a random reflexive RN module in [11]. Based on these and motivated by the idea of [15, 16], the purpose of this article is to investigate the conditional mean ergodicity for a special semigroup of random linear operator on the RN module $L^0_{\mathcal{F}}(\mathcal{E}, X)$ and the construction of $L^0_{\mathcal{F}}(\mathcal{E}, X)$ is detailed as follows.

Now let us first recall the construction of $L^0_{\mathcal{F}}(\mathcal{E})$ in [16]. Let (Ω, \mathcal{E}, P) be a probability space, \mathcal{F} a sub σ -algebra of \mathcal{E} and $\tilde{L}^0(\mathcal{E})$ (or $L^0(\mathcal{E})$) the set of equivalence classes of \mathcal{E} -measurable extended real-valued (real-valued) random variables on Ω . Let $\tilde{L}^0_{\mathcal{F}}(\mathcal{E}) = \{\xi \in \tilde{L}^0(\mathcal{E}) \mid \xi \geq 0\}$ and $L^0_{\mathcal{F}}(\mathcal{E}) = \{\xi \in L^0(\mathcal{E}) \mid \xi \geq 0\}$. Similarly, one can understand such notions as

Random Linear Operators

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