

Continuity equation for probability as a requirement of inference over paths

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© EDP Sciences, Società Italiana di Fisica, Springer-Verlag 2016. Local conservation of probability, expressed as the continuity equation, is a central feature of non-equilibrium Statistical Mechanics. In the existing literature, the continuity equation is always motivated by heuristic arguments with no derivation from first principles. In this work we show that the continuity equation is a logical consequence of the laws of probability and the application of the formalism of inference over paths for dynamical systems. That is, the simple postulate that a system moves continuously through time following paths implies the continuity equation. The translation between the language of dynamical paths to the usual representation in terms of probability densities of states is performed by means of an identity derived from Bayes' theorem. The formalism presented here is valid independently of the nature of the system studied: it is applicable to physical systems and also to more abstract dynam