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Pathwise definition of second order SDEs

Lluis Quer-Sardanyons, Samy Tindel (IECN)

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In this article, a class of second order differential equations on [0,1], driven by a general H\"older continuous function and with multiplicative noise, is considered. We first show how to solve this equation in a pathwise manner, thanks to Young integration techniques. We then study the differentiability of the solution with respect to the driving process and consider the case where the equation is driven by a fractional Brownian motion, with two aims in mind: show that the solution we have produced coincides with the one which would be obtained with Malliavin calculus tools, and prove that the law of the solution is absolutely continuous with respect to the Lebesgue measure.

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