

# On Asymptotic Preserving schemes for some SDEs and SPDEs in the diffusion approximation regime.

vendredi 4 décembre 2020 15:00 (30 minutes)

We introduce and study a notion of Asymptotic Preserving schemes, related to convergence in distribution, for a class of slow-fast Stochastic Differential Equations (SDE). We focus on an example in the so-called diffusion approximation regime:  $dX_t^\epsilon = \frac{\sigma(X_t^\epsilon)m_t^\epsilon}{\epsilon} dt$ , where  $dm_t^\epsilon = -\frac{m_t^\epsilon}{\epsilon^2}dt + \frac{1}{\epsilon}d\beta_t$ . The solution  $X^\epsilon$  then converges in distribution when  $\epsilon \rightarrow 0$  to the solution diffusion equation  $dX_t = \sigma(X_t) \circ dW_t$ , with a Stratonovitch interpretation of the noise  $W$ . The natural schemes fail to capture the correct limiting equation, as they give a limit scheme consistent with an Itô interpretation of the noise ( $dX_t = \sigma(X_t)dW_t$ ). We propose an Asymptotic Preserving scheme, in the sense that the scheme converges when  $\epsilon \rightarrow 0$ , and that the limit scheme is consistent with the limiting equation with the correct interpretation of the noise. We also present a kinetic stochastic PDE  $\partial_t f^\epsilon + \frac{1}{\epsilon}v \cdot \nabla_x f^\epsilon = \frac{1}{\epsilon^2}L f^\epsilon + \frac{1}{\epsilon}m^\epsilon f^\epsilon$ , which also converge to a diffusion equation  $\partial_t \rho = \text{div}(K\rho) + \rho \circ QdW$ , and some ideas on how to construct AP schemes for this SPDE.

Preprints: <https://arxiv.org/abs/2011.02341>, <https://arxiv.org/abs/2009.10406>

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