OPTION PRICING WITH STOCHASTIC VOLATILITY: APPLYING PARSEVAL'S THEOREM

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We consider the pricing of European derivatives in a Black-Scholes model with stochastic volatility. We show how Parseval's theorem may be used to express those prices as Fourier integrals. This is a significant improvement over Monte Carlo simulation in many cases. The main ingredient in our method is the Laplace transform of the ordinary (constant volatility) price of a put or call in the Black-Scholes model, where the transform is taken with respect to maturity (T). We derive these formulas and then apply them to the case where volatility is modelled as a Markov chain in continuous time, the so-called "Markov regime switching model". This model has been used previously in stochastic volatility modelling, but mostly with only $N = 2$ states. We show how to use $N = 3$ states without difficulty, and how larger number of states can be handled. Numerical illustrations are given, including the volatility smile in a three-state model.