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HYDRODYNAMICS OF MARKETS

Hidden Links between Physics and Finance

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Hydrodynamics of Markets

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Abstract: An intriguing link between a wide range of problems occurring in physics and financial engineering is presented. These problems include the evolution of small perturbations of linear flows in hydrodynamics, the movements of particles in random fields described by the Kolmogorov and Klein–Kramers equations, the Ornstein–Uhlenbeck and Feller processes, and their generalizations. They are reduced to affine differential and pseudo-differential equations and solved in a unified way by using Kelvin waves and developing a comprehensive math framework for calculating transition probabilities and expectations. Kelvin waves are instrumental for studying the well-known Black–Scholes, Heston, and Stein–Stein models and more complex path-dependent volatility models, as well as the pricing of Asian options, volatility and variance swaps, bonds, and bond options. Kelvin waves help to solve several cutting-edge problems, including hedging the impermanent loss of automated market makers for cryptocurrency trading. This Element is also available as Open Access on Cambridge Core.

Keywords: affine processes, Kelvin waves, Kolmogorov equation, Klein–Kramers equation, stochastic volatility

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