Abstract

Recent field and experimental studies show that mobility patterns for humans exhibit scale-free nonlocal dynamics with heavy-tailed distributions characterized by Levy flights. To study the long-range geographical spread of infectious diseases, in this paper we propose a susceptible-infectious-susceptible epidemic model with Levy flights in which the dispersal of susceptible and infectious individuals follows a heavy-tailed jump distribution. Owing to the fractional diffusion described by a spectral fractional Neumann Laplacian, the nonlocal diffusion model can be used to address the spatiotemporal dynamics driven by the nonlocal dispersal. The primary focuses are on the existence and stability of disease-free and endemic equilibria and the impact of dispersal rate and fractional power on spatial profiles of these equilibria. A variational characterization of the basic reproduction number R0 is obtained and its dependence on the dispersal rate and fractional power is also examined. Then R0 is utilized to investigate the effects of spatial heterogeneity on the transmission dynamics. It is shown that R0 serves as a threshold for determining the existence and nonexistence of an epidemic equilibrium as well as the stabilities of the disease-free and

endemic equilibria. In particular, for low-risk regions, both the dispersal rate and fractional power play a critical role and are capable of altering the threshold value. Numerical simulations were performed to illustrate the theoretical results. (Based on G. Zhao & S. Ruan, J. Math Pures Appl. 2023).