1173-60-14 **Xia Li**, **Chuntian Wang*** (`cwang27@ua.edu`), **Hao Li** and **Andrea L Bertozzi**. *A martingale formulation for stochastic Susceptible-Infected-Resistant (SIR) models to analyze finite-size effects in COVID-19 case studies.*

Deterministic compartmental models for infectious diseases give the mean behavior of stochastic agent-based models. These models work well for counterfactual studies in which a fully mixed large-scale population is relevant. However, with finite size populations, chance variations may lead to significant departures from the mean. In real-life applications, finite size effects arise from the variance of individual realizations of an epidemic course about its fluid limit. In this article, We consider the classical stochastic Susceptible-Infected-Resistant (SIR) model and derive a martingale formulation consisting of a deterministic and a stochastic component. The deterministic part coincides with the classical deterministic SIR model and we provide an upper bound for the stochastic part. Through analysis of the stochastic component depending on varying population sizes, we provide a theoretical explanation of finite size effects. Our theory is supported by quantitative and direct numerical simulations of theoretical in infinitesimal variance. Case studies of coronavirus disease 2019 (COVID-19) transmission in smaller populations illustrate that the theory provides an envelope of possible outcomes that include the field data. (Received July 13, 2021)