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A general phase transition model for vehicular traffic

We propose a new macroscopic model for traffic flow accounting for phase transitions between free and congested phases. The congestion phase is described by a two-dimensional zone defined around an equilibrium flux known as the classical fundamental diagram. General criteria to build such a set-valued fundamental diagram are enumerated, and applied to several equilibrium fluxes with different concavity properties. The solution of the Riemann problem in the presence of phase transitions is obtained through the construction of a Riemann solver, which enables the definition of the solution of the Cauchy problem using wavefront tracking. The free-flow phase is described using a Newell-Daganzo fundamental diagram, which allows for a more tractable definition of phase transition compared to the original Colombo phase transition model. The accuracy of the numerical solution obtained by a modified Godunov scheme is assessed on benchmark scenarios for the different flux functions constructed.