Mathematics and Statistics Thesis Defense

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Eden Furtak-Cole

Department of Mathematics and Statistics
University of Nevada, Reno

A series solution to the Porous Medium Equation

Abstract: The Porous Medium Equation is a generalization of the Boussinesq equation, when the diffusivity is a power-law function of the hydraulic head, not only a linear function as in case of the Boussinesq equation. We consider the case of a one dimensional aquifer, initially dry, and of semi-infinite extent. At the boundary representing a fluid source, the boundary condition is specified as a power-law function of time. Following Barenblatt's approach, self-similar variables can be introduced. This reduces the original initial-boundary value problem for the partial differential equation to a boundary value problem for a nonlinear ordinary differential equation. The boundary representing the wetting front is not known, and must be found in the process of solution. A power series solution is found for this nonlinear ODE. We construct a recurrence relation for the coefficients of the series, and show the convergence of the series. Results are compared against a highly accurate numerical solution of this ODE, and the results of a lab-scale experiment.