

# ABSTRACT

## NONLINEAR DYNAMICS OF LONGITUDINAL GROUND VEHICLE TRACTION

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The purpose of this study is to investigate and understand the nonlinear dynamics of longitudinal ground vehicle traction. Specifically, the performance of rubber-tired automobiles under straight ahead braking and acceleration conditions is discussed in detail. Two vehicle traction models are considered—a quarter-car, or single wheel model, and a half-car, or two wheel model—and nonlinear analyses are undertaken for each. Customarily, the forward vehicle speed and the rotational rate of each tire/wheel are taken as dynamic states. This thesis motivates an alternative formulation where wheel slip, a dimensionless measure of the difference between the vehicle speed and the circumferential speed of the tire relative to the wheel center, replaces the angular velocity of the tire/wheel as a dynamic state. This formulation offers new insight into the dynamic behavior of vehicle traction. In each case considered, the unique features of the modeling approach allow one to capture the full range of dynamic responses of the single and two wheel traction models in a relatively simple geometric manner. The models developed here may also be useful for developing and implementing ABS and TCS control schemes.