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The Cartwheel CME's Evolution in the Low Solar Corona Simulated with Non-Equilibrium Charge States and Spectra for Comparison to High-Resolution EUV Spectroscopic Observations

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High-resolution EUV spectroscopy of the corona provides the most informative diagnostic tool for the early evolution of coronal mass ejections (CMEs) since it can directly measure many physical properties of CME plasma close to the Sun, which cannot be determined from coronagraphs and full-disk imagers. *Hinode*/EIS captured its full range of high-resolution EUV spectra of the April 9th, 2008 event, also known as the Cartwheel CME, during its initial acceleration period. Unique to this work, simulations of the Cartwheel CME with the Alfven Wave Solar atmosphere Model (AWSoM) and the Gibson-Low flux rope model, were performed to provide insight into the plasma structure and dynamics during the early evolution of this CME. We combined self-consistent non-equilibrium charge state calculations in the EUV spectral line synthesis for the first time, to account for the plasma departures from ionization equilibrium everywhere in the CME. Overall, the model is able to reproduce the dynamics of the CME, including the eruption of cold, dense prominence material. We discuss the thermodynamic evolution of CME's plasma structure in the low solar corona, with particular attention given to the cold prominence material, and how the non-equilibrium charge states and EUV spectra evolve.