# Potential Field Source Surface and Non-linear Force-Free Field Extrapolation to Model Magnetic Field Structure for a Giant Solar Filament

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## Abstract

Solar filaments are intriguing structures suspended in the solar corona at heights up to 100 Mm above the chromosphere, but they are made of chromospheric material which is one hundred times cooler and denser than the coronal material. Studying filament magnetic field structures, magnetic energy and electric current density is crucial to know its stability, because unstable conditions can result in explosive events like flares and coronal mass ejections (CMEs). A few recent studies have been conducted to model large-scale filaments in the quiet Sun though the majority of studies focus on modeling small-scale active region filaments. This study is the first to use potential field source surface (PFSS) and non-linear force-free field (NLFFF) models in spherical geometry to study a giant filament (with length more than 800 Mm) along a polarity inversion line (PIL) in a weak-field region (with photospheric field region of ≈ 50 G). The two modeling methods are applied to data obtained from a giant filament observation on February 10, 2015 with preprocessing of photospheric full-disk vector magnetograms from the Helioseismic and Magnetic Imager (HMI) and Vector Spectromagnetograph (VSM) using optimization procedure to make the boundary data more consistent with the force-free principle. The large-scale magnetic configuration surrounding the filament is derived from the PFSS model, while the NLFFF extrapolation provides a detailed three-dimensional structure of the filament using both HMI and VSM data. Results from both instruments show good agreement. The NLFFF extrapolation based on HMI data yields higher total and free magnetic energy compared to VSM data. Moreover, the total surface electric current density is greater with VSM data, consistent with the magnetic field strength derived from both instruments.

**Keywords** Sun: Magnetic field structure, magnetic energy. Sun: corona, filaments, prominences. Methods: numerical