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Coronal vector magnetic field and the plasma beta determined from the NoRH and multiple satellites observations

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In the solar corona, there are various kinds of eruptive phenomena, such as flares and coronal mass ejections, which are caused by interactions between the coronal magnetic field and plasma. Hence, it is important to precisely measure the coronal plasma parameters, including the magnetic field, plasma density, and temperature, in order to understand the mechanisms that generate these eruptive coronal phenomena.

The solar coronal vector magnetic field, plasma density, and temperature is derived from coordinated observations of the radio thermal free-free emission using the Nobeyama Radioheliograph (NoRH) and multiple line-of-sight extreme ultraviolet observations using the Solar Dynamic Observatory (SDO) and the Solar Terrestrial Relations Observatory (STEREO). We observed a post-flare loop on the west limb on 2013 April 11. The line-of-sight magnetic field was derived from the circularly polarized free-free emission observed by NoRH, which was combined with the tilt angle toward the Earth observed with STEREO and converted to a vector magnetic field. The emission measure and temperature were derived from the Atmospheric Imaging Assembly (AIA) onboard SDO. The derived temperature was used to estimate the emission measure from the NoRH radio free-free emission observations. The derived density from NoRH was 40% larger than that determined using AIA, which is due to the fact that the low temperature plasma is not within the temperature coverage range of the AIA filters used in this study. The derived plasma parameters (vector magnetic field, plasma density, and temperature) were used to derive the plasma beta, which is a ratio between the magnetic pressure and the plasma pressure. The derived plasma beta is about 6.2×10^{-3} at the pool top region. The plasma parameters derived in this study were all based on observational results, and the calculated vector magnetic field presented herein is one of the least affected by assumptions or modeling ever derived.

Keywords: Sun, corona, magnetic fields, polarization observation, Nobeyama Radioheliograph