Radio emission processes and magnetic field measurement of an M-class flare on August 27 2015

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Abstract

In order to understand the radiation and particle acceleration processes during solar flares, we analyze a typical M-class flare observed on 2015 August 27. The radio light curves of this flare as observed by Nobeyama radio polarimeter (NoRP) and Nobeyama radio heliograph (NoRH) have two distinct components: an impulsive and a gradual component with the latter well correlated with the GOES SXR light curves. NoRH images show that the impulsive component is associated with a compact region with a high brightness temperature (>4.5e5K at 17GHz). The gradual component is mainly associated with an extended low-brightness temperature region. We show that the hot plasma responsible for the GOES SXR emission can reproduce the gradual component of the radio emission via the bremsstrahlung (free-free emission) process. Two patches of the extended gradual radio emission region show strong and variable polarization with opposite signs, which can be used to measure the magnetic field component along the line-of-sight. The field associated with a foot point is comparable to the photosphere field observed by the SDO/HMI. The magnetic field associated with the corona loop is much weaker, which is consistent with the B field structure in the solar atmosphere. Although the impulsive radio component does not show strong polarization, the high-brightness temperature suggests that it is produced by high energy electrons via the gyro-synchrotron process. The lack of radio polarization may be attributed to the compactness of the source, which is confirmed by RHESSI imaging observations up to 50 keV. These analyses also show that the gyro-synchrotron process produces a prominent pulse followed by a gradual decaying tail in the radio band. The above results and interpretations is further supported by the Hinode XRT and SDO/AIA imaging observations of the magnetic field structure during the flare.