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Estimation of a coronal mass ejection magnetic field strength using radio observations of gyrosynchrotron radiation

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Coronal mass ejections (CMEs) are large eruptions of plasma and magnetic field from the low solar corona into interplanetary space. These eruptions are often associated with the acceleration of energetic electrons which produce various sources of high intensity plasma emission. In relatively rare cases, the energetic electrons may also produce gyrosynchrotron emission from within the CME itself, allowing for a diagnostic of the CME magnetic field strength. Such a magnetic field diagnostic is important for evaluating the total magnetic energy content of the CME, which is ultimately what drives the eruption. Here we report on an unusually large source of gyrosynchrotron radiation in the form of a type IV radio burst associated with a CME occurring on 2014-September-01, observed using instrumentation from the Nançay Radio Astronomy Facility. A combination of spectral flux density measurements from the Nançay instruments and the Radio Solar Telescope Network (RSTN) from 300 MHz to 5 GHz reveals a gyrosynchrotron spectrum with a peak flux density at $\sim$1 GHz. Using this radio analysis, a model for gyrosynchrotron radiation, a non-thermal electron density diagnostic using the *Fermi* Gamma Ray Burst Monitor (GBM) and images of the eruption from the GOES Soft X-ray Imager (SXI), blackwe were able to calculate both the magnetic field strength and the properties of the X-ray and radio emitting energetic electrons within the CME. We find the radio emission is produced by non-thermal electrons of energies $>$1 MeV with a spectral index of $\delta\sim3$ in a CME magnetic field of 4.4 G at a height of 1.3 $R_{\odot}$, while the X-ray emission is produced from a similar distribution of electrons but with much lower energies on the order of 10 keV. We conclude by comparing the electron distribution characteristics derived from both X-ray and radio and show how such an analysis can be used to define the plasma and bulk properties of a CME.