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Investigate the impact of magnetar on the kilonova afterglow emission in short GRBs through late-time radio observations

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The coincident detection of Gravitational Wave (GW˜170817) and short Gamma Ray Burst (GRB˜170817A) confirmed their common origin from the coalescence of binary neutron stars (BNS). Depending on the BNS masses and equations of state, the outcome could be a black hole or a millisecond magnetar. In the presence of a magnetar, a significant portion of its rotational energy is transferred to the emerging ejecta, leading to late-time radio brightening known as "kilonova afterglow" emission upon interaction with the surrounding medium. Detection of this late-time radio brightening in short GRBs can have profound implications for understanding the progenitor physics. This study presents the deepest and extensive search for radio emission at late times from a short GRB up to 2016 incorporating a proper frequency regime, a wider observation span, and a relativistic correction. Using the Giant Meter Wave Radio Telescope (GMRT) at 1250, 610, and 325 MHz bands, observations were conducted approximately 2 to 11 years post-burst for five short GRBs. The estimated upper limits at the burst location are used to constrain the parameters of the burst and its surrounding environment. The magnetar model, with appropriate modifications, constrains the number density of the ambient medium for these bursts to be between 10^{-4} - 10^{-2} cm^{-3}. Our analysis rules out a stable magnetar with an energy of 10^{53} erg for four out of the five GRBs in our sample. The upcoming radio telescope like the Square Kilometer Array (SKA) (in MHz frequencies) with increased sensitivity of μJy level will push the detection limits of kilonova afterglow emission at late times.

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