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Simultaneous multi-frequency limits on radio emission at the time of a bright X-ray burst from SGR 1935+2154

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GCN circulars GCN #27714 and #27715 reported two bright X-ray bursts from the currently active magnetar SGR 1935+2154 (ATel #13681, #13684, #13685) detected on May 10 at UT 06:12:02.624 and UT 21:51:17.280. At the time of the first burst, we were performing coordinated radio observations using the Westerbork single 25-m dish RT1 (P-band, 313.49-377.49 MHz), the Onsala 25-m telescope (L-band, 1360-1488 MHz), and the Torun 32-m telescope (C-band, 4550-4806 MHz). Here we report radio fluence upper limits. The data were coherently dedispersed to the recently estimated dispersion measure DM = 332.8 pc/cc (CHIME/FRB, ATel #13681) using the software correlator SFXC (Keimpema et al., 2015). This procedure also shifts all the samples to a geocentric reference frame. Subsequently, the data were converted to filterbank files and searched for bursts. An initial automated search and also a manual inspection lead to no detection in any of the three observing bands. After correcting for dispersive delay, we detect no radio bursts within +/- 5 seconds of the expected geocentric arrival times in any of the three radio-frequency bands. Using the radiometer equation and the canonical values for the system equivalent flux density of each observing system (Westerbork: 2100 Jy, Onsala: 350 Jy, Torun: 220 Jy), we estimate 7-sigma upper limits on the fluence of a potential simultaneous radio burst of 78 Jy ms, 8 Jy ms and 3 Jy ms at 350 MHz, 1400 MHz and 4700 MHz, respectively. In the calculation we adopted an additional sensitivity scaling factor of 1.5 that accounts for the 2-bit quantization of the baseband data and further imperfections in the electronics. The entire observing run with all three stations observing simultaneously started on May 09 UT 22:10. Torun, Onsala and Westerbork then observed until May 10 UT 06:30, UT 09:30 and UT 10:00, respectively. Westerbork began observations at 1400 MHz (UT 2210 - UT 0218) and then switched to the 350-MHz band from UT 02:45 - UT 10:00. A deep search of the

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entire data set is still in progress. We are also analyzing data from other observing days and continuing to monitor SGR 1935+2154. To verify our systems and analysis we observed pulsars B1919+21 (WSRT, detected with S/N=34), B1933+16 (Onsala, detected with S/N=98), and B2020+28 (Torun, detected with S/N=22) at the beginning of each observing run. These strictly simultaneous radio upper limits during a bright X-ray burst stand in stark contrast to the earlier reported kJy-ms to MJy-ms burst detected by CHIME/FRB (ATel #13681) and STARE2 (ATel #13684), which was coincident with a bright X-ray burst (e.g. ATel #13685). Plausible explanations for the radio non-detections include: beamed radio emission that misses Earth; narrow-band emission outside the frequencies probed by our observations; or the possibility that not all X-ray bursts are accompanied by coherent radio emission. We acknowledge the help of Anna Ridnaia (Ioffe Institute) who provided us with the geocentric Earth-crossing times of the bursts reported in GCN #27714 and #27715.

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