EGU21-9853
https://doi.org/10.5194/egusphere-egu21-9853
EGU General Assembly 2021

Exploring the circular polarisation of low-frequency solar radio bursts with LOFAR and estimating the coronal magnetic field

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The Sun is an active star that often produces numerous bursts of electromagnetic radiation at radio wavelengths. In particular, low frequency (< 150 MHz) radio bursts have recently been brought back to light with the advancement of novel radio interferometric arrays. However, the polarisation properties of solar radio bursts have not yet been explored in detail, especially with the Low Frequency Array (LOFAR). Here, we explore the circular polarisation of type III radio bursts and a type I noise storm and present the first Stokes V low frequency radio images of the Sun with LOFAR in tied array mode observations. We find that the degree of circular polarisation for each of the selected bursts increases with frequency for fundamental plasma emission, while this trend is either not clear or absent for harmonic plasma emission. In the case of type III bursts, we also find that the sense of circular polarisation varies with each burst, most likely due to their different propagation directions, despite all of these bursts being part of a long-lasting type III storm. Furthermore, we use the degree of circular polarisation of the harmonic emission of type III bursts to estimate the coronal magnetic field at distances of 1.4 to 4 solar radii from the centre of the Sun. We found that the magnetic field has a power law variation with a power index in the range 2.4-3.6, depending on the individual type III burst observed.