Do LOFAR Galactic depolarization canals have their origin in the warm neutral medium?

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Abstract

Faraday tomography observations using the Low Frequency Array (LOFAR) have revealed a multitude of depolarisation canals in the Galaxy's polarised synchrotron emission, providing a fascinating insight into interstellar magnetic fields. The observed correlation with the orientation of dust polarization and HI emission suggests that these canals are linked to the neutral interstellar medium. We investigate this relationship by estimating the Faraday depth of the warm neutral medium (WNM) in the local ISM. Our work combines UV spectroscopy from FUSE and dust polarization observations from Planck with LOFAR data. We derive electron column densities from UV absorption spectra towards nine background stars, within the field of the LOFAR data presented by Erceg et al. (2022), and estimate Faraday depths using a model of the local magnetic field fitted on Planck dust polarization data. We compare our Faraday depths estimates with first and second moments measured of LOFAR Faraday spectra at the positions of our stars. We find that they are consistent if the WNM electrons are distributed over the same distance as the polarized synchrotron. Based on this result, we suggest that depolarization canals revealed by LOFAR observations at high Galactic latitude could result from differential Faraday rotation across local WNM gas. This tentative resut can be tested on a larger sample of stars when maps from the full Northern sky survey of LOFAR will be available.

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