Jessica's research focuses on the multiphase nature of our Galaxy's magnetic field and how it connects between different phases of the interstellar medium (ISM). Whether it is the turbulent warm ionized medium (WIM) that fills much of the Galaxy or the cold neutral medium (CNM) often found in sheets and filaments, this complex ISM is permeated with high energy cosmic rays and magnetic fields. When accelerated by the magnetic field, these cosmic rays emit radio synchrotron radiation that is strongly linearly polarized. As this polarized emission passes through the foreground ISM, thermal electrons and magnetic fields in the WIM rotate the plane of polarization, an effect called Faraday rotation. These cosmic rays can also penetrate and ionize the densest regions of the ISM, causing even the predominantly neutral medium to be coupled to the magnetic field via linear 21 cm HI structures called 'HI fibers.' Despite the wealth of magnetic field information about the WIM and CNM, very little is known about how they relate to one another. Do the diffuse ionized and cold clumpy media share a common magnetic field? If so, how often does this occur, and under what circumstances? These are the questions driving Jessica's research.

Figure 1 shows a region that she calls S1-C where the local magnetic field appears to be coupled between the diffuse WIM and clumpy CNM, soon to appear in ApJ. The red image shows the spatial gradient of the synchrotron polarization vector, also called the polarization gradient, which identifies abrupt changes in the thermal electron density and/or line-of-sight magnetic field strength within the WIM. The polarization gradient shows two prominent filaments, F1 and F3, that run parallel to the Galactic plane. The first of these filaments, F1, is coincident with a bright h-alpha filament, shown in green, which highlights an increase in gas density and/or ionization that is likely producing the Faraday rotation associated with F1. The southern end of F1 contains a knee feature along which there is an ionization front, which then breaks off into a fork morphology. Interestingly, F3 is not found in any other tracer and is possibly caused by a change in the magnetic field geometry, itself an interesting find. Figure 2 shows Planck dust emission at 353 GHz, where the coloured image is the total (unpolarized) intensity and the textured lines indicate the magnetic field orientation. The dust emission clearly contains the same knee and fork morphologies, and the overall field orientation is roughly parallel to the polarized filaments F1 and F3. There is yet another filament seen in the dust, F3, which runs between F1 and F3 in parallel and contains prominent HI fibers. This alignment between F1, F2, F3, HI fibers, and dust field orientation is very exciting because it suggests that the magnetic field within the WIM somehow "knows" about that within the CNM. More comprehensive studies are needed to understand whether regions like S1-C are unique places in the Galaxy or if they represent a more global trend of magnetic field coupling between ISM phases.