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Properties of magnetic structures within the quasi-parallel shock: evidence for refraction

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The Earth's parallel bow shock has within it large amplitude magnetic field pulsations, termed SLAMS, which grow from the upstream wave field as the plasma is convected towards the shock. It is thought that the ensemble of SLAMS act to slow and deflect the plasma. Simulations of this process show that the pulsations become refracted as they convect Earthwards, with the wave fronts becoming aligned parallel to the nominal shock surface. We study four spacecraft Cluster observations of the parallel shock, using data taken during a variety of tetrahedron separation scales, in order to look for observational evidence of such refraction. We present a case study of a shock at which signatures of refraction are seen. We then aim to quantify the effect statistically, using a sample of several shocks, in order to establish where and when refraction occurs. It is already known that the magnetic field pulsations grow rapidly as the approach the shock, and so we also consider the relationship between SLAMS evolution and SLAMS refraction.