INTERSTELLAR MAGNETOHYDRODYNAMIC WAVES AS REVEALED BY RADIO ASTRONOMY

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The plasma density fluctuations responsible for interstellar scintillations occur on the same scales as interstellar magnetohydrodynamic waves (Alfvén waves), which are responsible for many important processes such as the acceleration of the cosmic rays. This suggests that these density fluctuations represent a compressive component of MHD waves, and raises the exciting possibility that radioastronomical observations can provide more or less direct measurements of interstellar microphysical processes. Extraction of MHD wave properties from the radio scattering measurements requires a sound theoretical understanding of the relationship between the magnetic field in an MHD wave and the corresponding plasma density perturbation. We present a plasma kinetic theory treatment of the density compression associated with an MHD wave field. The density perturbation may be expressed as the sum of three terms. These terms are proportional to the wave amplitude, wave intensity, and sine transform of the wave intensity, respectively. The coefficients of these three terms are functions of the plasma β, the electron-to-ion temperature ratio, and the angle of wave propagation with respect to the large scale magnetic field. This relation can serve as the basis for inferring the MHD wave field given a radio scattering measurement of the density fluctuation statistics. In an attempt to apply these ideas to the interstellar plasma turbulence, we have made VLBI angular broadening measurements of sources whose lines of sight pass close to supernova remnants. The intensity of MHD waves is expected to be high in the vicinity of the shock waves associated with supernova remnants. We do not yet have unambiguous evidence of enhanced radio wave scattering due to shock-associated MHD waves. However, we have found anomalously high scattering for the source CL4, whose line of sight passes through the Cygnus Loop.

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