A RELATIONSHIP BETWEEN MHD TURBULENCE AND THE POLARIZED SPECTRA OF ASTROPHYSICAL MASERS

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We consider astrophysical maser radiation that is created in the presence of mildly supersonic, magnetohydrodynamic (MHD) turbulence. The focus is on the OH masers for which the magnetic field is strong enough that the separations of the Zeeman components are greater than the spectral linebreadths. A longstanding puzzle has been the absence of the Zeeman π components and the high circular polarization in the observed spectra of these masers. We first argue that the elongation of eddies along the field that has recently been recognized in MHD turbulence will enhance the optical depth parallel to the magnetic field in comparison with that perpendicular to the magnetic field. We then simulate maser emission with a numerical model of MHD turbulence to demonstrate quantitatively how the intensities of the linearly polarized π components are suppressed and the intensities of the nearly circularly polarized σ components are enhanced. This effect is also generic in the sense that most spectral lines in MHD turbulence with Mach number $M \sim 1$ should have larger optical depth parallel to the magnetic field than perpendicular. The effect is reduced considerably when $M < 1$. The simulations also demonstrate that the velocity and magnetic field variations due to the turbulence can (but do not necessarily) cause one of the σ components to be much more intense than the other, as is often observed for mainline OH masers.