

# Electromagnetic ion cyclotron waves with frequency below the proton gyrofrequency in large $\beta_{\parallel}$ multicomponent plasmas

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Electromagnetic ion cyclotron waves below the proton gyrofrequency in multicomponent plasmas have been extensively studied in recent years. However, it has recently been suggested that an often used analytical approach might break down due to the influence of hot plasma effects, and that from numerical methods it is not possible to say under what conditions the approximation remains valid. The approximation is known to be valid for low  $\beta_{\parallel}$  plasmas,  $\beta_{\parallel} \ll 1$ . However, it is shown that the approximation continues to be a good approximation even for large  $\beta_{\parallel}$  plasmas,  $\beta_{\parallel}$  approximately  $\approx 1$ , provided that the heavy ion components are either not too hot or of very low density, which is normally the case for magnetospheric plasmas. This is done by introducing thermal corrections to the cold plasma dispersion relation and by extending the theory to high  $\beta_{\parallel}$  plasmas. The analytical results are in good agreement with exact numerical calculations. The resulting equations, although