Kinetic Theory of Alfven Cascades

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Introduction

- This work considers kinetic effects of thermal ions and energetic particles on Alfven Cascades.
- MHD dispersion relation for Alfven cascades:

$$\omega^2 = k_{||}^2 v_A^2 + \omega_{GAM}^2 + \Delta_{MHD}$$

$$\omega_{GAM}^2 = \frac{2\gamma P}{\rho R^2}$$

- What is γ ?

Kinetic Dispersion Relation

- MHD $\omega_{GAM}^2 = \frac{2\gamma P}{\rho R^2}$
- Kinetic $\omega_{KGAM}^2 = \frac{2(\gamma_e P_e + \gamma_i P_i + \gamma_h P_h)}{\rho R^2}$

$$\gamma_e = \frac{(1 - \omega_{\star pi}/\omega)^2}{1 + \frac{T_e}{T_i}\omega_{\star ni}/\omega}$$

for q >> 1

$$\gamma_i = \frac{7}{4}(1 - \frac{\omega_{\star pi}}{\omega} - \frac{\omega_{\star Ti}}{\omega})$$

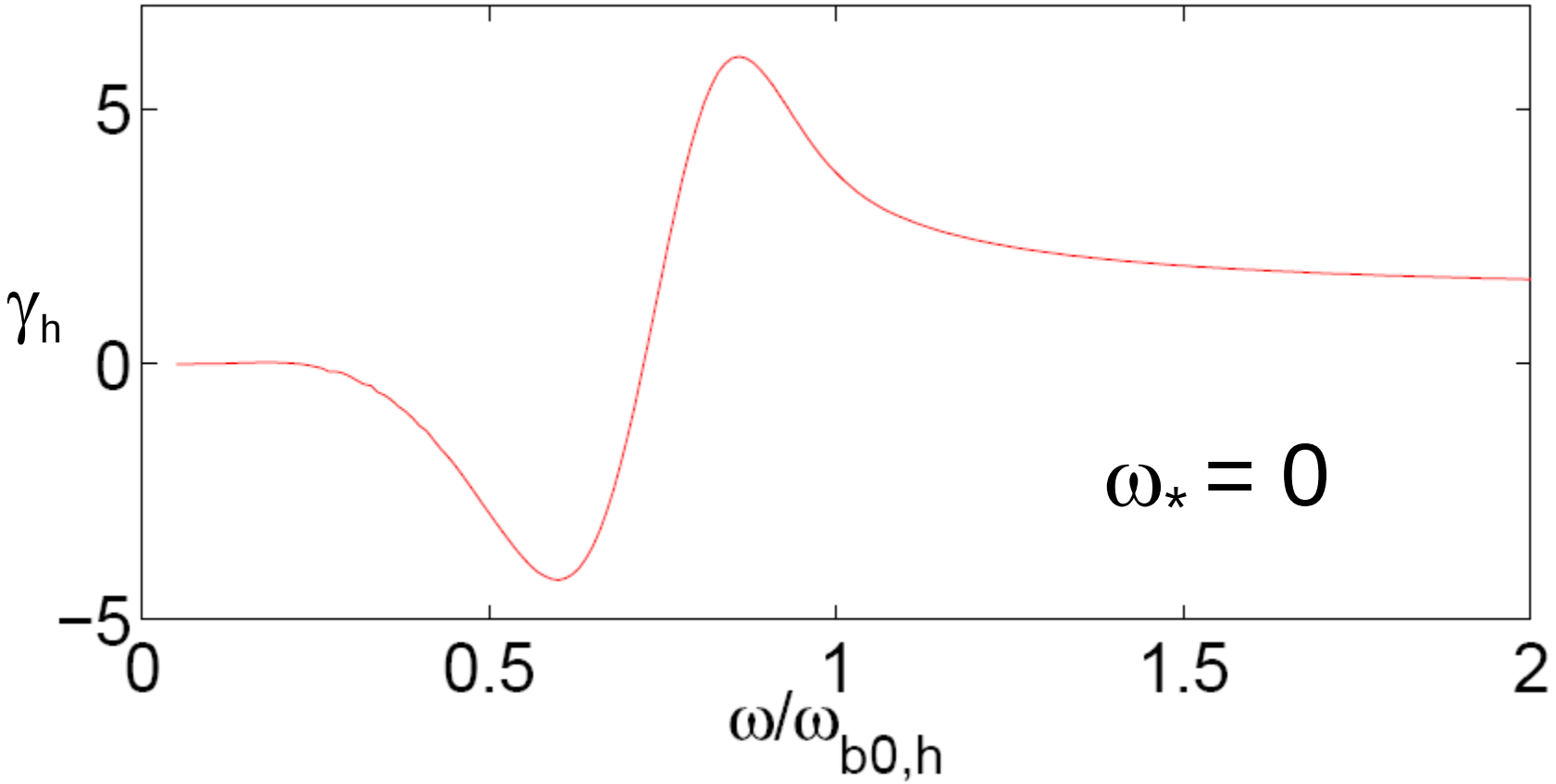
Energetic Particle Contribution

$$\gamma_h = -\frac{2\int \frac{\partial f}{\partial E} E^3 dE d\Lambda \tau_b H_1^2 (1-\omega_{\star h}/\omega)\omega^2/(\omega^2-\omega_b^2)}{\int f E^2 dE d\Lambda \tau_b < 2-\Lambda B >}$$

$$H_1 = \frac{1}{\tau_b}\int dt'(2-\Lambda B) G(r',\theta') sin(\omega_b t')$$

$$G(r,\theta) = -\frac{B_\phi R}{J B^3}\frac{\partial B}{\partial \theta}$$

Energetic Particle Contribution: frequency dependence



Summary

- We have derived a kinetic dispersion relation for Alfven cascade modes including kinetic effects of thermal ions and energetic particles;
- Thermal ion temperature gradient can drive high-n Alfven cascade modes;
- Kinetic theory should be used for evaluation of Alfven Cascade frequency;
- In principal, energetic particle effects can reduce Cascade mode frequency.