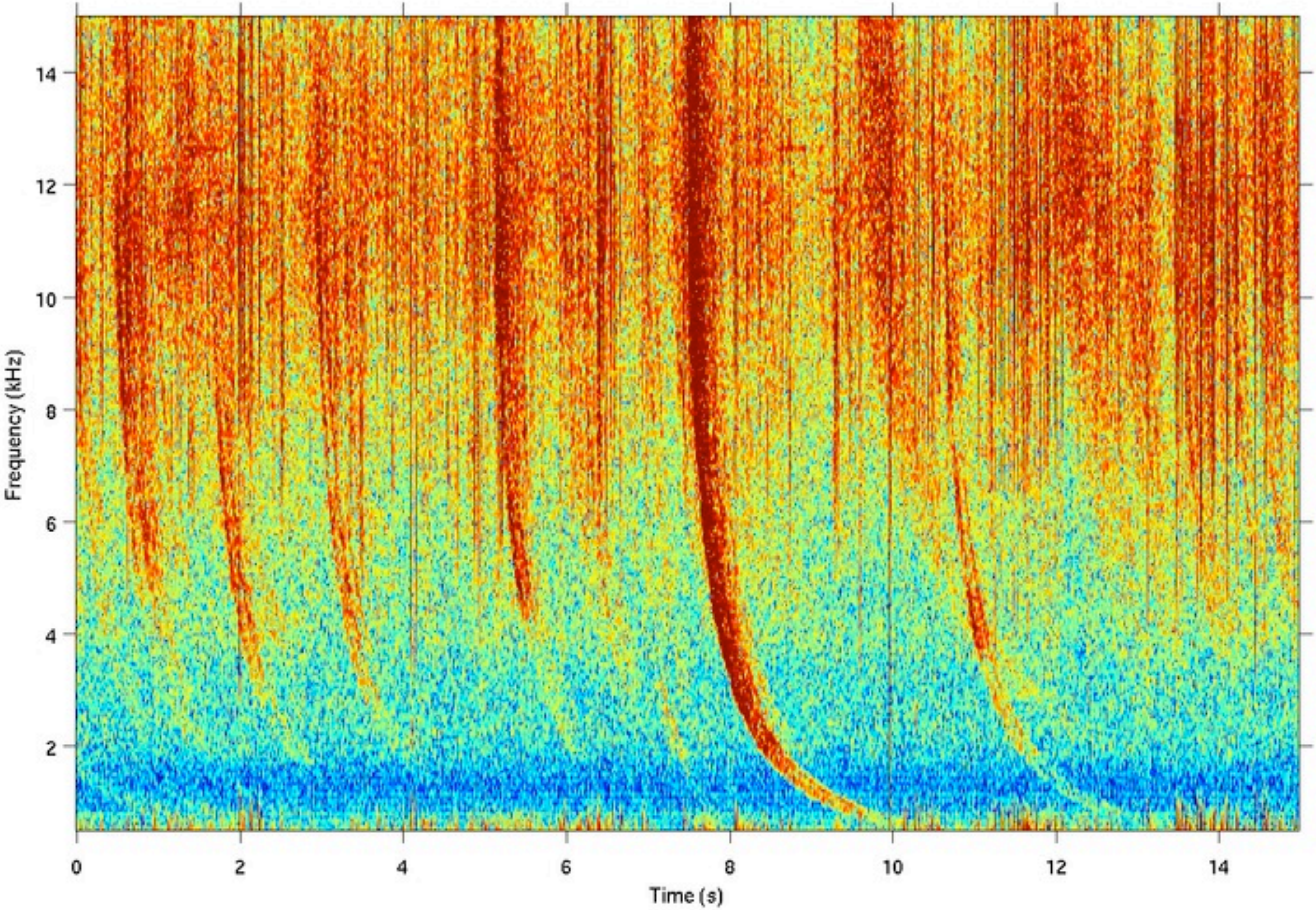
Properties of Waves

- Dispersion (relationship between f,λ)
- Phase and Group velocity
- Type (compressional or transverse)
- energy, momentum transport
- Interference (Beats, standing waves)
- Diffraction (Bending of waves around objects)



Frequency (kHz)
14
12
10
8
6
4
2
0
2
4
6
8
10
12
14
Time (s)

More propagation along B

$$n^2{}_R = 1 - \frac{\Omega^2{}_p}{(1+\beta_+)(1-\beta_-)} = 1 - \frac{\omega^2{}_{pe}}{(\omega+\omega_{ci})(\omega-\omega_{ce})}$$

$$\mathrm{v}_{\mathrm{phase}} = \frac{\omega}{k} = \sqrt{\frac{\omega\omega_{ce}c^2}{\omega_{pe}^2}} \qquad \omega^2 = \frac{\omega\omega_{ce}c^2}{\omega_{pe}^2}k^2$$

$$\omega = \frac{\omega_{ce}c^2}{\omega_{pe}^2}k^2$$

$$d\omega = \frac{\omega_{ce}c^2}{\omega_{pe}^2}2kdk$$

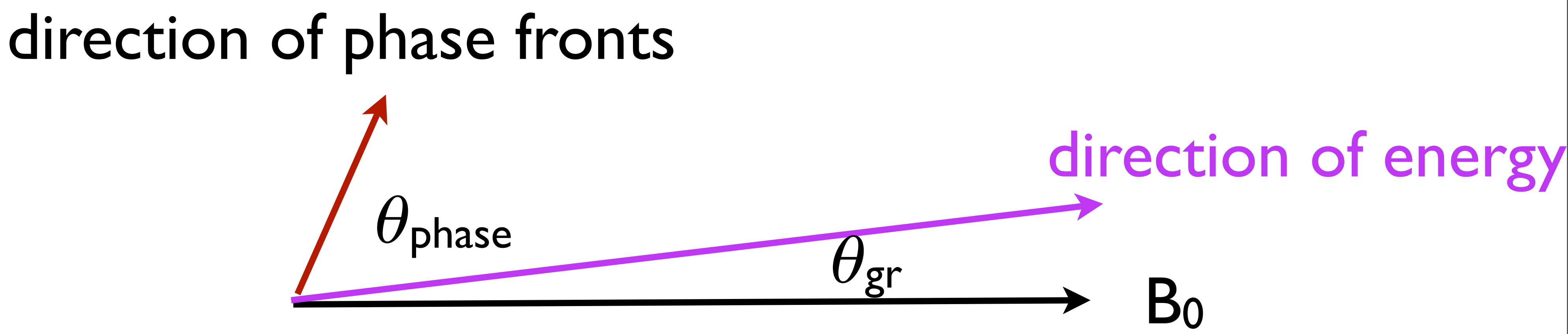
$$\mathrm{v}_{\mathrm{group}} = \frac{\partial\omega}{\partial k} = \frac{2k\omega_{ce}c^2}{\omega_{pe}^2} \propto \omega^{\frac{1}{2}}$$

Whistler parallel wavelength

$$\lambda_{||} \cong 5.6\sqrt{\frac{B_0}{nf}} \quad \text{B(Gauss), n units of } 10^{12}\ \text{cm}^{-3}\text{, f MHz, } \theta\text{=0}$$

B = 80G, n=5.0X10^{10} cm^{-3}, f = 60.6 MHz
($\lambda_{||}$ = 28.8 cm)

experimental result = 26 cm


direction of phase fronts
direction of energy
θ_{phase}
θ_{gr}
B_0

Group Velocity

$$n = \frac{kc}{\omega}$$

$$\mathrm{v}_{group} = \frac{c}{\frac{d}{df}(nf)}$$

$$\mathrm{v}_g = 2c \frac{\sqrt{f}}{f_{pe} f_{ce} \cos\theta} \left(f_{ce} \cos\theta - f\right)^{\frac{3}{2}}$$

group velocity verses phase angle

$$\theta_{group} = a\tan\left\{\frac{\sin\theta\left(\cos\theta - 2\frac{f}{f_{ce}}\right)}{1+\cos\theta\left(\left(\cos\theta - 2\frac{f}{f_{ce}}\right)\right)}\right\}$$