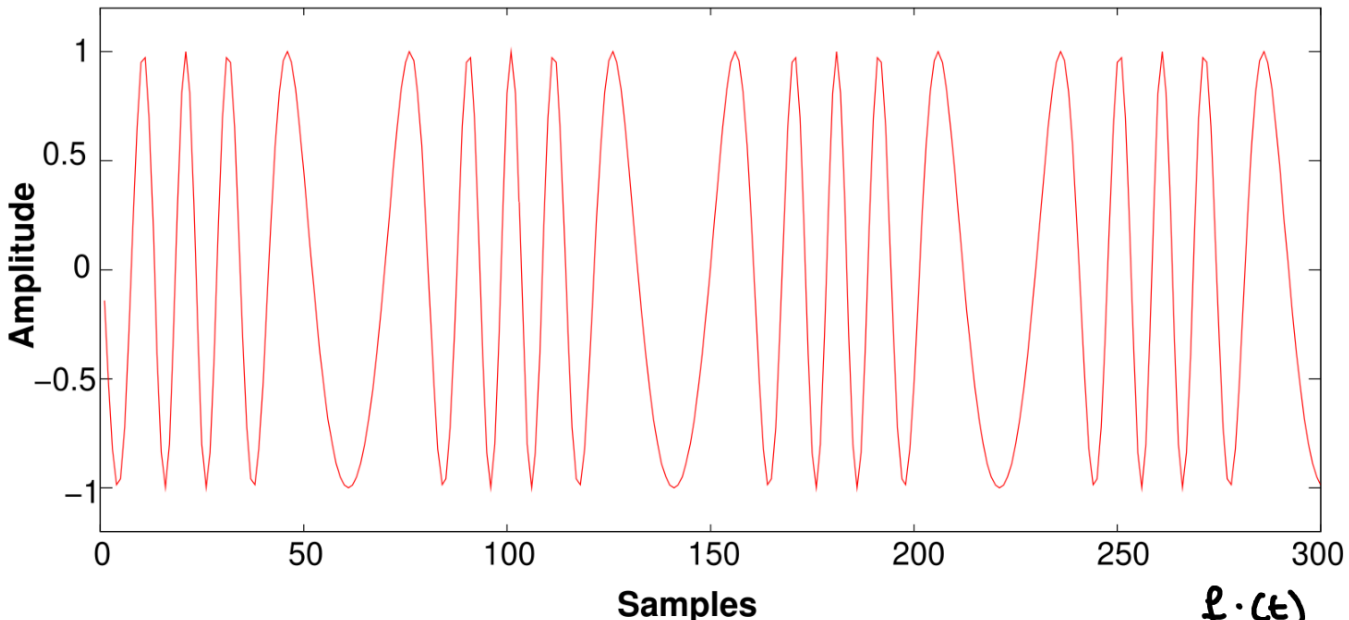
Short-time Fourier transform (STFT)

Nonstationary signal analysis

Herman Kamper

Nonstationary sinusoid



$\sin\left(\Theta(t)\right)$

→ Instantaneous freq:

$$f_i(t) = \frac{1}{2\pi}\frac{d}{dt}\Theta(t)$$

e.g. $\sin(2\pi f_0 t)$

→ $f_i(t) = \frac{1}{2\pi}\frac{d}{dt}[2\pi f_0 t]$

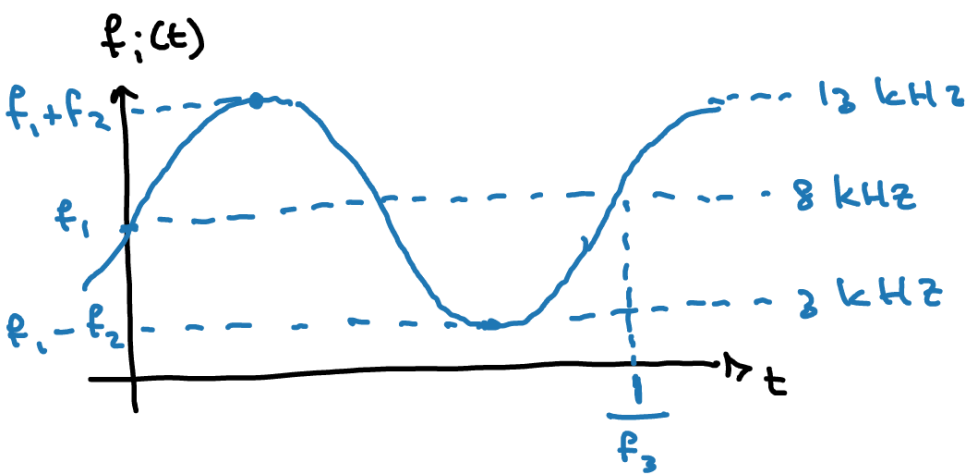
$= \frac{1}{2\pi} 2\pi f_0 = f_0$

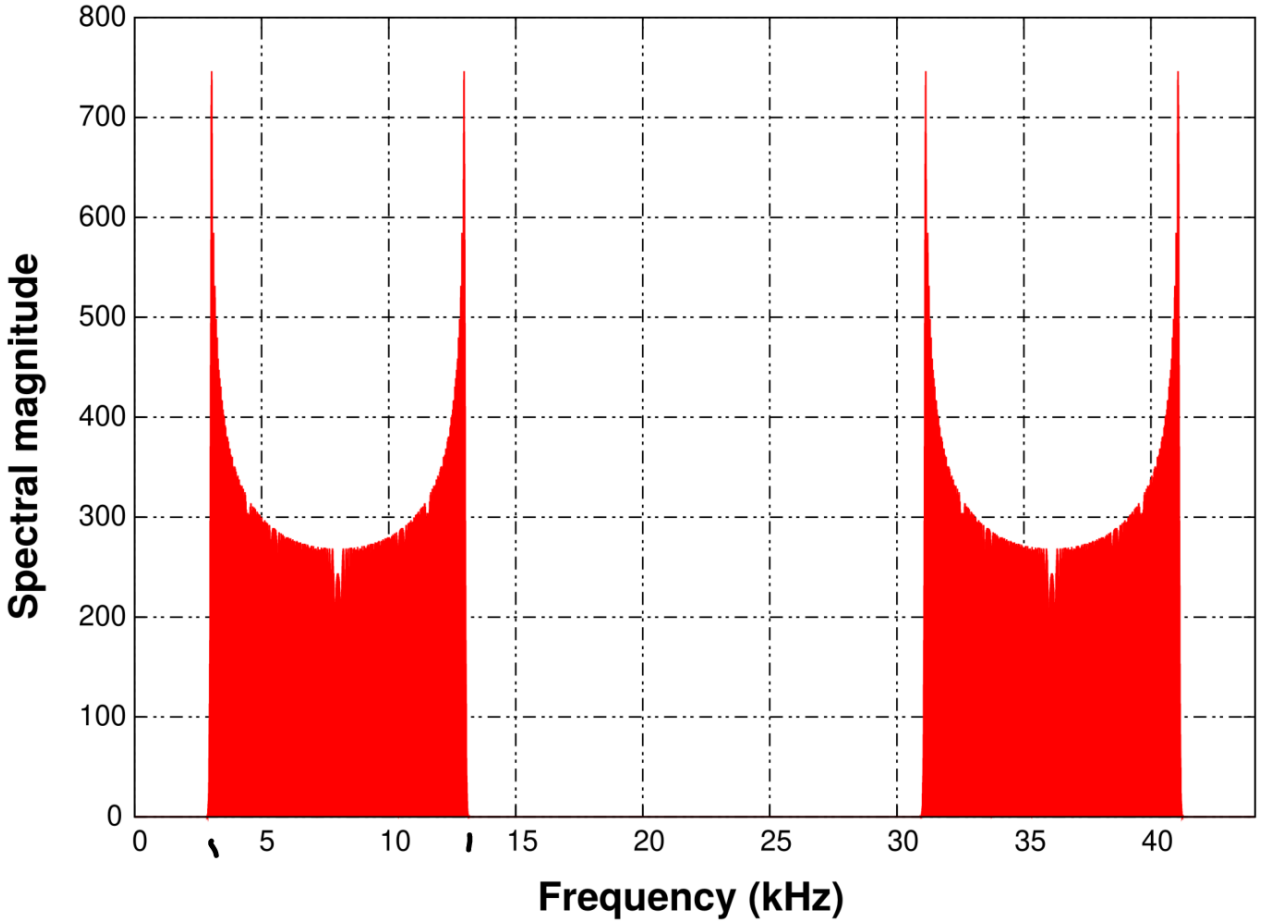
$$y(t) = \sin\left(\underbrace{2\pi f_1 t - \frac{f_2}{f_3}\cos(2\pi f_3 t)}_{\Theta(t)}\right)$$

$$f_i(t) = \frac{1}{2\pi}\frac{d}{dt}\Theta(t)$$

$$= \frac{1}{2\pi}\left[2\pi f_1 + \frac{f_2}{f_3}\sin(2\pi f_3 t)\, 2\pi f_3\right]$$

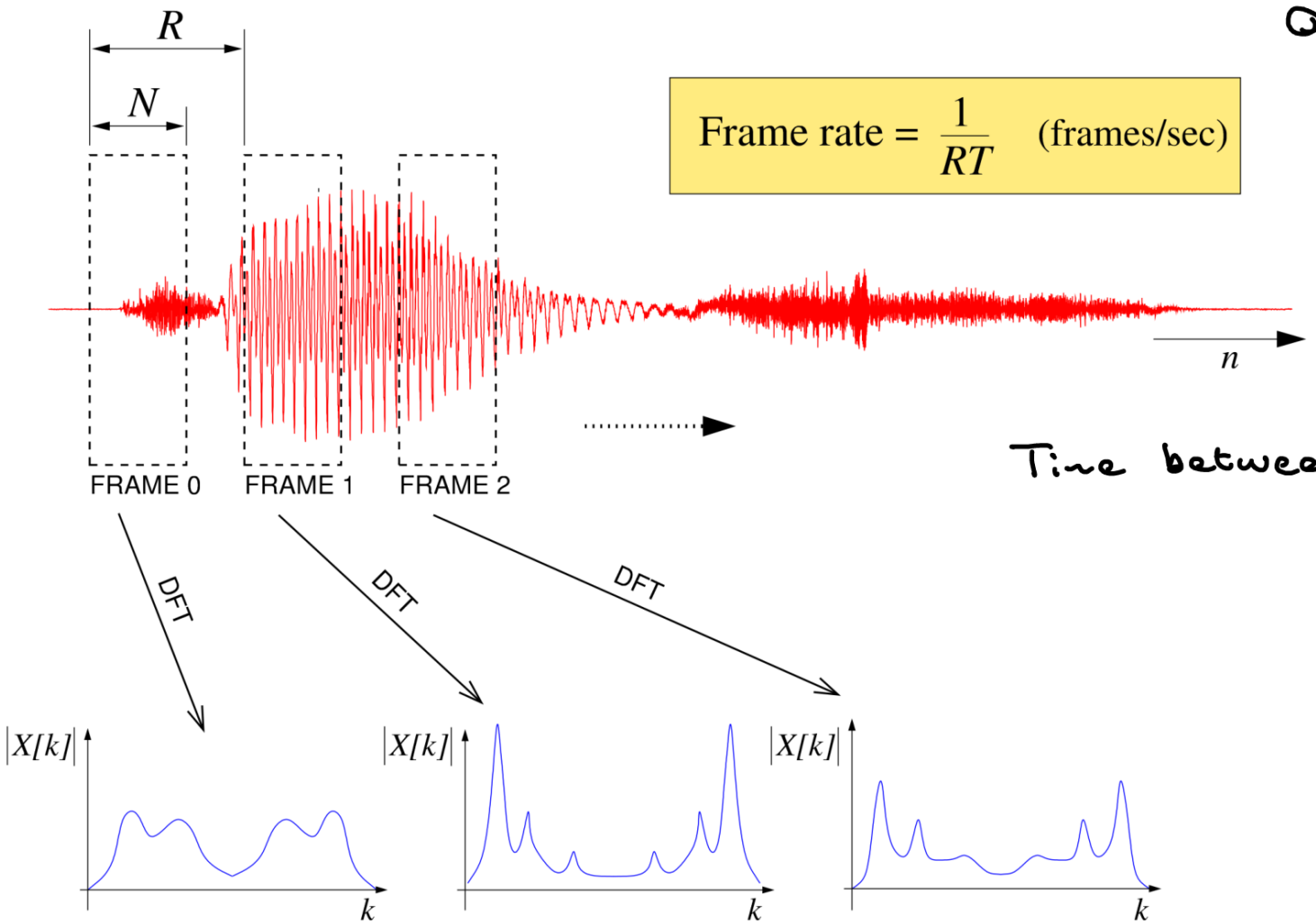
$$= f_1 + f_2 \sin(2\pi f_3 t)$$





$$y[n] = \sin\left(2\pi f_{\omega_1} n - \frac{f_{\omega_2}}{f_{\omega_3}} \cdot \cos(2\pi f_{\omega_3} n)\right)$$

Short-time Fourier transform (STFT)



$$\text{Frame rate} = \frac{1}{RT} \quad \text{(frames/sec)}$$

Overlap: $R < N$

Time between frames = R (samples) $\times T$ [sec/frame]

$\frac{1}{RT}$ frames/sec

Spectrogram