color map (matlab)

R G B

[- - -]

↑ 0 → 1

[0 0 0] : black

[1 1 1] : white

[0.5 0.5 0.5] : midtone gray

[1 0 0] : red

[0 1 0] : green

[0 0 1] : blue

4 bit gray level image

0	0	0	0	0	0	0	0
1	0.33	0.33	0.33				
2	0.66	0.66	0.66				
3	1	1	1				
				255	1	1	1

colormap

256 × 3

colormap(gray)

SAR Azimuth Resolution : L

other references $L/2$

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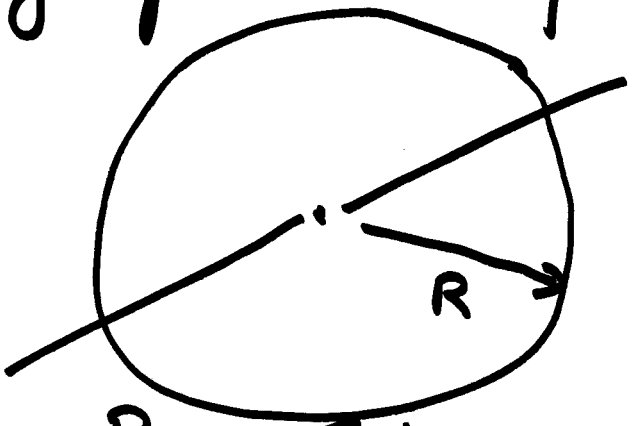
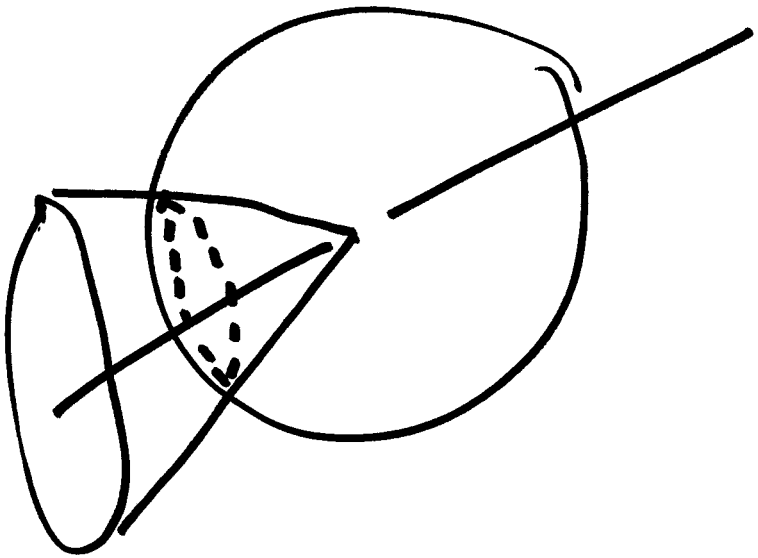
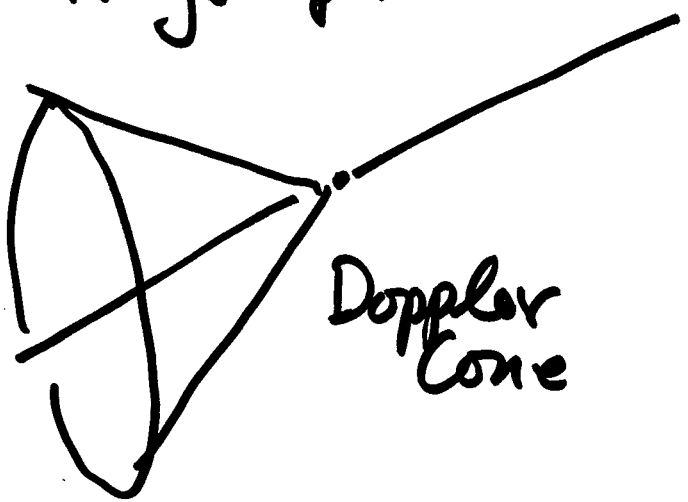
2 Equations : SAR geopositioning

1. range equation
2. doppler equation



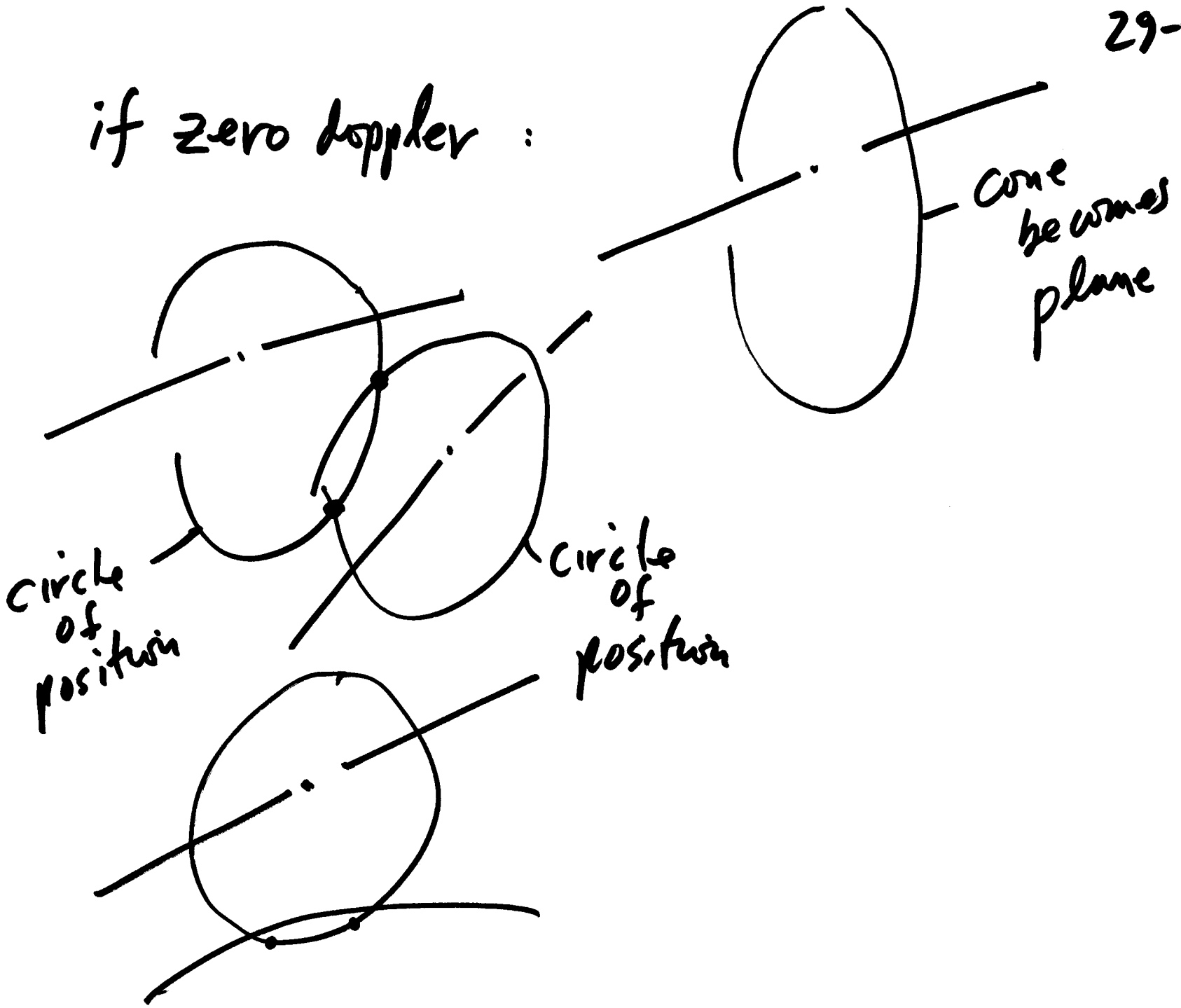
Range Sphere

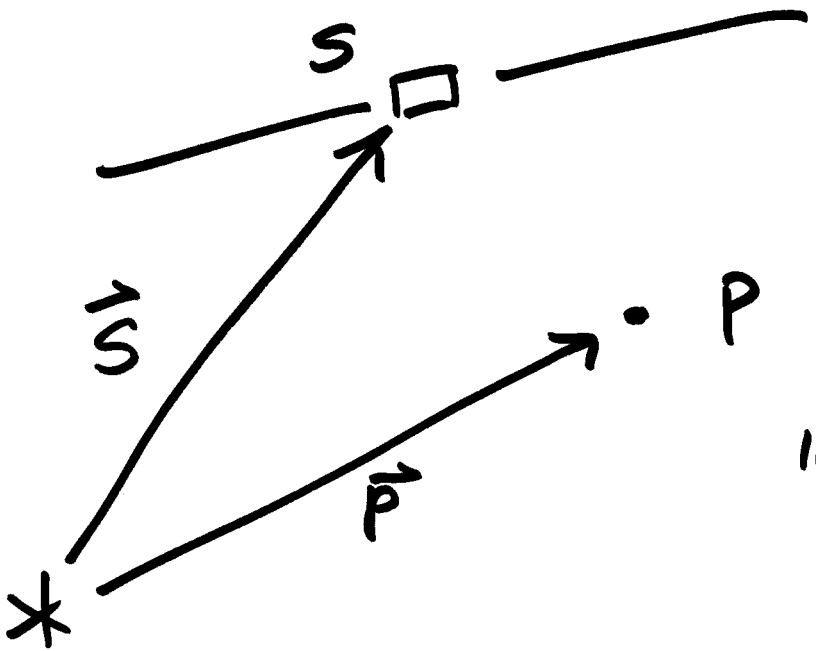




Doppler Cone

if zero doppler :





Range

$R = |\vec{P} - \vec{S}|$

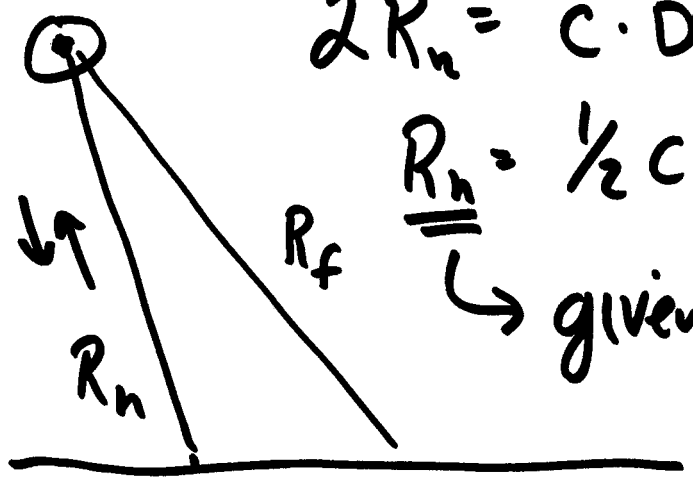
$\vec{S}$: image metadata

$\vec{P}$: unknown

$\vec{S}$: metadata

$\vec{P} = \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$

delay = DT @ near range



$2R_n = c \cdot DT$

$R_n = \frac{1}{2} c \cdot DT$

R_n ↳ given in support data

for pixel in line j

$$R_j = R_n + \tfrac{1}{2} c \frac{j}{f_s}$$

ERS : $f_s = 1.89625 \text{ e } 07$ Hz

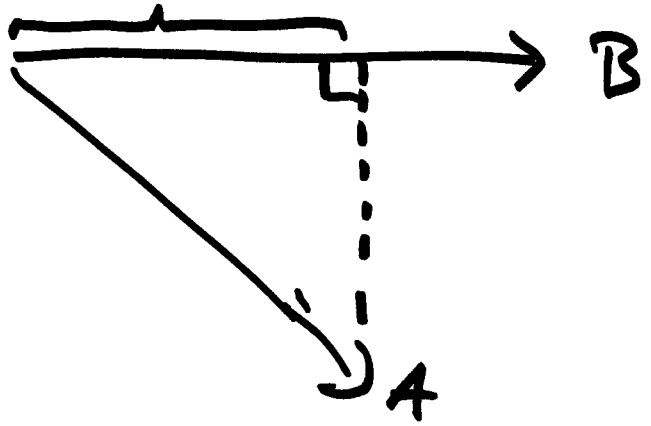
18.96 Mhz

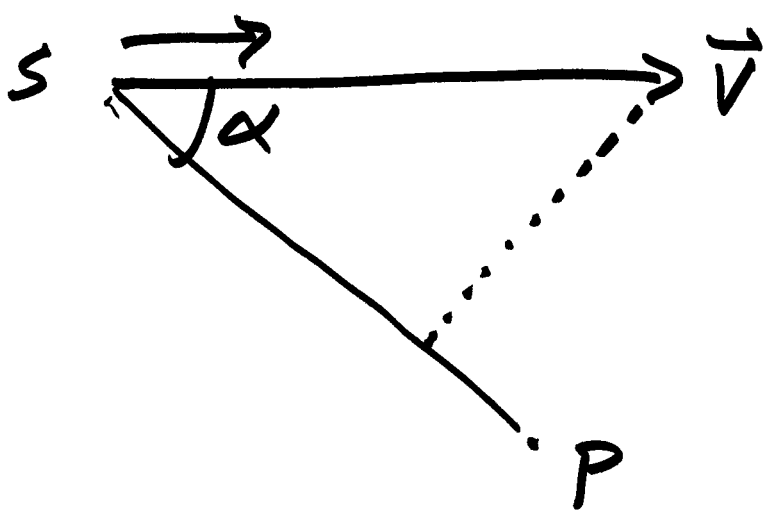
2. Doppler, range rate $\frac{dR}{dt}$

projection of $\vec{V}$ onto range vector

project A onto B

$\vec{A} \cdot \hat{b}$





magnitude of proj $\vec{V}$ onto R

$\vec{V} \cdot \hat{r}$

$|V| \cdot \cos\alpha$

$$\frac{dR}{dt} = -|V| \cos\alpha \quad m/s$$

$$f_D = + \frac{2|V| \cos\alpha}{\lambda(m/cy)}$$

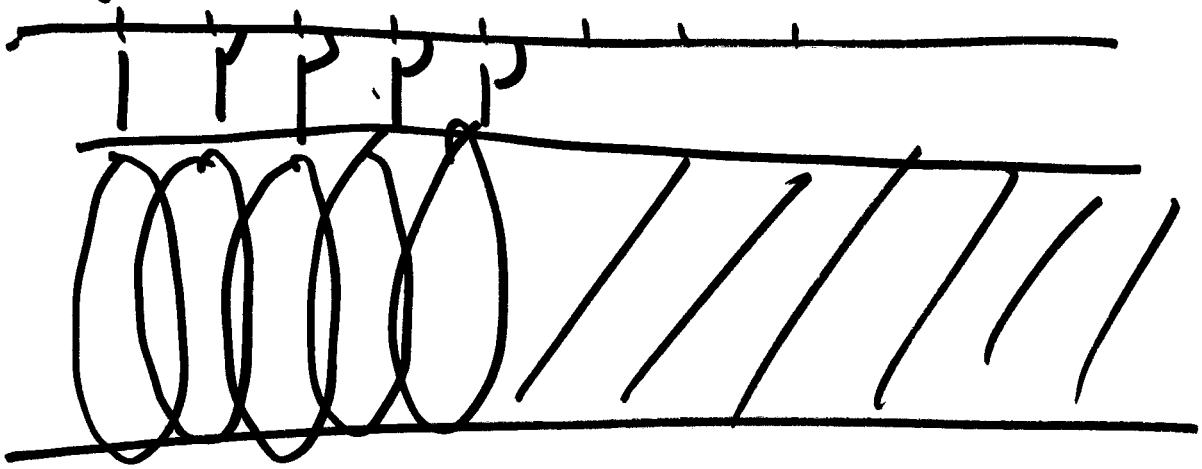
2 : round trip

λ : wavelength

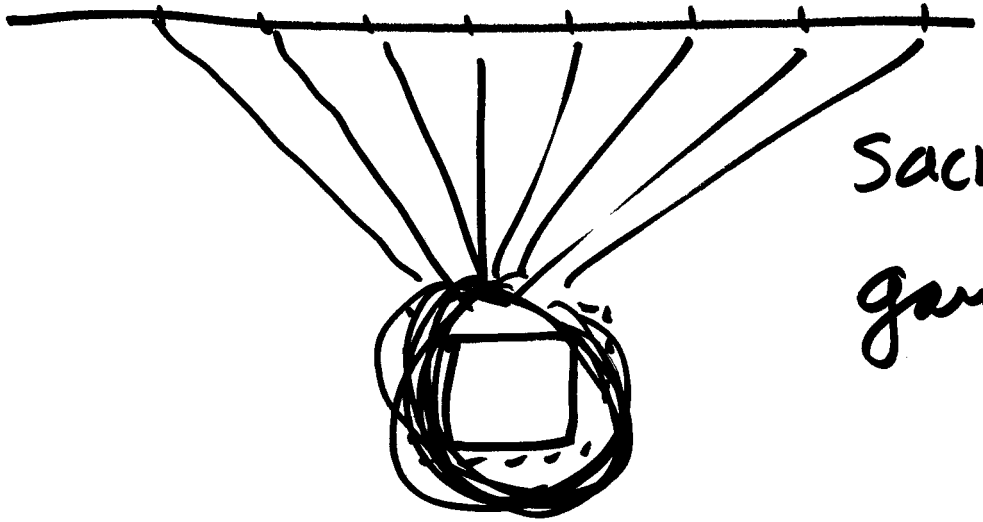
define + = closing

− = departing

Strip mode (commercial sensors)



Spotlight mode Radarsat 2, TerraSAR X



Steer antenna

Sacrifice coverage

gain. spatial resolution

use $f_D = \frac{2}{\lambda} |V| \cos\alpha$, observe f_D

may find f_D in support

otherwise compute f_D from data

$\Rightarrow$ obtain α, $\cos\alpha$

$$\cos\alpha = \frac{(\vec{P}-\vec{S})\cdot\vec{V}}{|\vec{P}-\vec{S}|\ |\vec{V}|}$$

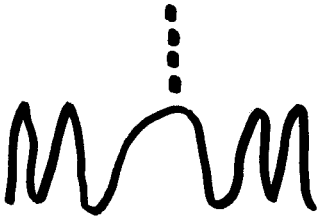
$$\alpha = \cos^{-1}\frac{(\vec{P}-\vec{S})\cdot\vec{V}}{|\vec{P}-\vec{S}|\ |\vec{V}|}$$

strip mode: α constant

spotlight mode: α variable

Chapter 11 : $\alpha_D = \cos^{-1}\left[\frac{\vec{g}-\vec{s}}{R} \cdot \frac{\vec{s}}{|\vec{s}|}\right]$

Strip mode f_D, α_D are same for all lines



Zero f_{DC}

nonzero f_{DC}

if single image : 3rd equation to make unique solution

$$\frac{X_t^2 + Y_t^2}{R_e^2} + \frac{Z_t^2}{R_p^2} = 1$$

h : ellipsoid height

$R_p = (1-f)(R_e + h)$ f : flattening

1. range equation
2. doppler equation
3. ellipsoid constraint

} solve unknown vector

$$\vec{P} = \begin{pmatrix} X_t \\ Y_t \\ Z_t \end{pmatrix}$$

Solve @ time ECI
Convert results to ECF

Notice: SAR did not require altitude information

optical: $X_L Y_L Z_L \; \omega \; \phi \; \kappa$

SAR: $X_L Y_L Z_L \; V_x V_y V_z$ + Doppler α