

$$\underbrace{a + \frac{\dot{\theta}}{\theta}}_{\text{doesn't disappear in linearization}} = a \dot{\theta} \frac{1}{\theta}$$

↑  
big!

$\theta^2, \theta \dot{\theta}, \times \theta \Rightarrow \text{small} \Rightarrow \text{go to zero}$

$\sin \theta, \cos \theta \Rightarrow \theta, 1$

$$V_c^2 = |\dot{x}|^2 + |\dot{y}|^2 \Rightarrow V_c = \sqrt{(\dot{x})^2 + (\dot{y})^2}$$

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$$1 \quad \frac{\partial f(\theta, \dot{\theta}, t)}{\partial \theta} \quad 2 \quad \frac{\partial f(\theta, \dot{\theta}, t)}{\partial \dot{\theta}} \quad 3 \quad \frac{\partial f(\theta, \dot{\theta}, t)}{\partial t}$$

$$f = 2Ua \sin \theta \dot{\theta}$$

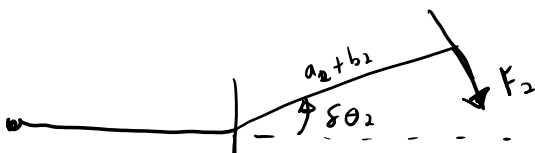
$$1) \quad 2Ua \dot{\theta} \cos \theta$$

$$2) \quad 2Ua \sin \theta$$

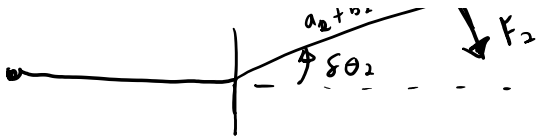
$$3) \quad 2Ua \sin \theta \ddot{\theta} + 2Ua \dot{\theta}^2 \cos \theta$$

$$f = \dot{\theta}^2$$

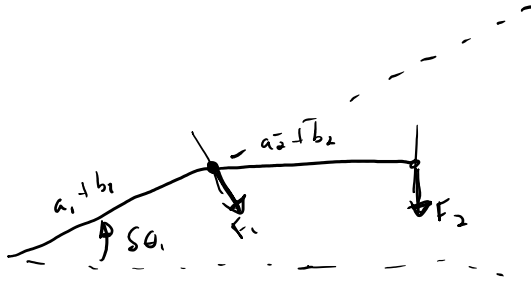
$$\frac{\partial f}{\partial \dot{\theta}} = 2\dot{\theta}$$



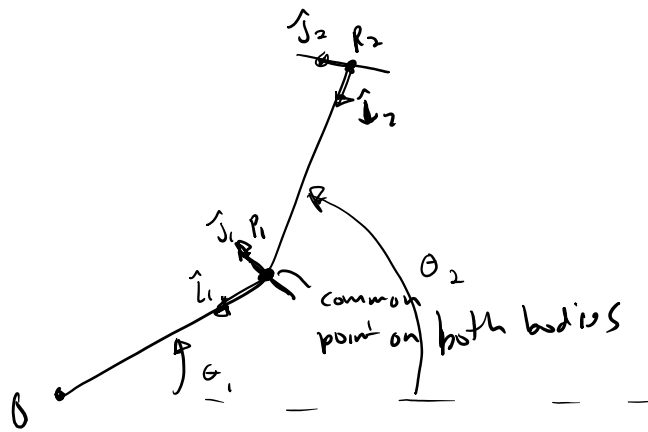
$$\delta W = -F_2 (a_2 + b_2) \delta \theta_2$$



$$\delta W = -F_2 (a_2 + b_2) \delta \theta_2$$



$$\delta W = [F_1 (a_1 + b_1) - F_2 (a_2 + b_2)] \delta \theta_1$$



$$\vec{V}_{P_1} = \vec{V}_0 + \dot{\theta}_1 \hat{z} \times \vec{r}_{P_1/O_1}$$

$$\vec{V}_{P_2} = \vec{V}_{P_1} + \dot{\theta}_2 \hat{z} \times \vec{r}_{P_2/P_1}$$

↑  
 $\hat{l}_2, \hat{j}_2$

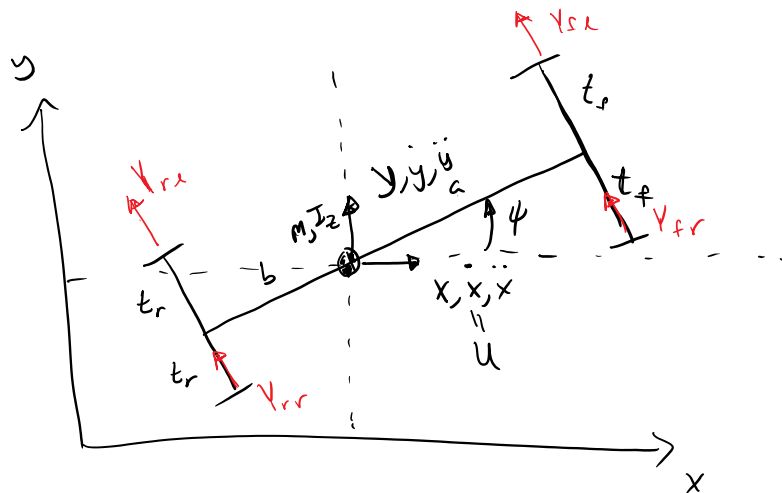
$$\hat{l}_2 = ( ) \hat{l}_1 + ( ) \hat{j}_1$$

$$\hat{j}_2 = ( ) \hat{l}_1 + ( ) \hat{j}_1$$

# Automobiles

Locus "lateral dynamics"  $\Rightarrow \dot{r}$  yaw rate  
 $y$  lateral deviation.

planar motion



## Parameters

$a, b, t_r, t_f, m, I_z, u$

## Variables

$x, y, \psi, v_{rx}, v_{fx}, v_{rr}, v_{fr}$

## Basic Motion

$x = ut, \dot{x} = u, \ddot{x} = 0$

$y = 0, \dot{y} = 0$

$\psi = 0, \dot{\psi} = 0$

## Equations Newton-Euler

$$\sum F_x = m\ddot{x}$$

$$\sum F_y = m\ddot{y}$$

$$\sum T_z = I_z \ddot{\psi}$$