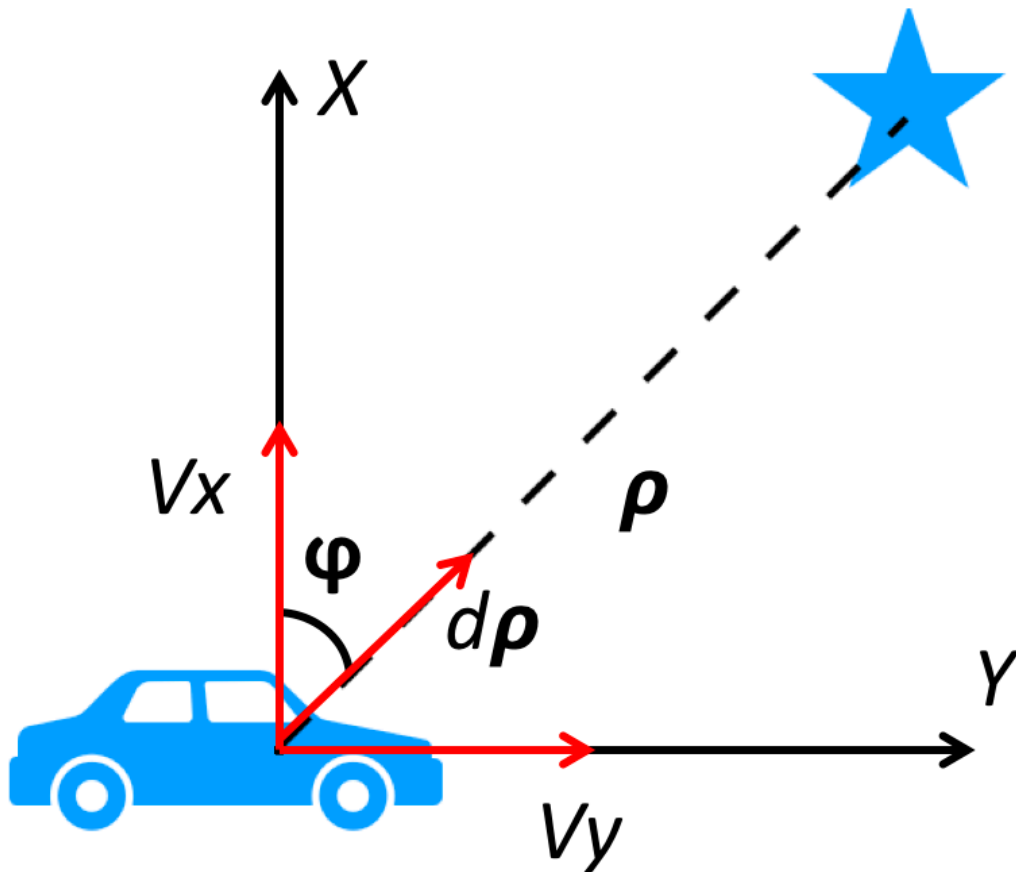# Mathematics

1. Radar measurements:

As the graph shows, the radar can only measure the radial distance ρ and radial velocity $\dot{\rho}$. As such the measurement transformation function from state (px, py, vx, py) to the radar measurement $(\rho, \phi, \dot{\rho})$ can be written as:

$$\rho = \sqrt{px^2 + py^2}$$

$$\phi = atan\frac{py}{px}$$

$$\dot{\phi} = vx * cos\phi + vy * sin\phi = \frac{vx * px + vy * py}{\rho}$$

and the Jacobian Matrix of Hj can be written as :

$$\begin{bmatrix} px/\rho & py/rho & 0 & 0 \\ -py/\rho^2 & px/\rho^2 & 0 & 0 \\ \frac{py(py*vx-px*vy)}{\rho^2} & \frac{px(px*vy-py*vx)}{\rho^2} & px/\rho & py/\rho \end{bmatrix}$$

given that

$$d(tanx) = \frac{1}{1+x^2} \Big|$$