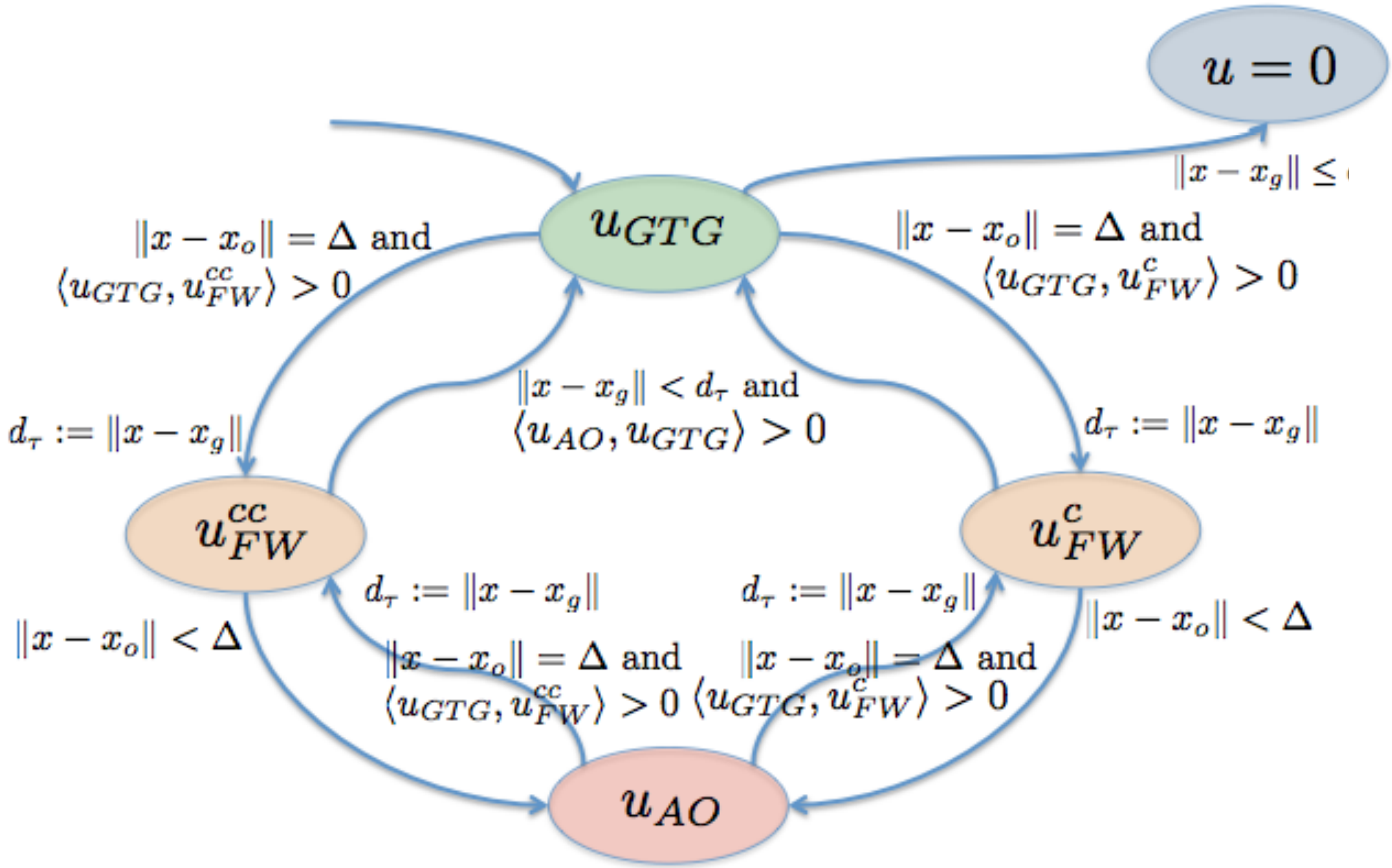
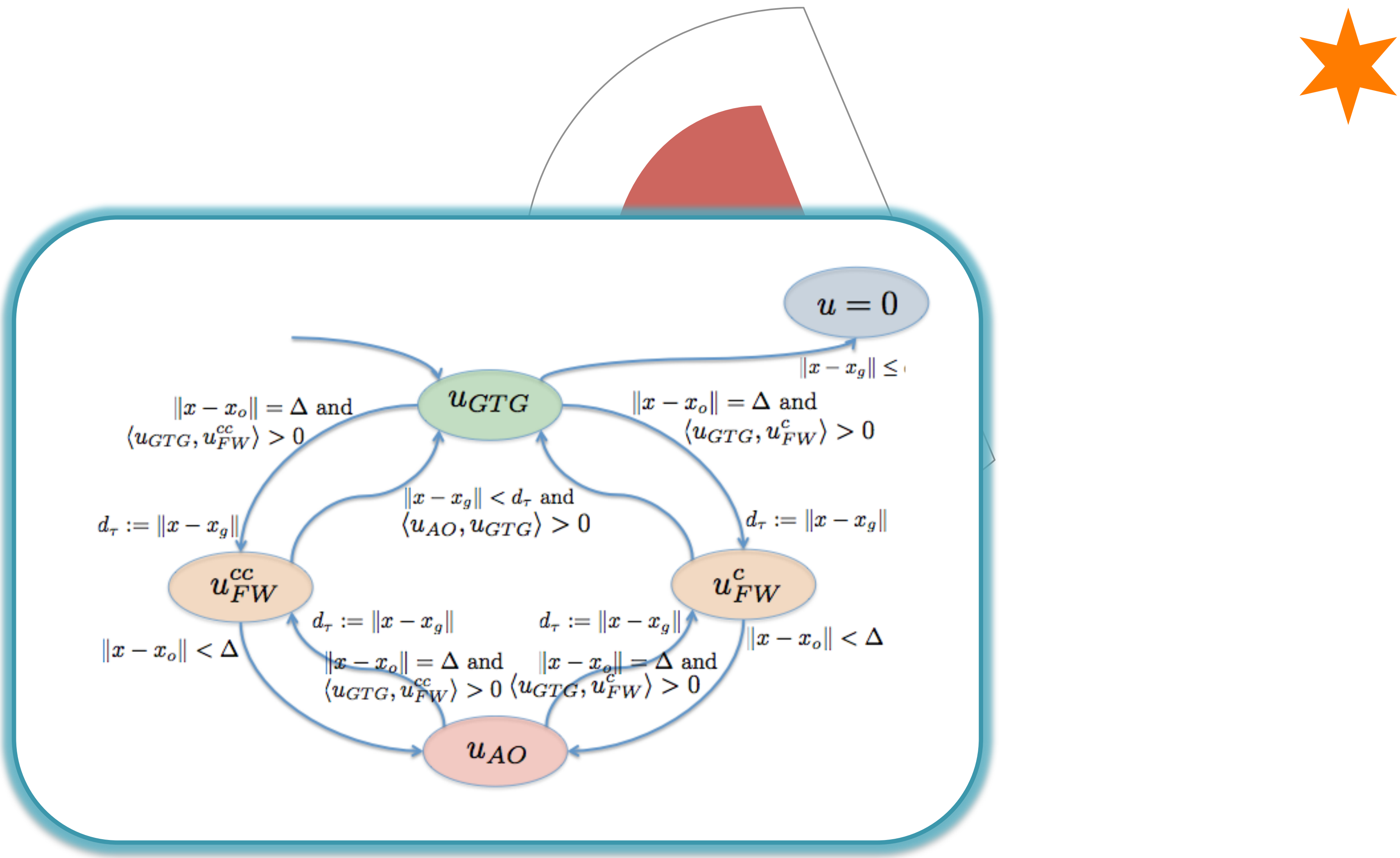
GLUE LECTURE 6 – Vectors for Navigation

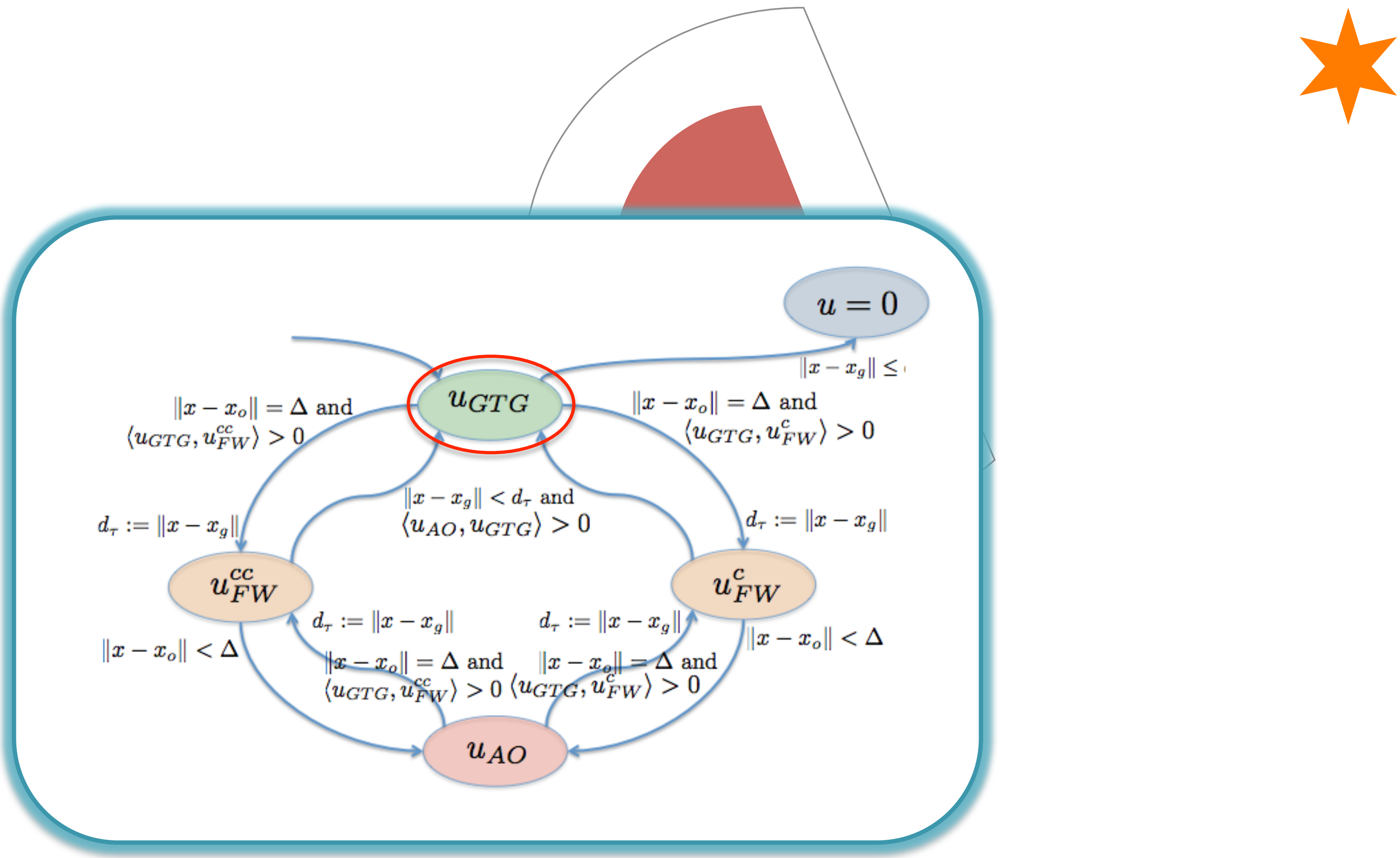
(This will be helpful for Quiz 6!)

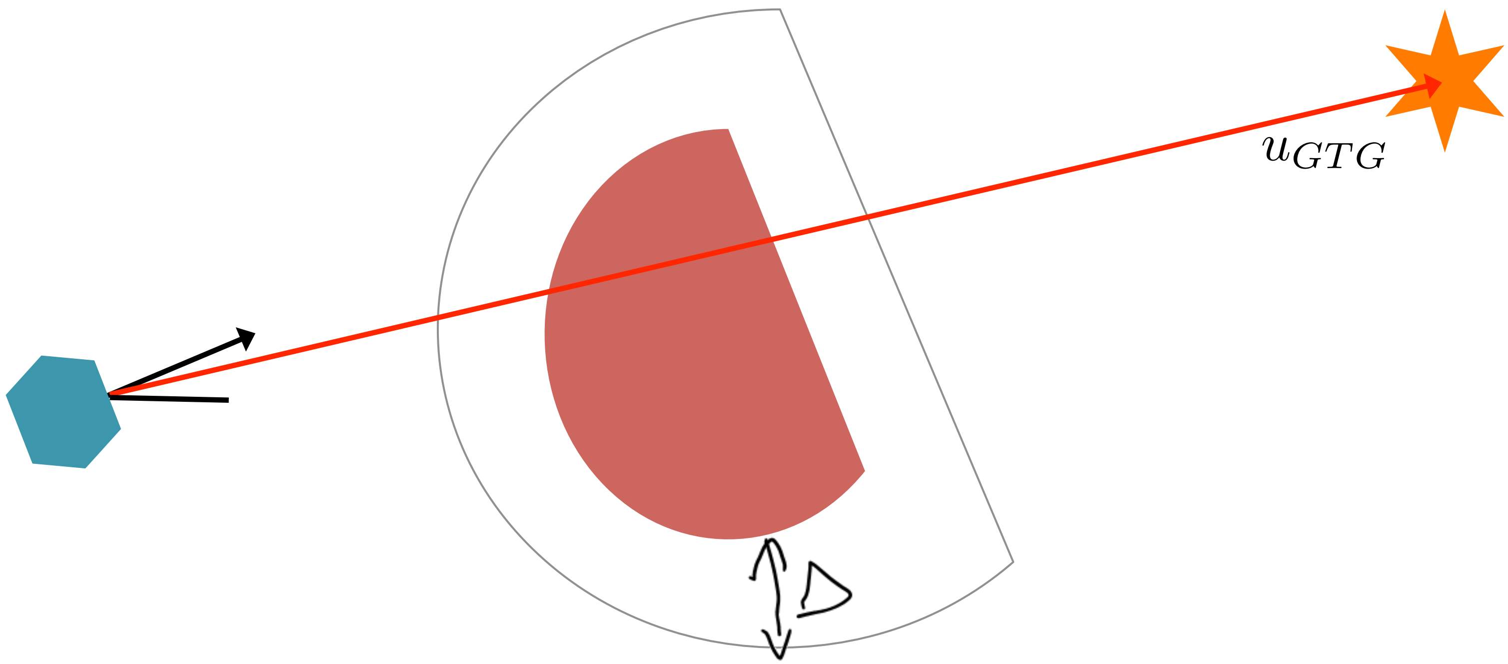


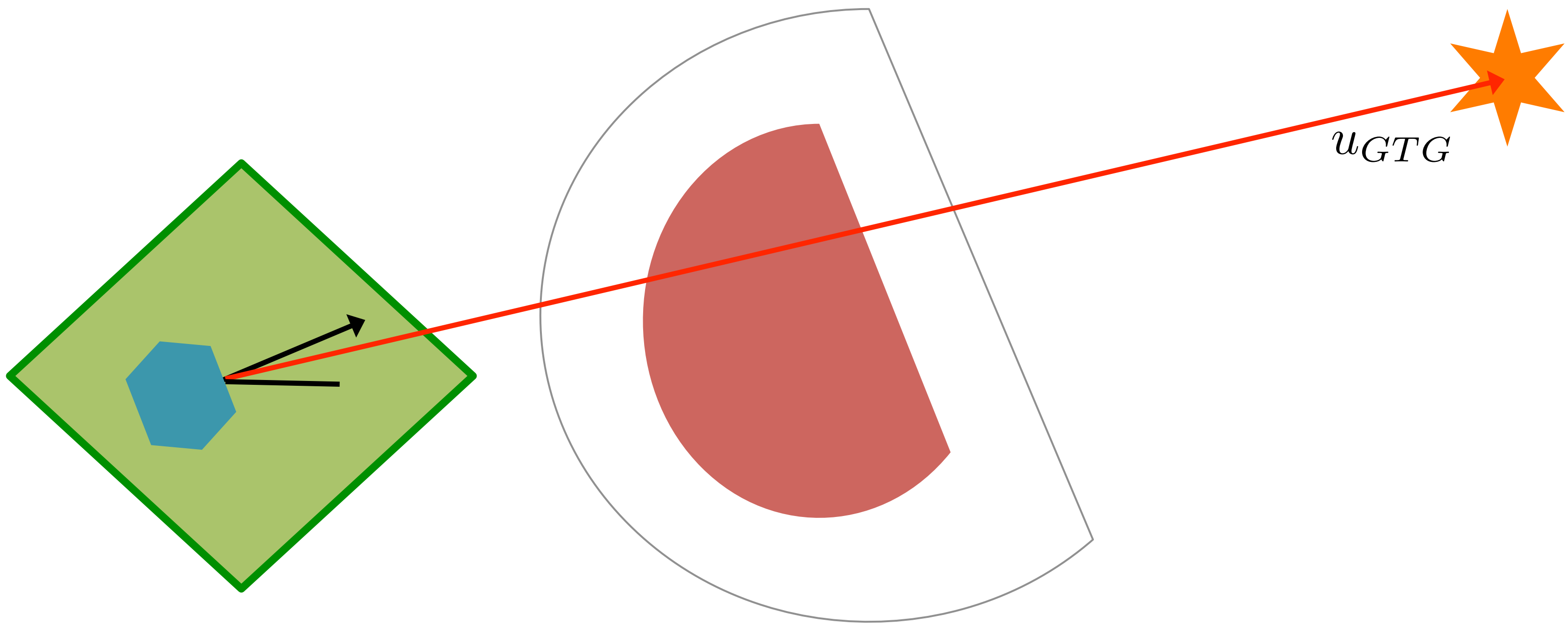
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u_{FW}^{cc}
u_{FW}^{c}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
u_{AO}



$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}


$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u_{FW}^{cc}
u_{FW}^{c}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
u_{AO}


u_{GTG}
Δ


u_{GTG}

Transitioning between different states in the hybrid automaton represents a switch between controllers. The desired direction of travel is obtained by tracking desired positions and rotating vectors.

$$u_{GTG} = K_{GTG}(x_{goal} - x)$$

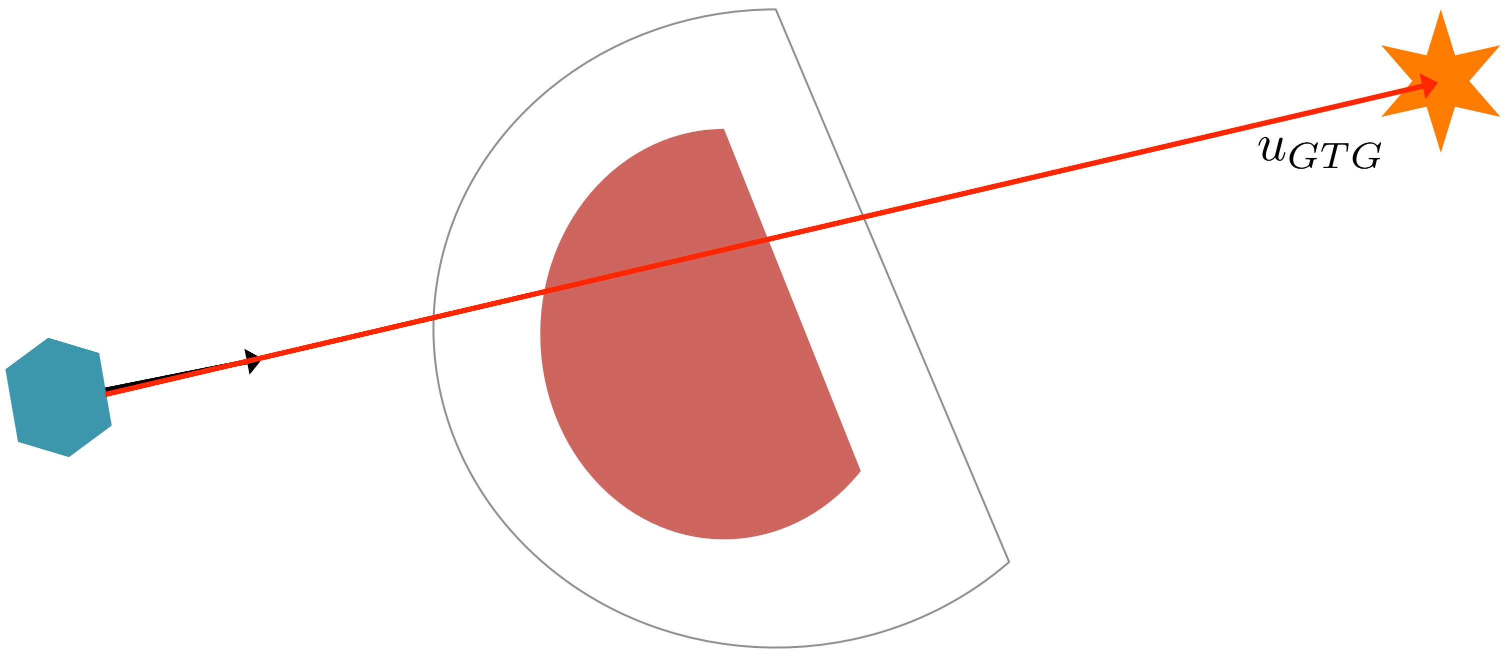
$$u_{AO} = K_{AO}(x - x_{obstacle})$$

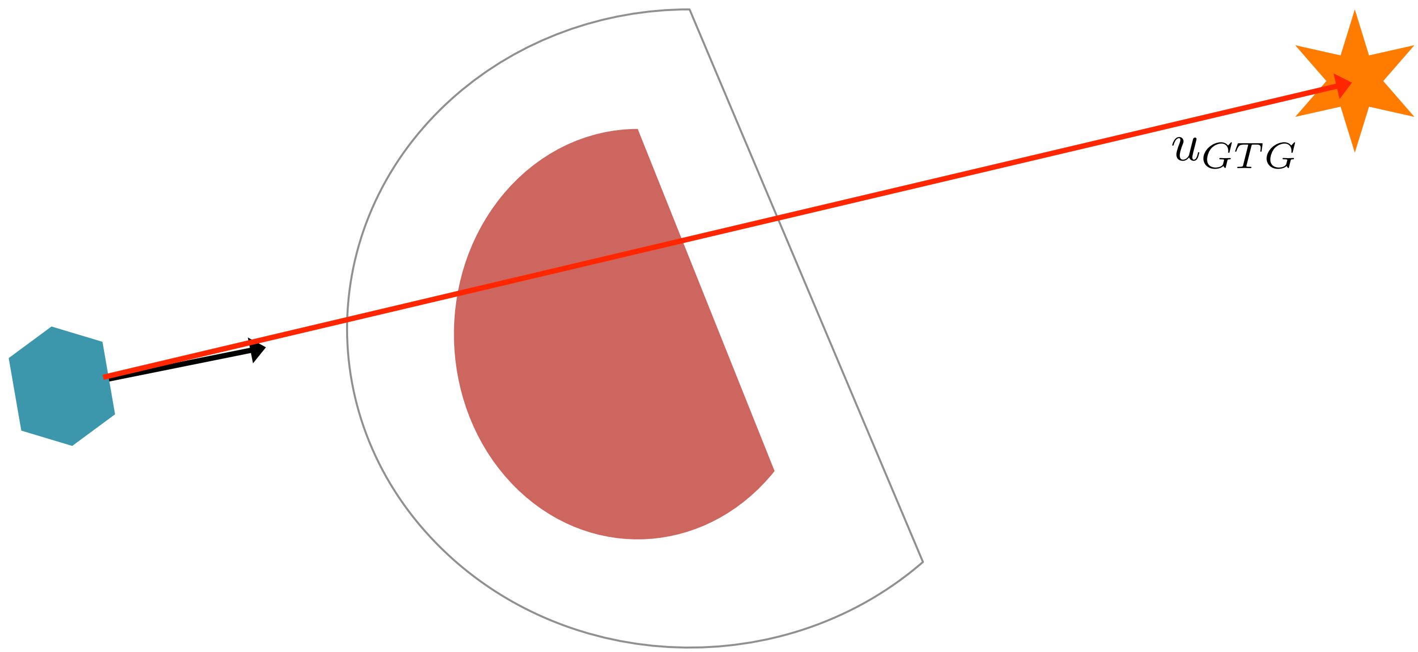
$$u_{FW} = \alpha R(\pm\pi/2)u_{AO}$$

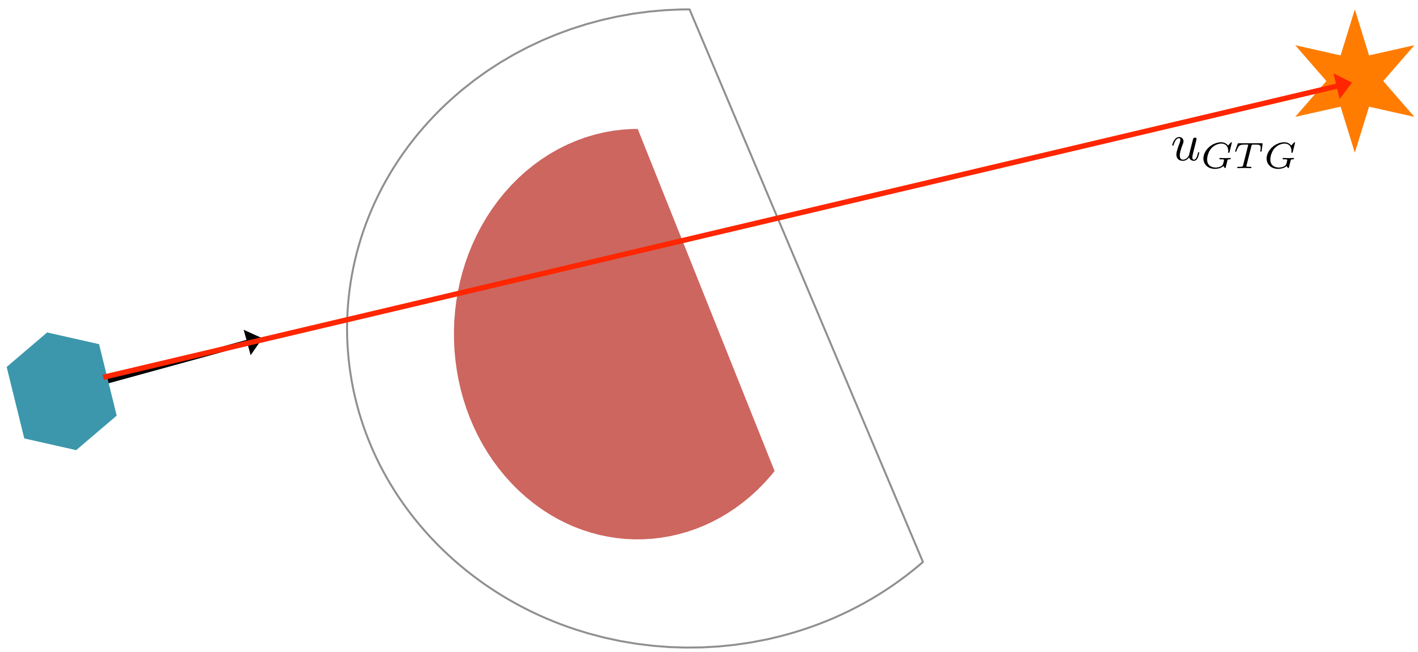
$$R(\theta) = \begin{bmatrix} cos(\theta) & -sin(\theta) \\ sin(\theta) & cos(\theta) \end{bmatrix}$$

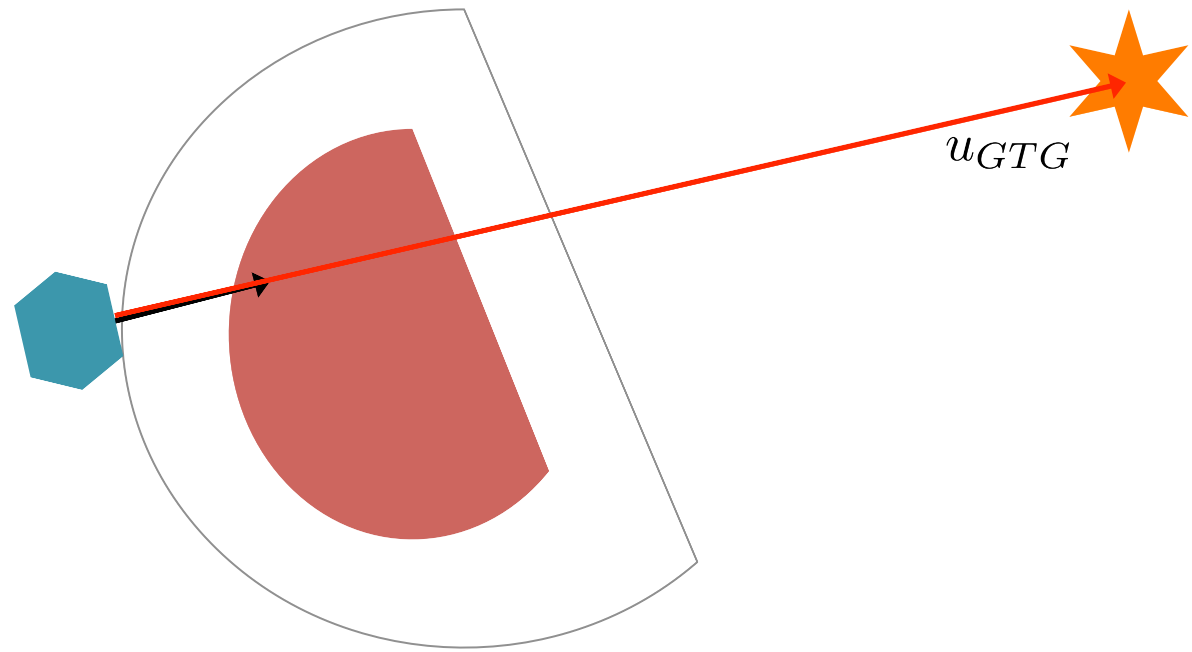
$$\text{where } \dot{x} = u$$

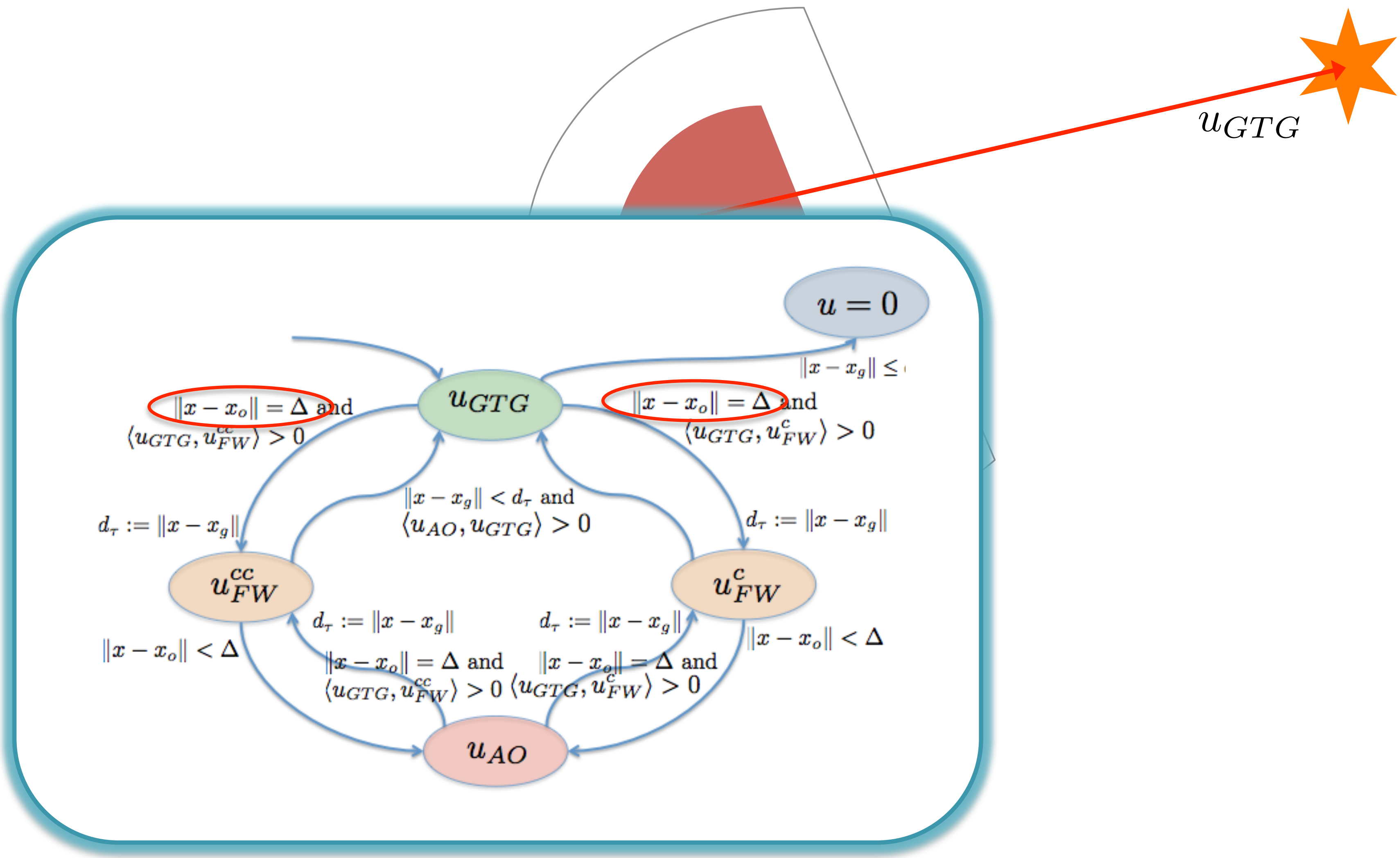
But remember, the robot implements these behaviors via (v, w) and actuator (wheel) commands for, for example, a differential drive robot. (See Module / Glue 2.)

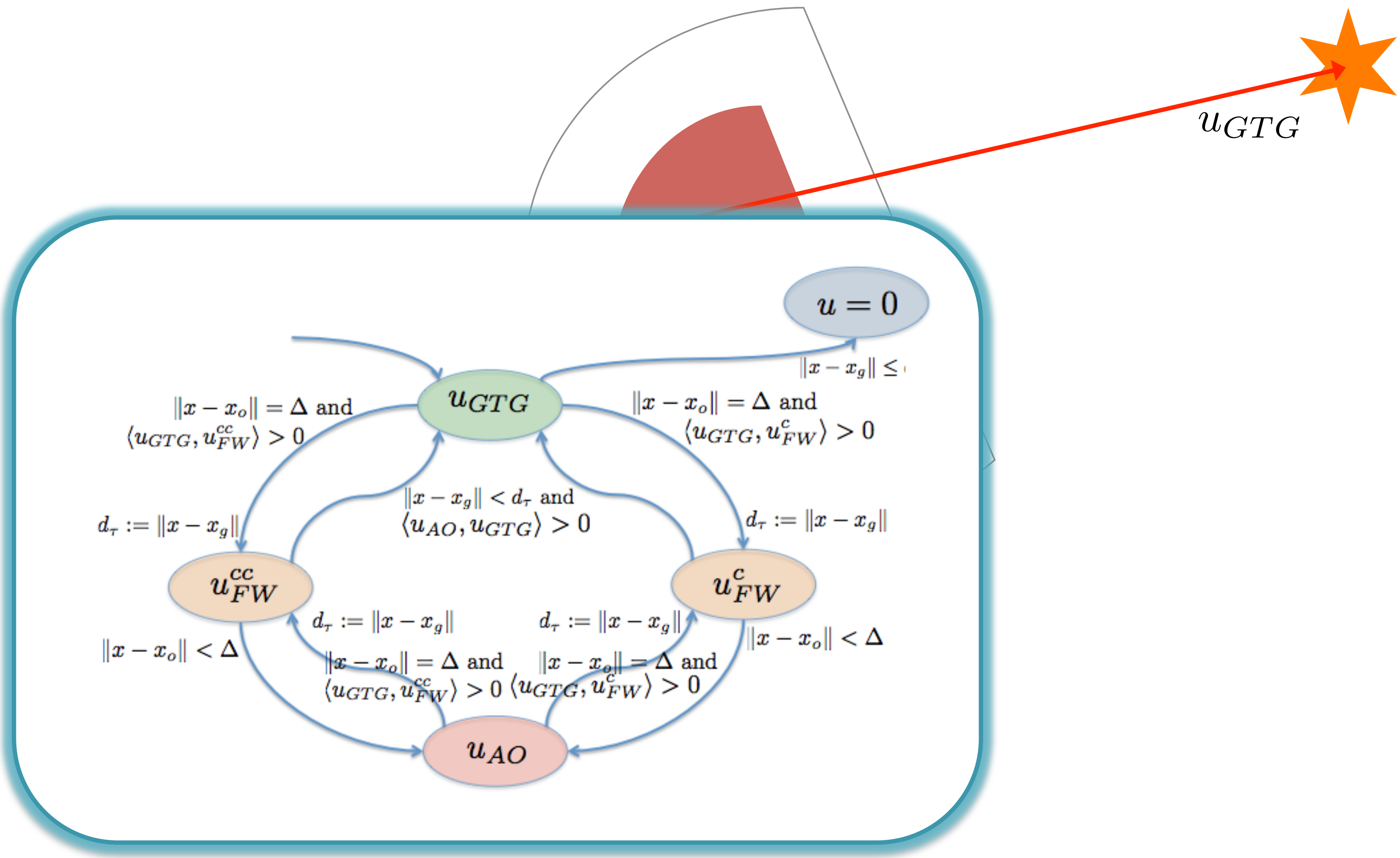

u_{GTG}


u_{GTG}

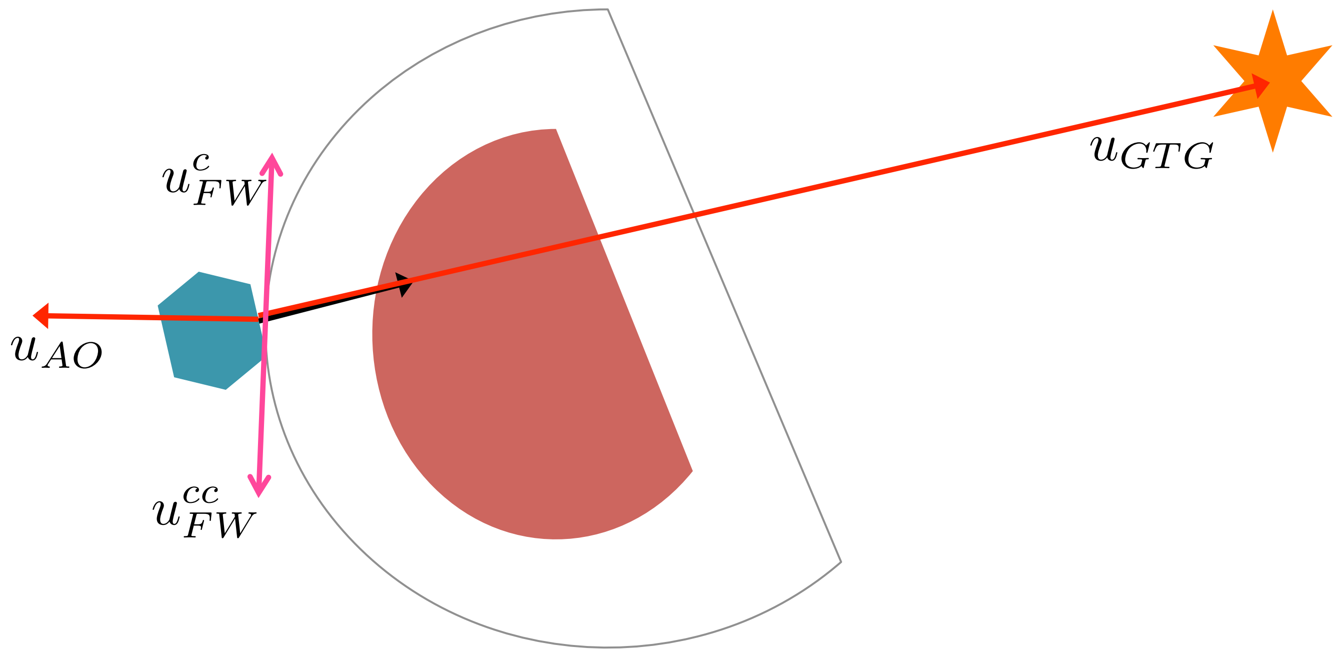

u_{GTG}

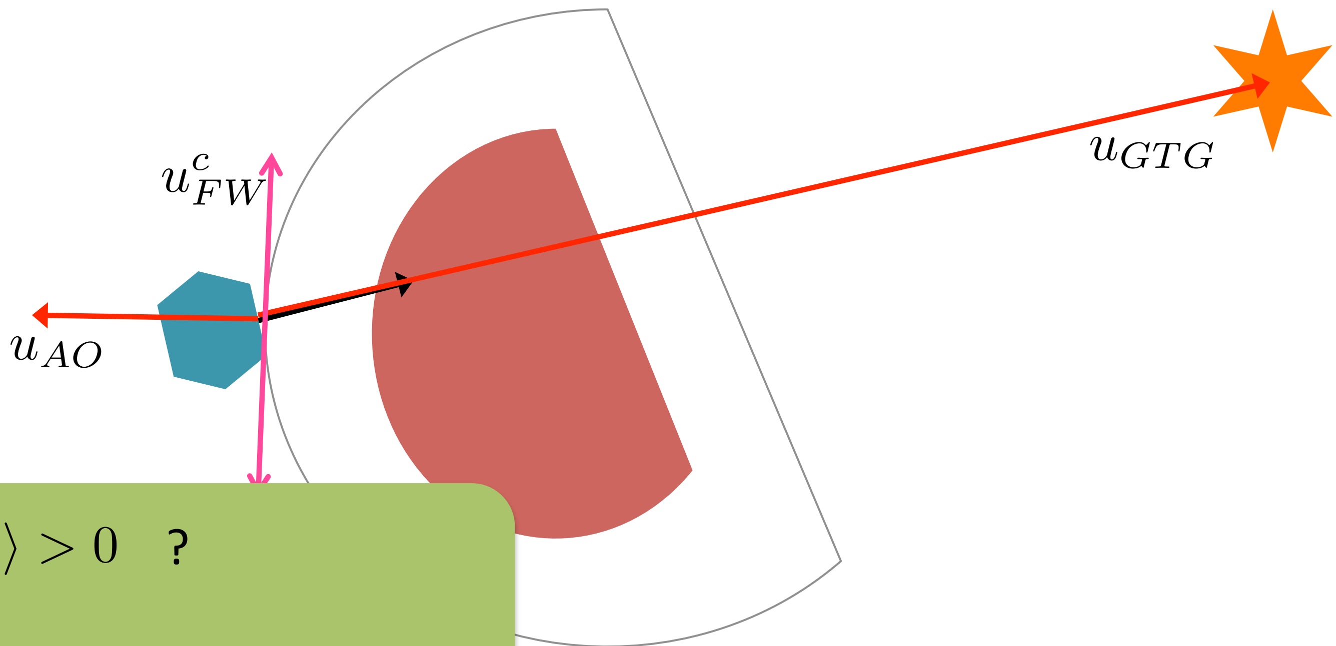

u_{GTG}


u_{GTG}
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u_{FW}^{cc}
u_{FW}^{c}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
u_{AO}



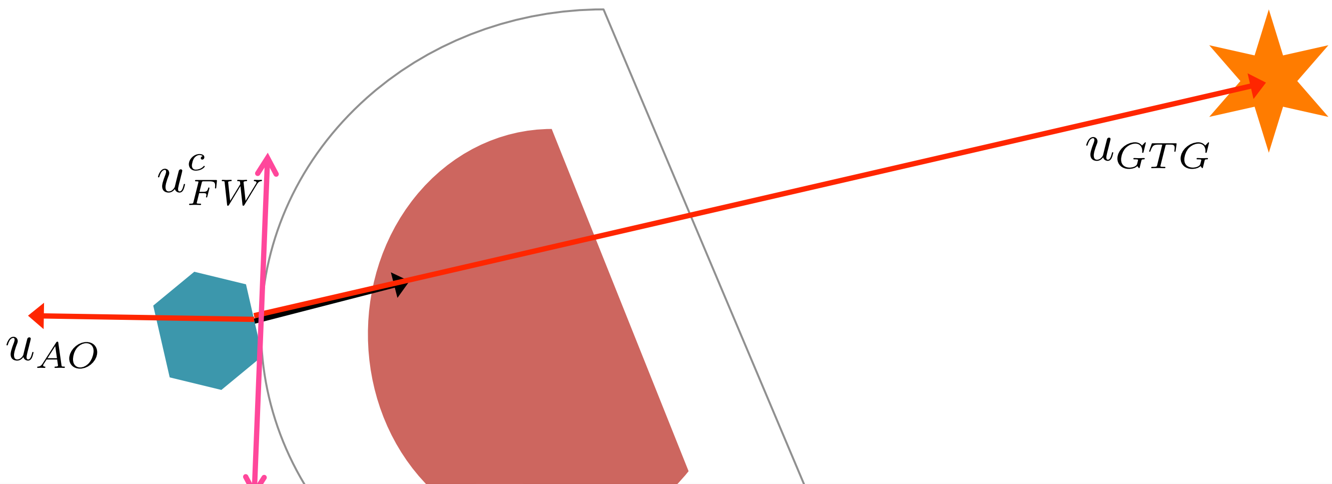
u_{GTG}
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u_{FW}^{cc}
u_{FW}^{c}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{cc} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u_{FW}^{c} \rangle > 0$
u_{AO}


u^{c}_{FW}
u_{AO}
u^{cc}_{FW}
u_{GTG}



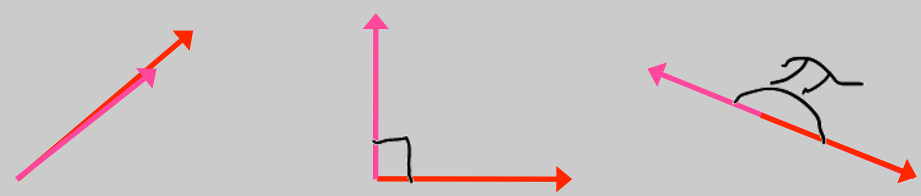
$$\langle u_{GTG}, u^c_{FW} \rangle > 0 \quad ?$$

$$= \|u_{GTG}\| \|u^c_{FW}\| \cos(\theta_{GTG,FW})$$

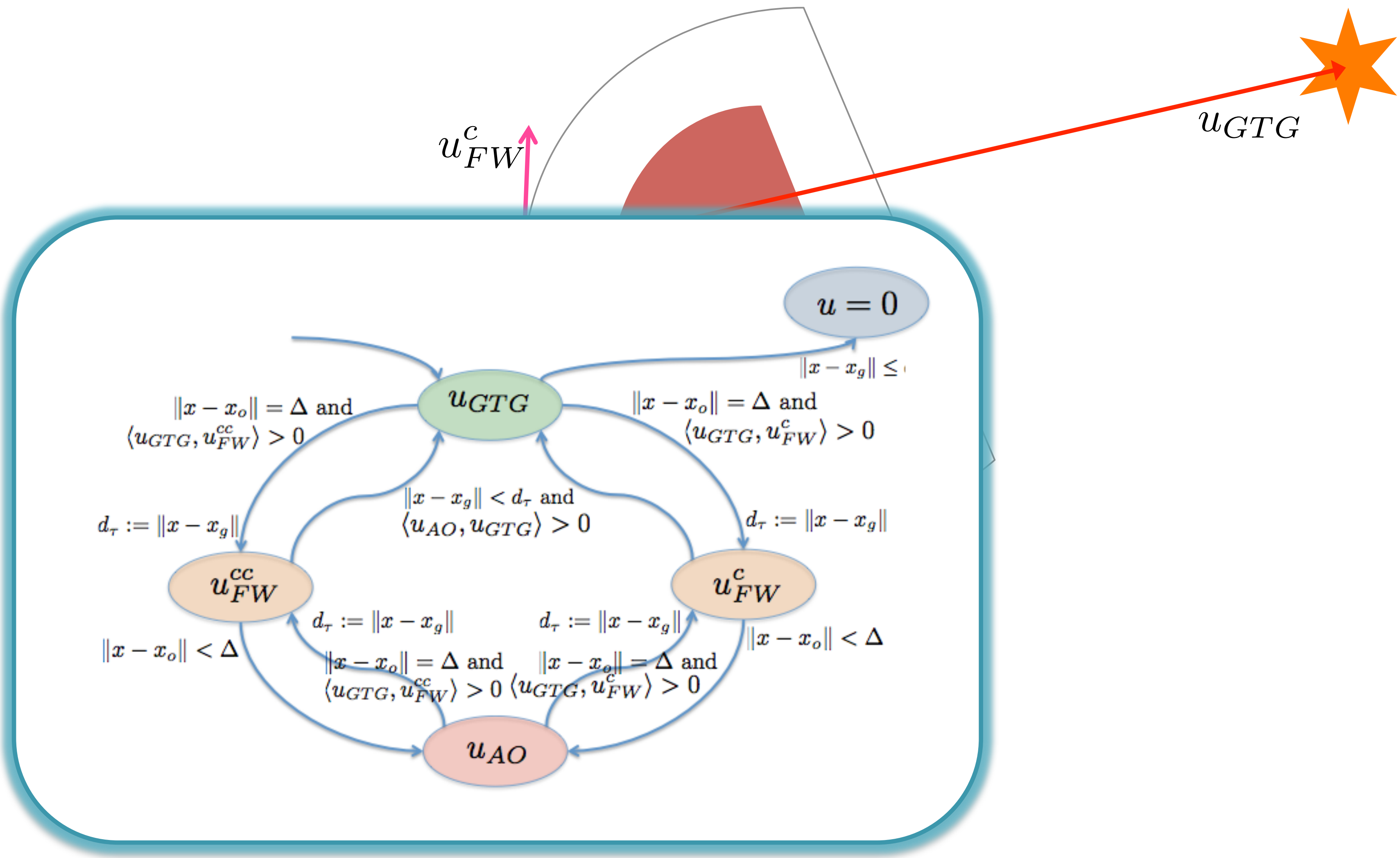


$\langle u_{GTG}, u^c_{FW} \rangle > 0$?

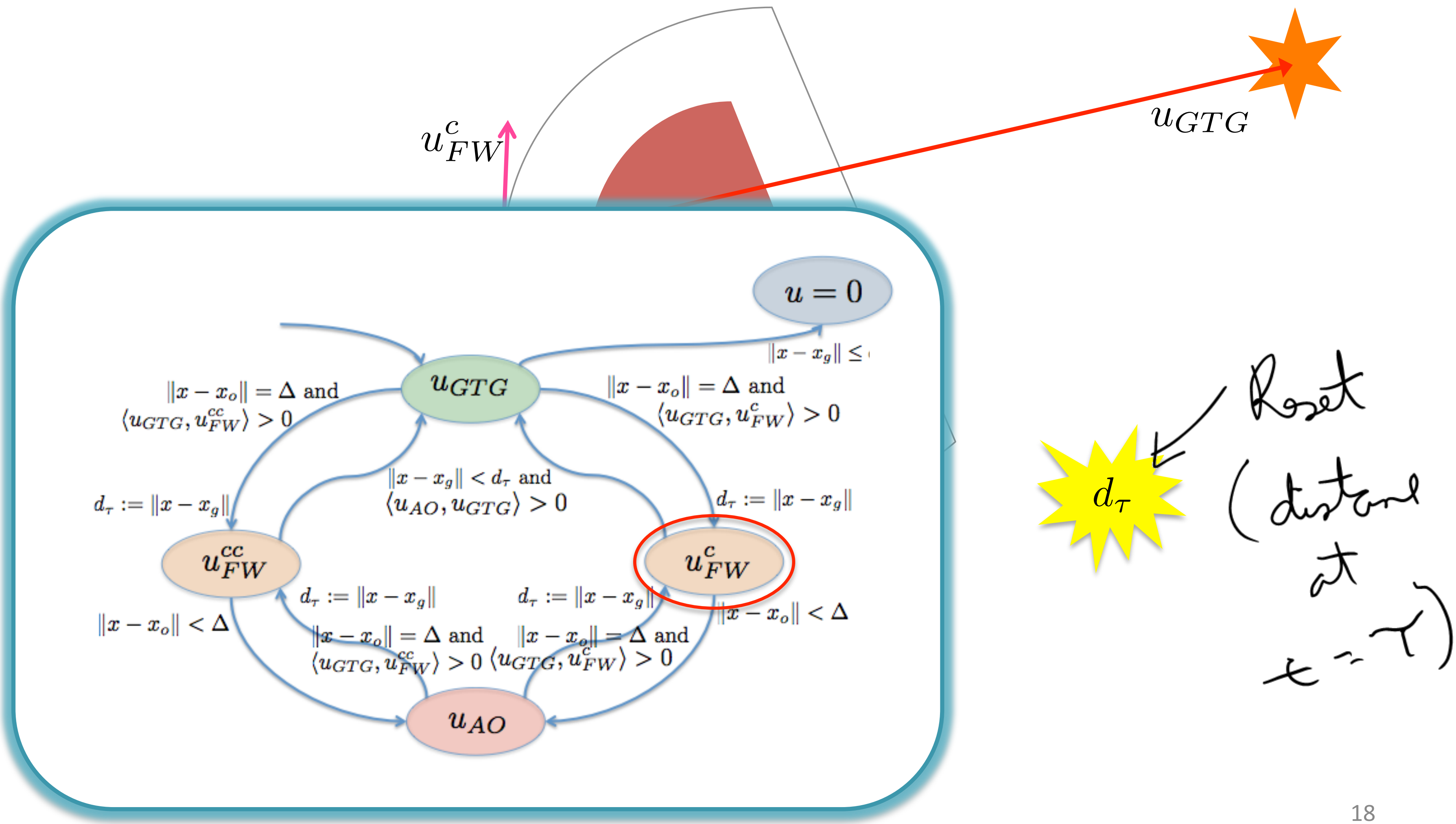
$= \|u_{GTG}\| \|u^c_{FW}\| \cos(\theta_{GTG,FW})$

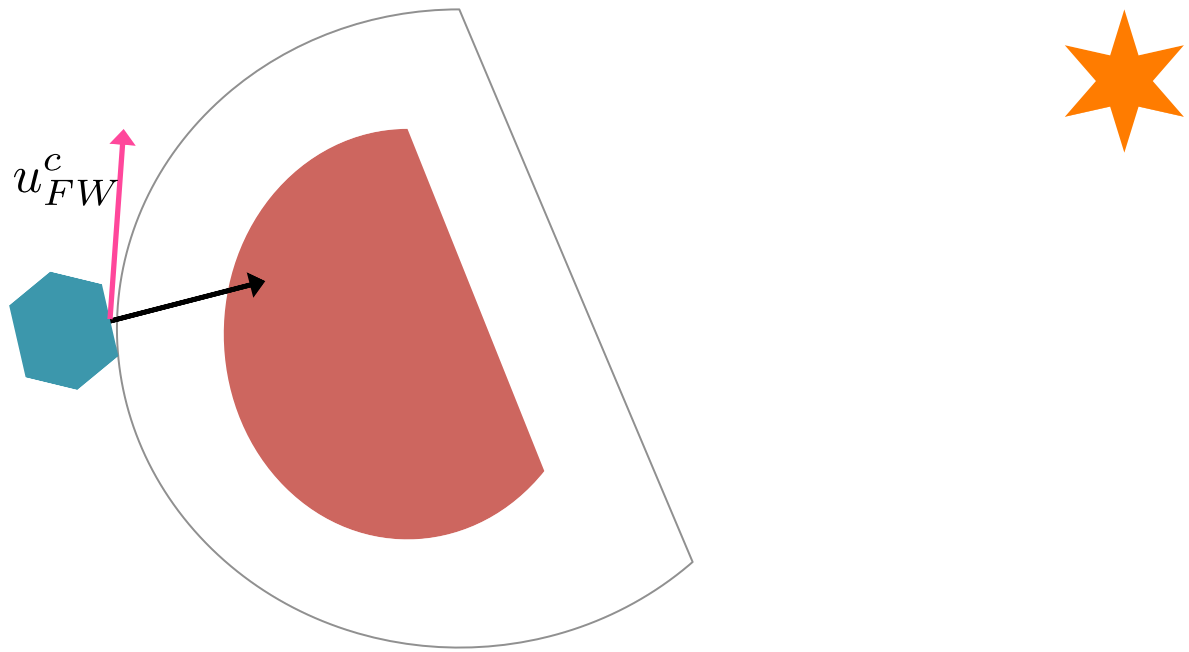


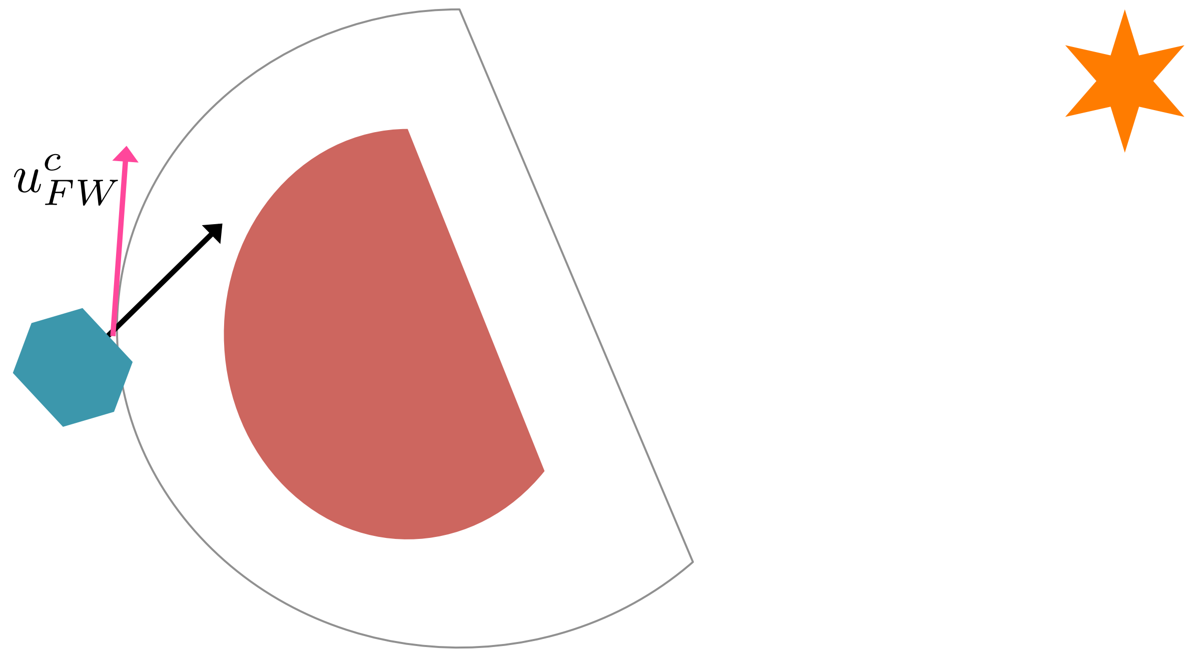
$\cos(0) = 1$ $\quad \cos\left(\frac{\pi}{2}\right) = 0$ $\quad \cos(\pi) = -1$

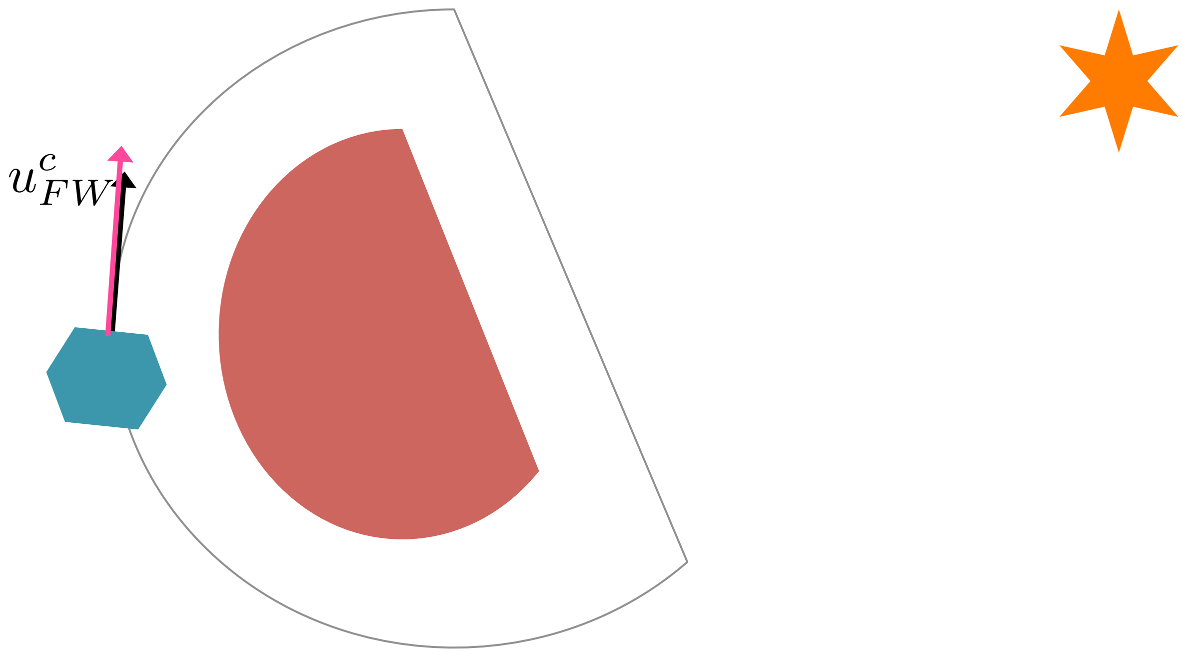


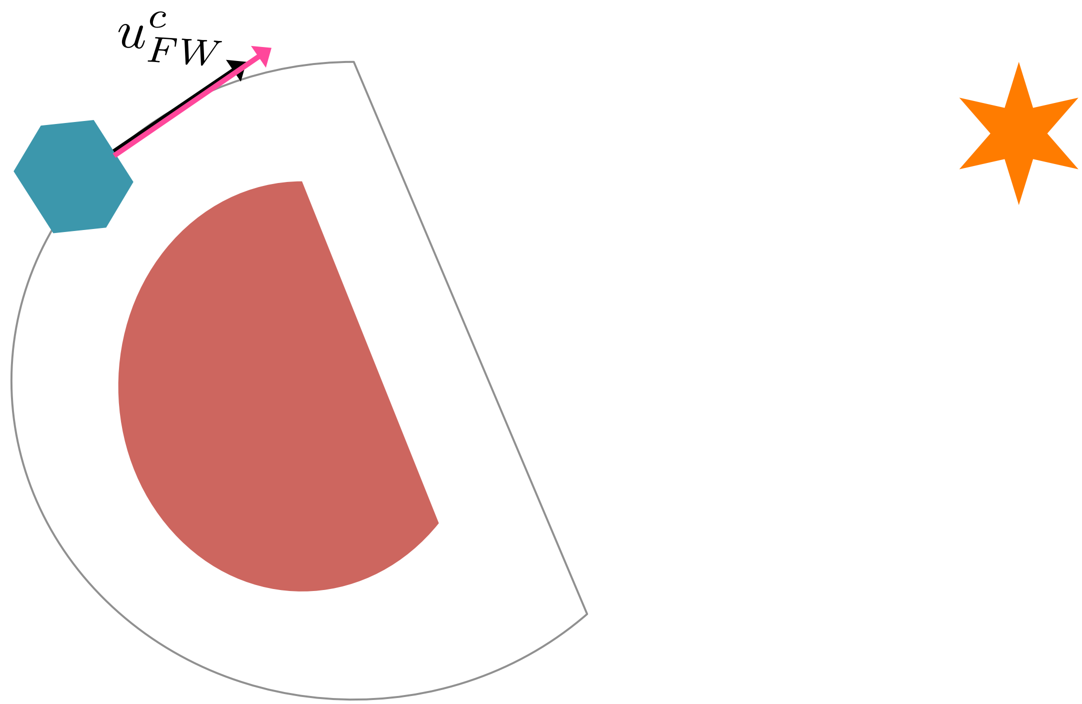
u^c_{FW}
u_{GTG}
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}

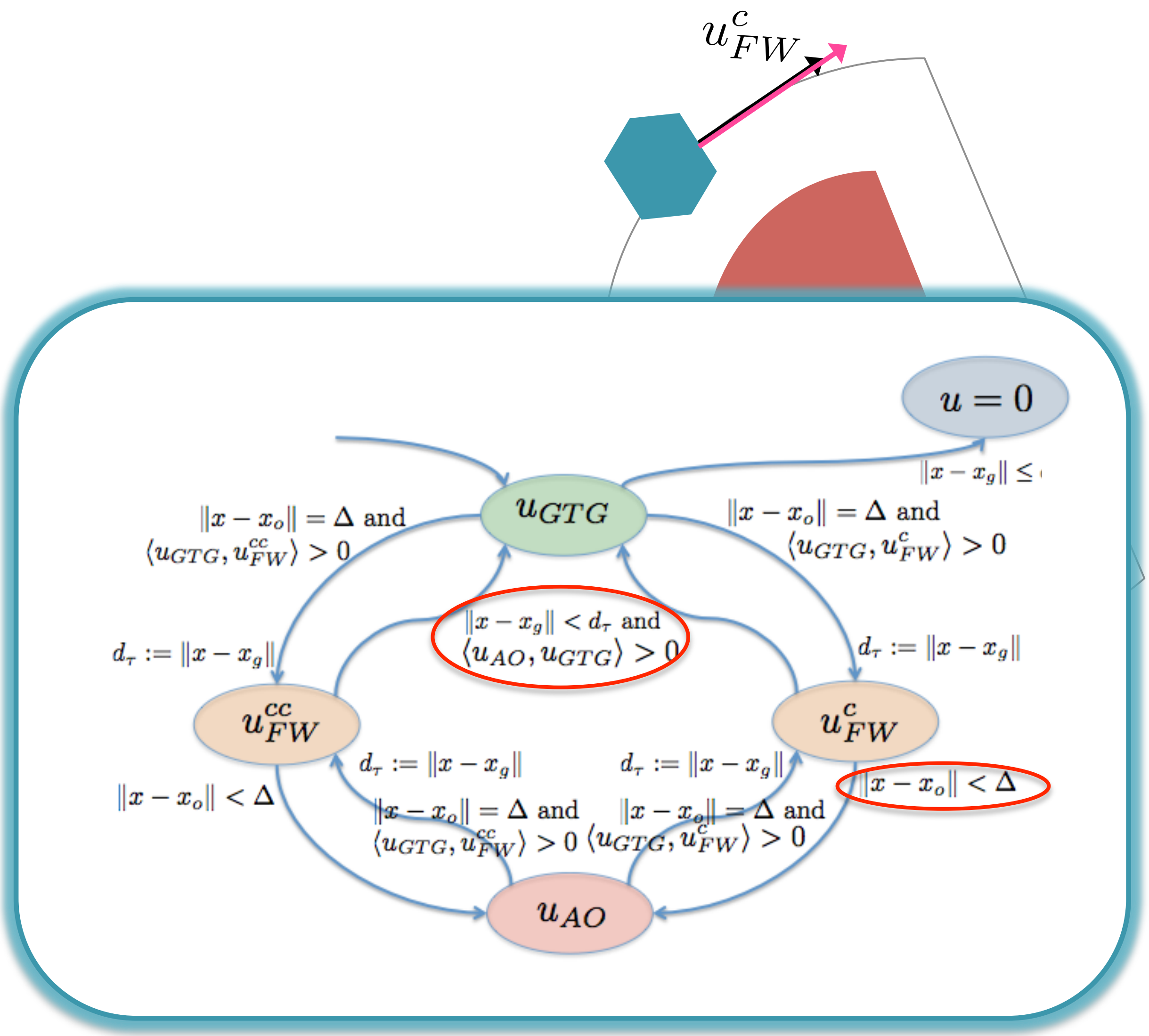

u^c_{FW}
u_{GTG}
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}
d_τ
Reset
(distance
at
$t = \tau$)

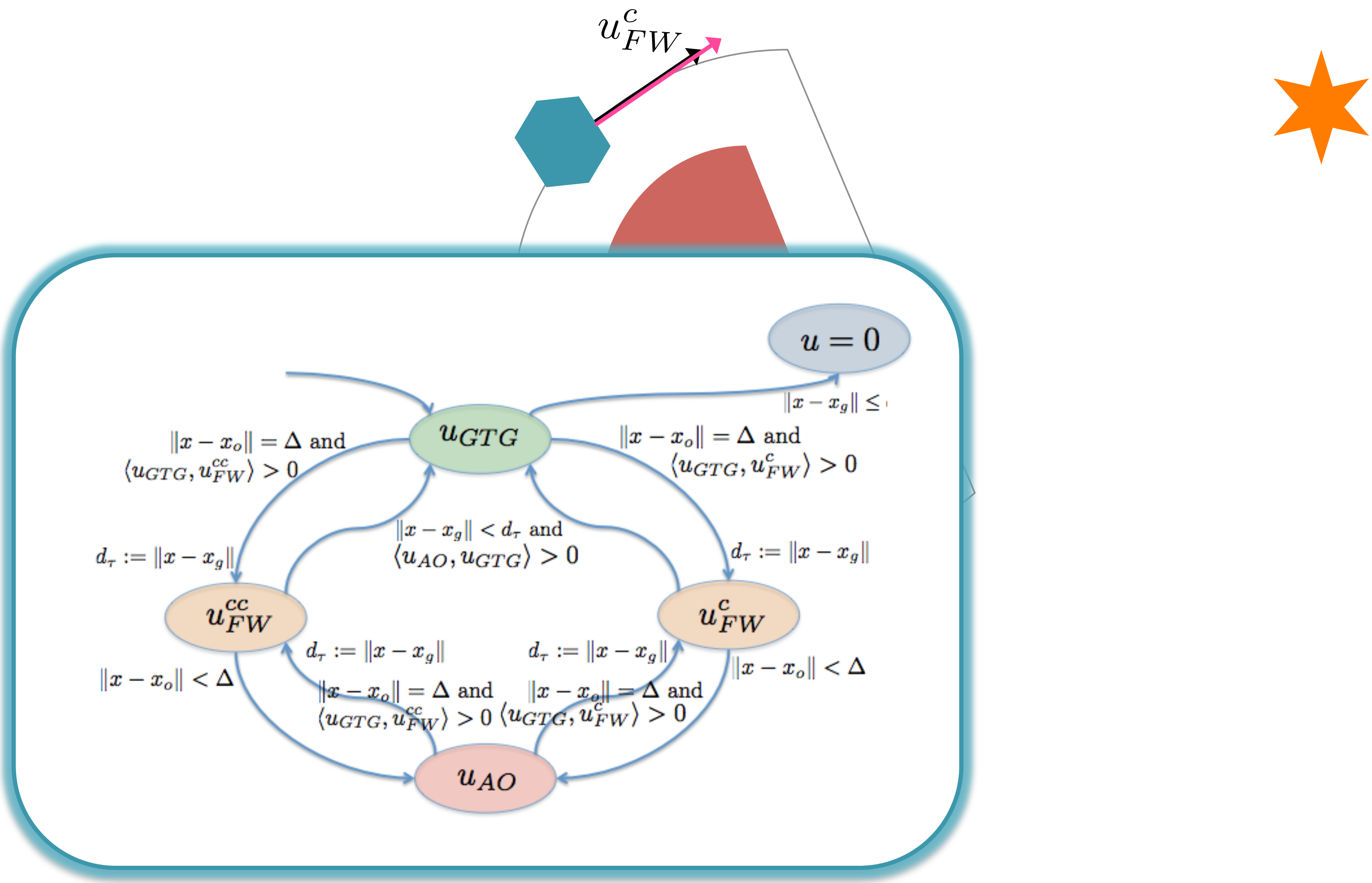

u^c_{FW}

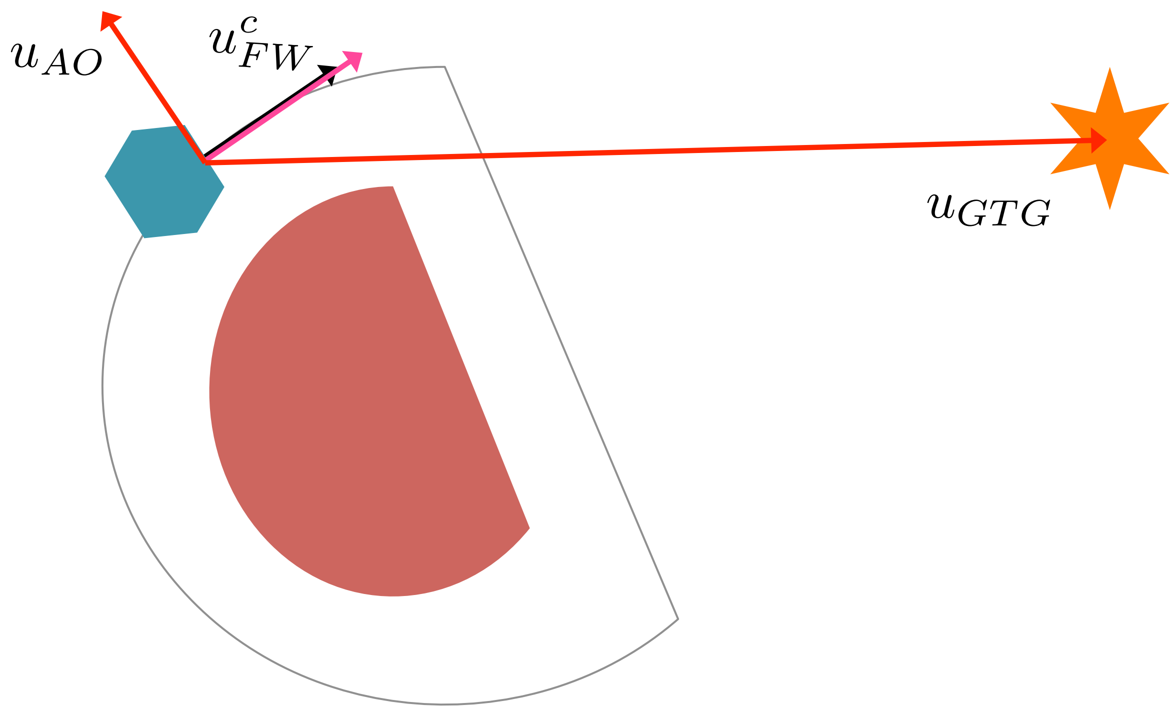

u^c_{FW}

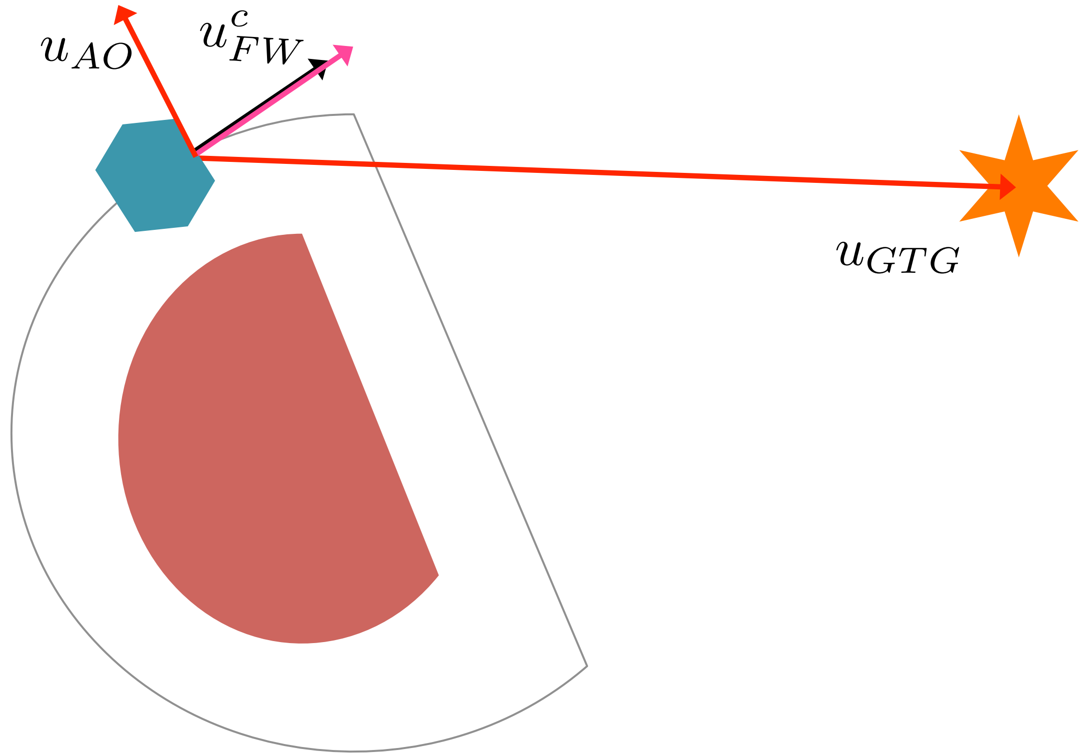

u^c_{FW}

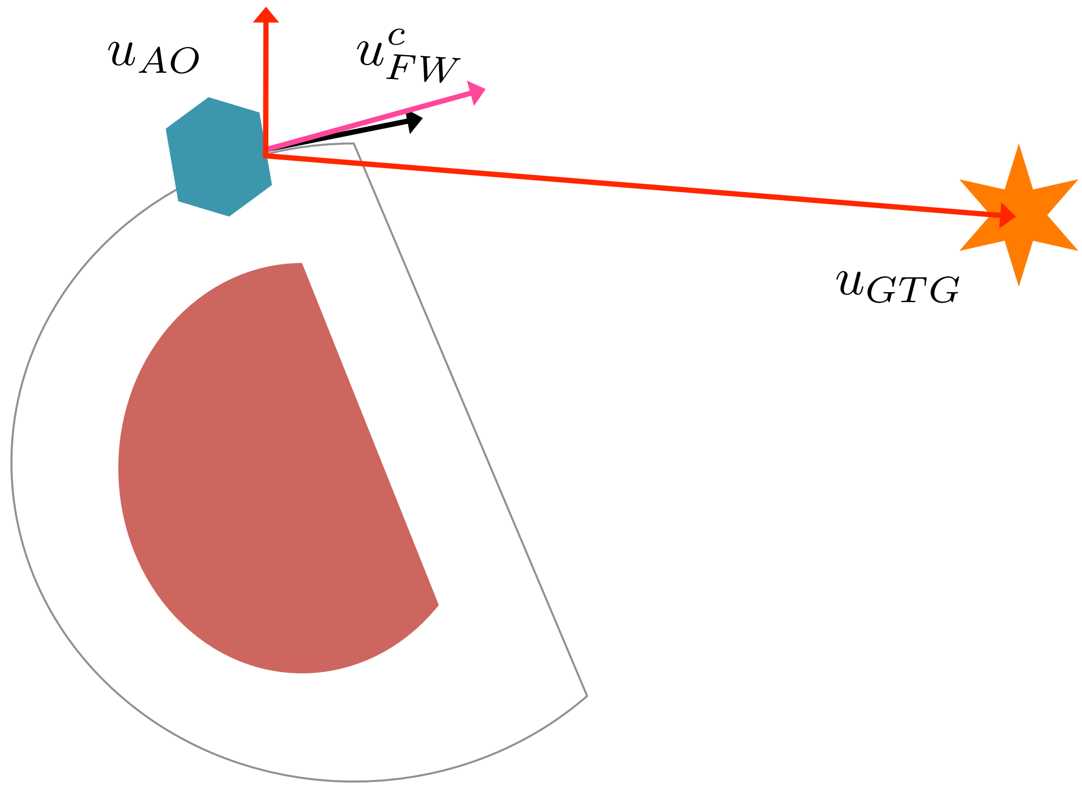

u^c_{FW}

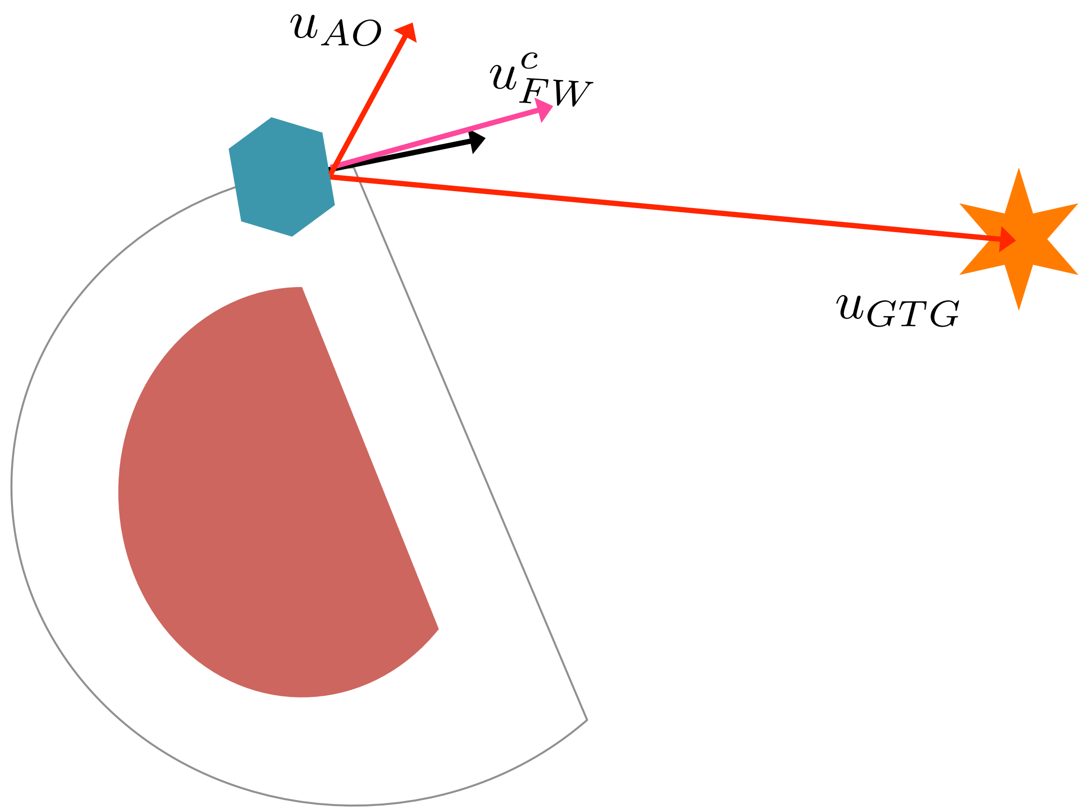

u^{c}_{FW}
$u = 0$
$\|x - x_g\| \leq$
u_{GTG}
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}

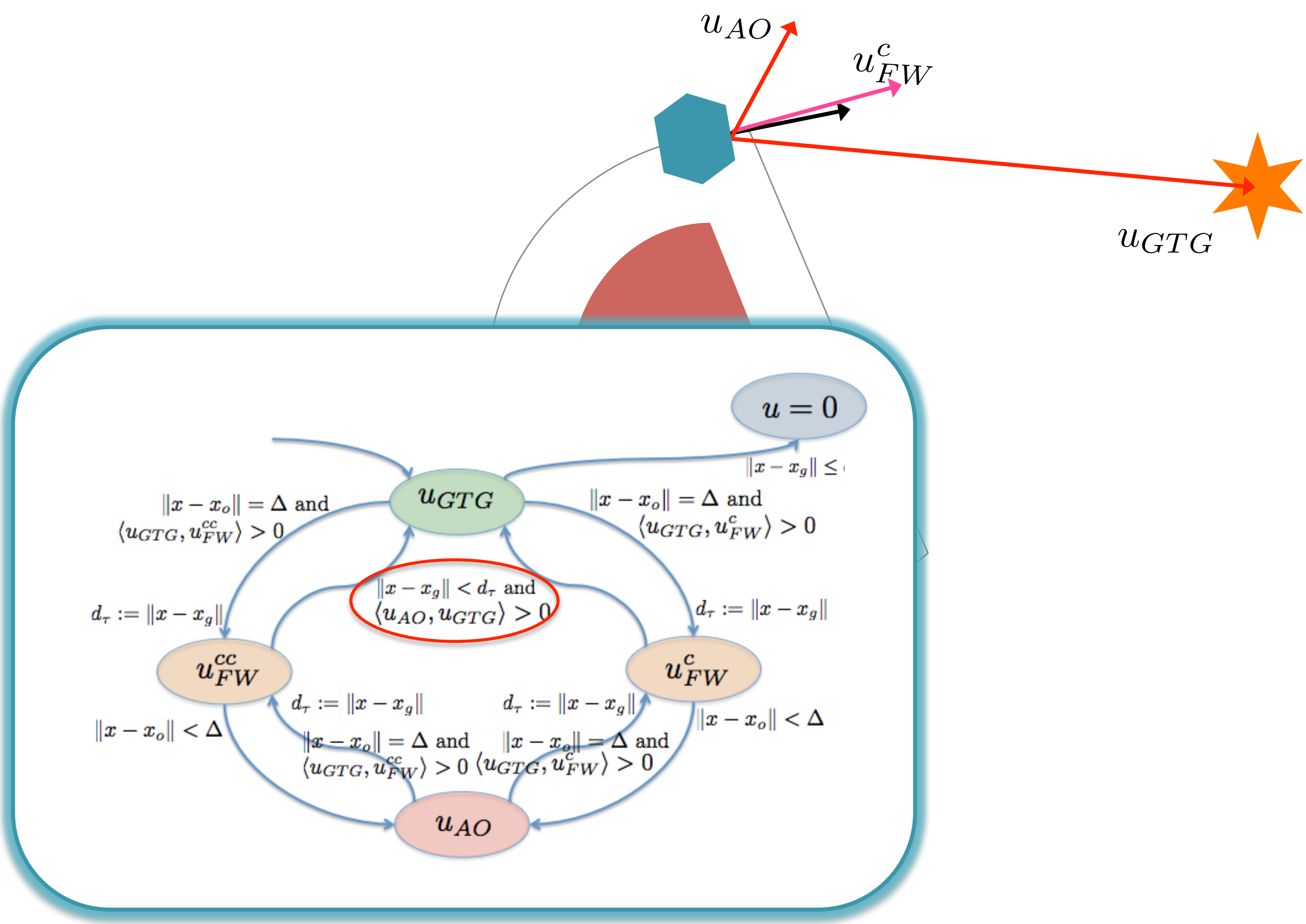

u^c_{FW}
$u = 0$
u_{GTG}
$\|x - x_g\| \leq$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}


u_{AO}
u^c_{FW}
u_{GTG}

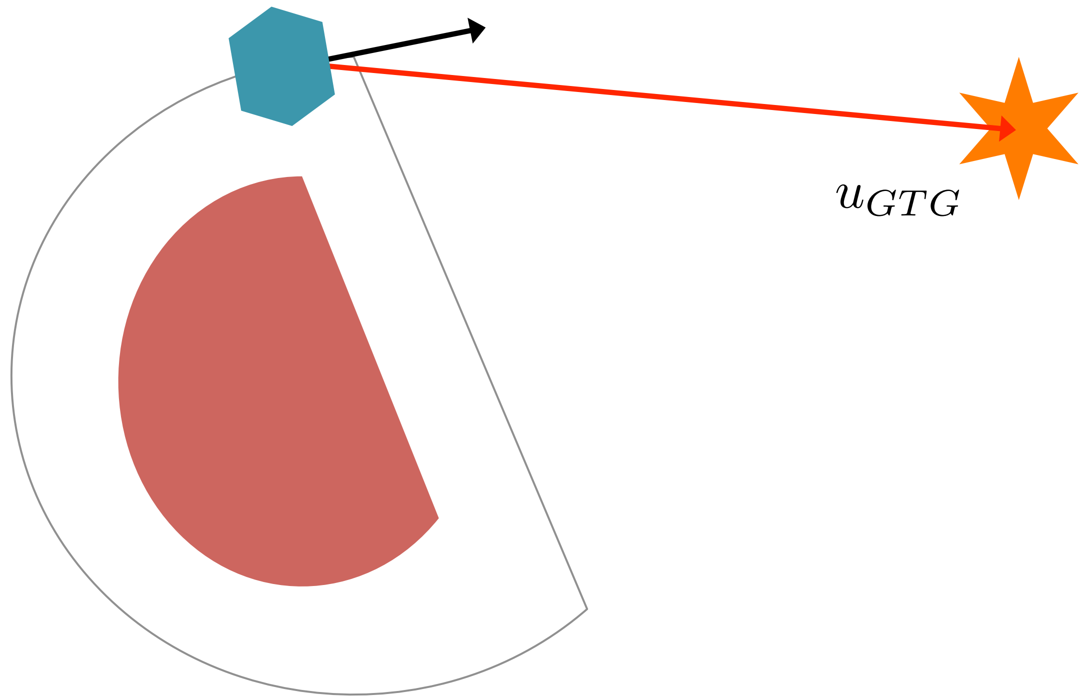

u_{AO}
u^c_{FW}
u_{GTG}

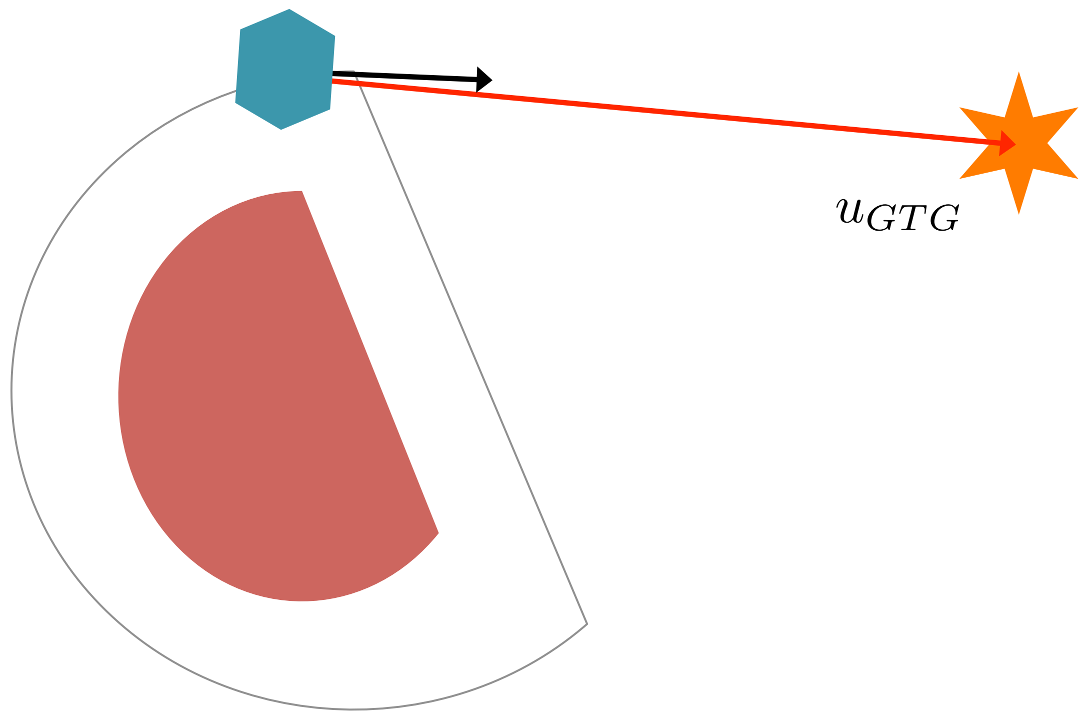

u_{AO}
u_{FW}^c
u_{GTG}

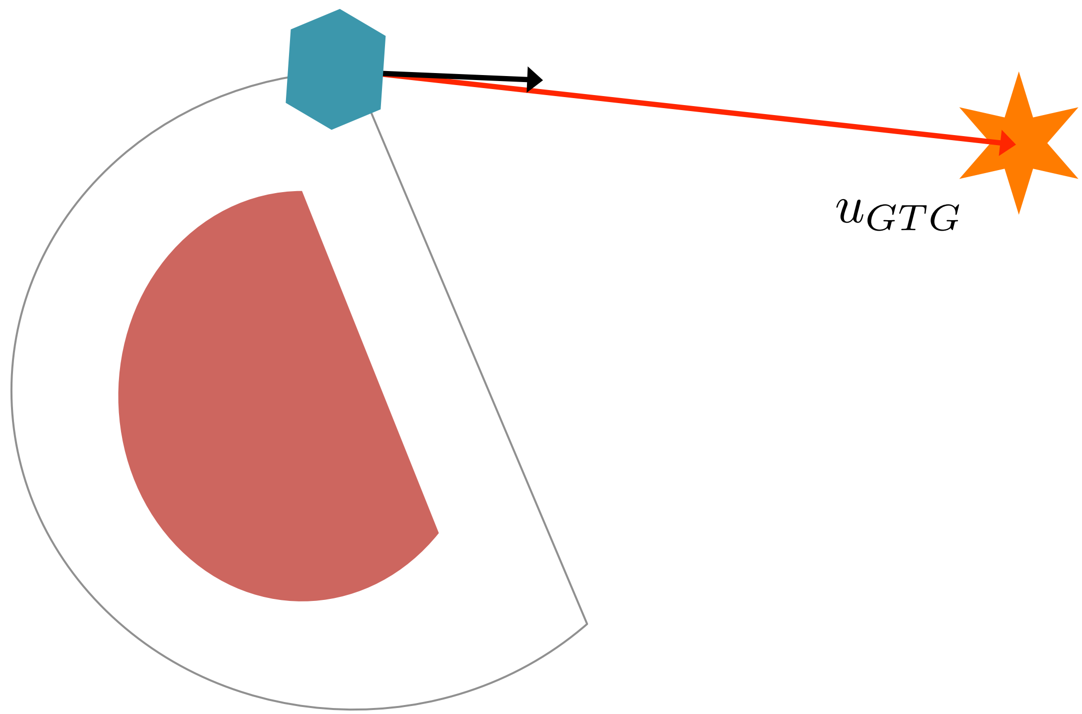

u_{AO}
u^c_{FW}
u_{GTG}

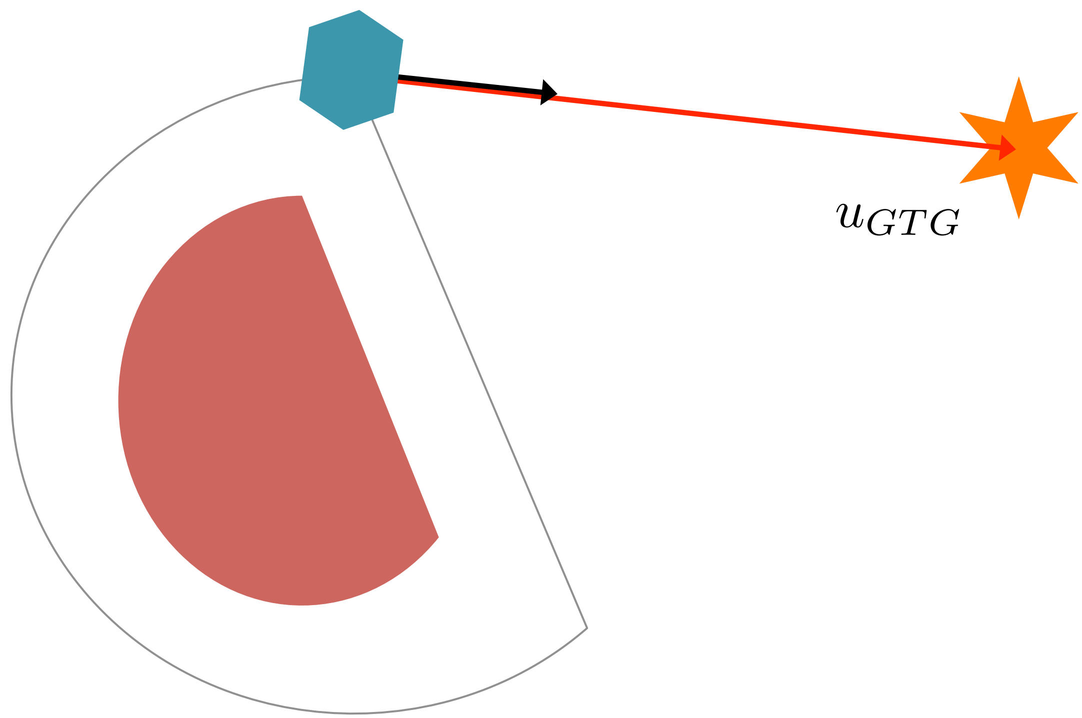


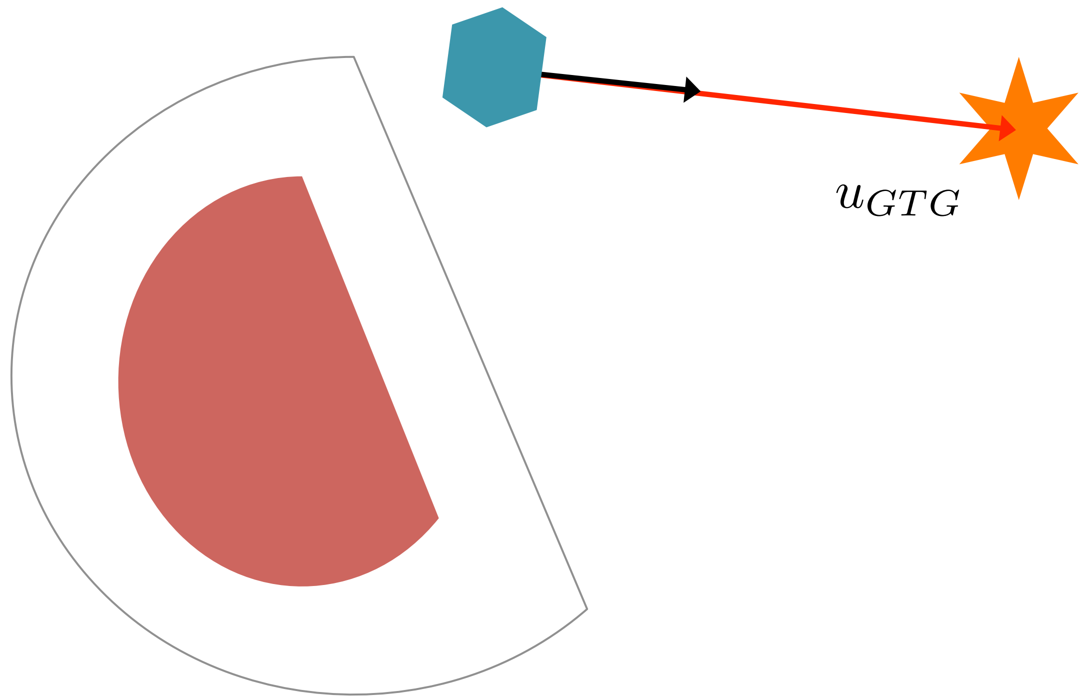
u_{AO}
u^c_{FW}
u_{GTG}
$u = 0$
$\|x - x_g\| \leq$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{GTG}
$\|x - x_g\| < d_\tau$ and $\langle u_{AO}, u_{GTG} \rangle > 0$
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
u^{cc}_{FW}
u^{c}_{FW}
$d_\tau := \|x - x_g\|$
$d_\tau := \|x - x_g\|$
$\|x - x_o\| < \Delta$
$\|x - x_o\| < \Delta$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{cc}_{FW} \rangle > 0$
$\|x - x_o\| = \Delta$ and $\langle u_{GTG}, u^{c}_{FW} \rangle > 0$
u_{AO}

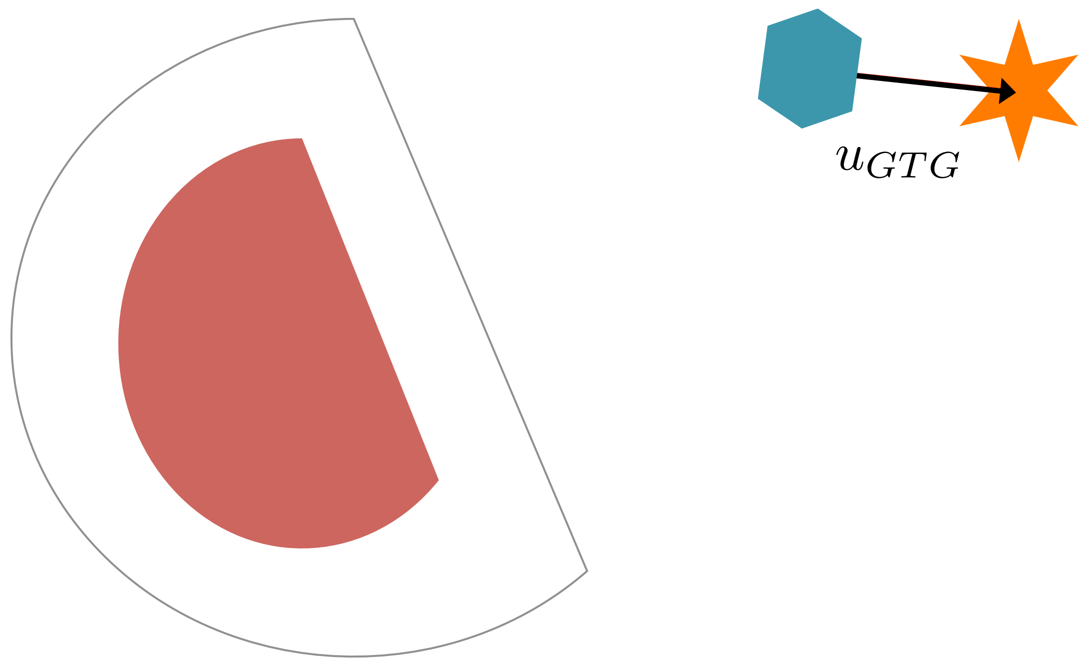

u_{GTG}

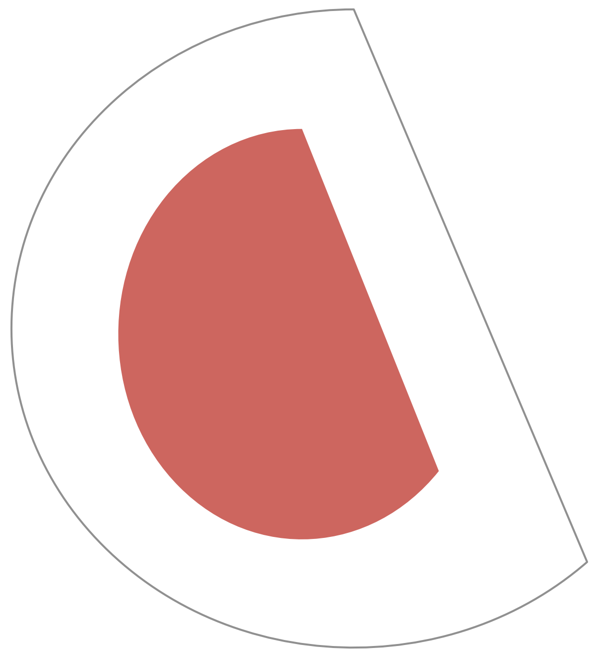

u_{GTG}

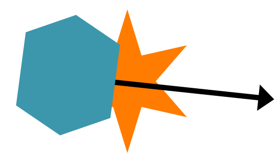

u_{GTG}


u_{GTG}


u_{GTG}


u_{GTG}





Check the forums for more help and good luck with Quiz 6!