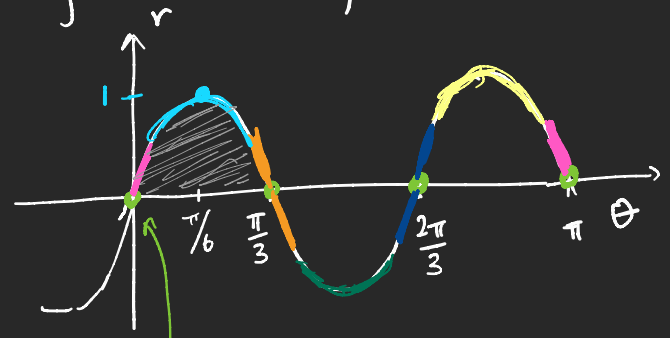
**Example** What's the area enclosed in one "petal" of the polar curve

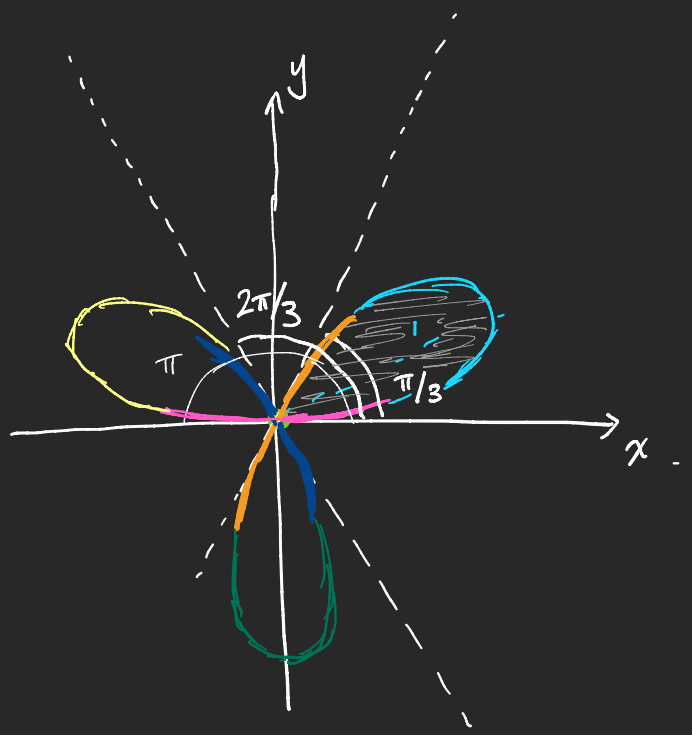
$$r = \sin(3\theta) \quad ?$$

Suggestion for sketching polar curves: start w/ drawing in the "$r\theta$"-plane:




$r=0$ means curve goes through origin

Then translate this into the $xy$-plane:



The integral is then

$$\int_0^{\pi/3} \frac{1}{2}\sin^2(3\theta)\,d\theta$$

(To compute this, use cosine double angle formula.)

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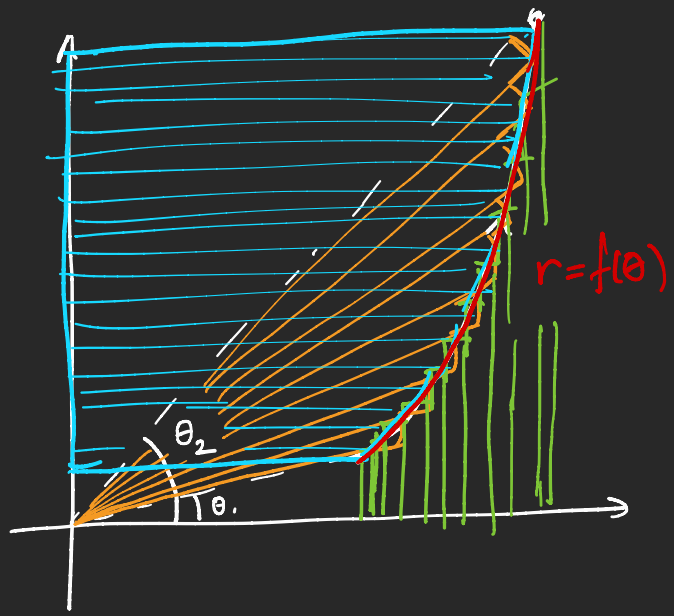
Given a polar curve, the formulas for slope and arclength are obtained just by switching to parametric:

e.g. $r = \sin(3\theta) \rightsquigarrow$ $x = r\cos\theta = \sin(3\theta)\cos\theta$, $y = r\sin\theta = \sin(3\theta)\sin\theta$

But on the other hand, the area formula for polar is different:




$$\int_{\theta_1}^{\theta_2} \frac{1}{2}r^2\,d\theta$$

$$\int_{\theta_1}^{\theta_2} \underbrace{r\sin\theta}_{y}\ \underbrace{\frac{d}{d\theta}(r\cos\theta)\,d\theta}_{dx}$$

$$\int_{\theta_1}^{\theta_2} \underbrace{r\cos\theta}_{x}\ \underbrace{\frac{d}{d\theta}(r\sin\theta)\,d\theta}_{dy}$$