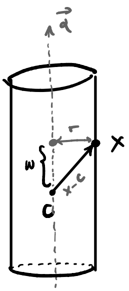
# Ray – Cylinder Intersection




- $\vec{a}$ is normalized
- We found $w$ using the projection formula $\|((x-c)\cdot a)\cdot a\| = (x-c)\cdot a\,\|a\|$
  $= (x-c)\cdot a$
  because $\|a\| = 1$.
- Pythagora's rule for the triangle:

$$r^2 + w^2 = |x-c|^2$$

$$r^2 + ((x-c)\cdot a)^2 - (x-c)^T(x-c) = 0$$

replace x with the ray's equation:

$$r^2 + ((o+td-c)\cdot a)^2 - (o+td-c)^T(o+td-c) = 0$$

Set $q = o - c$ :

$$r^2 + ((td+q)\cdot a)^2 - (td+q)^T(td+q) = 0$$

$$r^2 + ((td+q)^T a)^2 - (t^2 d^T d + td^T q + tq^T d + q^T q) = 0$$

$$r^2 + (td^T a + q^T a)^2 - (t^2 d^T d + td^T q + tq^T d + q^T q) = 0$$

$$r^2 + (t^2 d^T a d^T a + 2td^T a q^T a + q^T a q^T a) - t^2 d^T d - td^T q - tq^T d - q^T q = 0$$

$$t^2\underbrace{(d^T a d^T a - d^T d)}_{a} + t\underbrace{(2d^T a q^T a - d^T q - q^T d)}_{b} + \underbrace{(r^2 + q^T a q^T a - q^T q)}_{c} = 0$$

And then we solved the quadratic equation.

# Normal Derivations