```
(*megarayone & orthonorm*)
```

```
(*ray intersects plane*)
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```
(*ray intersects sphere*)
```

```
(*where is distance between line and sphere less than radius*)
r;(*sphere readius*)
Δp = {dx, dy, dz};(*normalized vector from origo, ray*)
p = {x, y, z};(*sphere coords*)
Solve[EuclideanDistance[p, Δp t] == r, t]
```

Solve::ifun : Inverse functions are being used by Solve, so
some solutions may not be found; use Reduce for complete solution information. ≫

$$\left\{\left\{t \to \frac{2\,dx\,x + 2\,dy\,y + 2\,dz\,z - \sqrt{(-2\,dx\,x - 2\,dy\,y - 2\,dz\,z)^2 - 4\left(dx^2 + dy^2 + dz^2\right)\left(-r^2 + x^2 + y^2 + z^2\right)}}{2\left(dx^2 + dy^2 + dz^2\right)}\right\},\right.$$

$$\left.\left\{t \to \frac{2\,dx\,x + 2\,dy\,y + 2\,dz\,z + \sqrt{(-2\,dx\,x - 2\,dy\,y - 2\,dz\,z)^2 - 4\left(dx^2 + dy^2 + dz^2\right)\left(-r^2 + x^2 + y^2 + z^2\right)}}{2\left(dx^2 + dy^2 + dz^2\right)}\right\}\right\}$$

$$\mathbf{EuclideanDistance[p,\ \Delta p\ t] - r == \sqrt{(p - \Delta p\ t).(p - \Delta p\ t)} - r}$$

$$-r + \sqrt{\mathrm{Abs}[-dx\,t + x]^2 + \mathrm{Abs}[-dy\,t + y]^2 + \mathrm{Abs}[-dz\,t + z]^2} == -r + \sqrt{(-dx\,t + x)^2 + (-dy\,t + y)^2 + (-dz\,t + z)^2}$$

$$\mathbf{\left(\sqrt{(p - \Delta p\ t).(p - \Delta p\ t)}\right)^2 == r^2}$$

$$(-dx\,t + x)^2 + (-dy\,t + y)^2 + (-dz\,t + z)^2 == r^2$$

$$\mathbf{(p - \Delta p\ t).(p - \Delta p\ t) == r^2}$$

$$(-dx\,t + x)^2 + (-dy\,t + y)^2 + (-dz\,t + z)^2 == r^2$$

$$\mathbf{Collect\left[ExpandAll\left[(p - \Delta p\ t).(p - \Delta p\ t) == r^2\right],\ t\right]}$$

$$\left(dx^2 + dy^2 + dz^2\right) t^2 + x^2 + y^2 + z^2 + t\,(-2\,dx\,x - 2\,dy\,y - 2\,dz\,z) == r^2$$

```
Δp.Δp
p.p
-2 Δp.p
```

$$dx^2 + dy^2 + dz^2$$

$$x^2 + y^2 + z^2$$

$$-2\,(dx\,x + dy\,y + dz\,z)$$

$$\mathbf{\Delta p.\Delta p\ t^2 + t + p.p - 2\,\Delta p.p - r^2 == 0}$$

$$-r^2 + t + \left(dx^2 + dy^2 + dz^2\right) t^2 + x^2 + y^2 + z^2 - 2\,(dx\,x + dy\,y + dz\,z) == 0$$

$$\mathbf{Solve\left[a\,t^2 + b\,t + c == 0,\ t\right]}$$

$$\left\{\left\{t \to \frac{-b - \sqrt{b^2 - 4\,a\,c}}{2\,a}\right\}, \left\{t \to \frac{-b + \sqrt{b^2 - 4\,a\,c}}{2\,a}\right\}\right\}$$

```
a = Δp.Δp
b = 1
c = p.p - 2 Δp.p - r^2
Solve[a t^2 + b t + c == 0, t]
```

$dx^2 + dy^2 + dz^2$

1

$-r^2 + x^2 + y^2 + z^2 - 2\,(dx\,x + dy\,y + dz\,z)$

$\{\{t \to (-1 - \sqrt{(1 - 4\,(dx^2 + dy^2 + dz^2)\,(-r^2 - 2\,dx\,x + x^2 - 2\,dy\,y + y^2 - 2\,dz\,z + z^2))}) / (2\,(dx^2 + dy^2 + dz^2))\},$
$\{t \to (-1 + \sqrt{(1 - 4\,(dx^2 + dy^2 + dz^2)\,(-r^2 - 2\,dx\,x + x^2 - 2\,dy\,y + y^2 - 2\,dz\,z + z^2))}) / (2\,(dx^2 + dy^2 + dz^2))\}\}$