```
> # propagação de variâncias-covariâncias numa irradiada
incluindo incertezas nas medições lineares e angulares,
assim como incertezas nas coordenadas do ponto estação
> #
> with(LinearAlgebra):
> #
> M2:=M1+d*sin(R);
```

$$M2 := M1 + d\sin(R)$$

```
> P2:=P1+d*cos(R);
```

$$P2 := P1 + d\cos(R)$$

```
>
sigma_obs:=Matrix([[s2M1,sM1P1,0,0],[sM1P1,s2P1,0,0],[0,0,s2d
,0],[0,0,0,s2R]]);
```

$$sigma\_obs := \begin{bmatrix} s2M1 & sM1P1 & 0 & 0 \\ sM1P1 & s2P1 & 0 & 0 \\ 0 & 0 & s2d & 0 \\ 0 & 0 & 0 & s2R \end{bmatrix}$$

```
>
J:=Matrix([[diff(M2,M1),diff(M2,P1),diff(M2,d),diff(M2,R)],[d
iff(P2,M1),diff(P2,P1),diff(P2,d),diff(P2,R)]]);
```

$$J := \begin{bmatrix} 1 & 0 & \sin(R) & d\cos(R) \\ 0 & 1 & \cos(R) & -d\sin(R) \end{bmatrix}$$

```
> sigma_coord:=J.sigma_obs.Transpose(J);
```

$$sigma\_coord :=$$
$$[s2M1 + \sin(R)^2\, s2d + d^2\cos(R)^2\, s2R,$$
$$sM1P1 + \sin(R)\, s2d\, \cos(R) - d^2\cos(R)\, s2R\, \sin(R)]$$
$$[sM1P1 + \sin(R)\, s2d\, \cos(R) - d^2\cos(R)\, s2R\, \sin(R),$$
$$s2P1 + \cos(R)^2\, s2d + d^2\sin(R)^2\, s2R]$$

```
> Aux0:=ScalarMultiply(Matrix(2,2,shape=identity),-lambda);
```

$$Aux0 := \begin{bmatrix} -\lambda & 0 \\ 0 & -\lambda \end{bmatrix}$$

```
> Aux1:=Add(sigma_coord,Aux0);
```

$$Aux1 :=$$
$$[s2M1 + \sin(R)^2\, s2d + d^2\cos(R)^2\, s2R - \lambda,$$
$$sM1P1 + \sin(R)\, s2d\, \cos(R) - d^2\cos(R)\, s2R\, \sin(R)]$$
$$[sM1P1 + \sin(R)\, s2d\, \cos(R) - d^2\cos(R)\, s2R\, \sin(R),$$
$$s2P1 + \cos(R)^2\, s2d + d^2\sin(R)^2\, s2R - \lambda]$$

```
> solve(Determinant(Aux1)=0,lambda);
```

$$\frac{1}{2}\,d^2\,s2R+\frac{1}{2}\,s2M1\,+\frac{1}{2}\,s2P1+\frac{1}{2}\,s2d+\frac{1}{2}\,\mathrm{sqrt}(\,d^4\,s2R^2+2\,s2M1\,\,d^2\,s2R-2\,d^2\,s2R\,\,s2P1$$
$$-2\,d^2\,s2R\,\,s2d+s2M1^{\,2}-2\,s2M1\,\,s2P1-2\,s2M1\,\,s2d+s2P1^{\,2}+2\,s2d\,\,s2P1+s2d^2$$
$$+8\,sM1P1\,\,\sin(R)\,\,s2d\,\cos(R)+4\,d^2\,s2R\,\,s2P1\,\,\sin(R)^2+4\,sM1P1^{\,2}$$
$$+4\,s2M1\,\,s2d\,\,\sin(R)^2-4\,\sin(R)^2\,\,s2d\,\,s2P1-4\,s2M1\,\,d^2\,\sin(R)^2\,\,s2R$$
$$-8\,sM1P1\,\,d^2\,\cos(R)\,\,s2R\,\,\sin(R)),\frac{1}{2}\,d^2\,s2R+\frac{1}{2}\,s2M1\,+\frac{1}{2}\,s2P1+\frac{1}{2}\,s2d-\frac{1}{2}\,\mathrm{sqrt}($$
$$d^4\,s2R^2+2\,s2M1\,\,d^2\,s2R-2\,d^2\,s2R\,\,s2P1-2\,d^2\,s2R\,\,s2d+s2M1^{\,2}-2\,s2M1\,\,s2P1$$
$$-2\,s2M1\,\,s2d+s2P1^{\,2}+2\,s2d\,\,s2P1+s2d^2+8\,sM1P1\,\,\sin(R)\,\,s2d\,\,\cos(R)$$
$$+4\,d^2\,s2R\,\,s2P1\,\,\sin(R)^2+4\,sM1P1^{\,2}+4\,s2M1\,\,s2d\,\,\sin(R)^2-4\,\sin(R)^2\,\,s2d\,\,s2P1$$
$$-4\,s2M1\,\,d^2\,\sin(R)^2\,\,s2R-8\,sM1P1\,\,d^2\,\cos(R)\,\,s2R\,\,\sin(R))$$