

```

> restart;

with(plots);

unprotect( $\gamma$ );

Digits := 50;

c := 299792458;

 $\lambda := \frac{c}{10.0E6}$ ;

NumberOfLoops := 1;
SingleLoopLength := 5;

TotalArmLength := NumberOfLoops · SingleLoopLength;

Altitude :=  $38.5 \cdot \frac{\pi}{180}$ ;

Azimuth := 180;

vWind := 486000;

v := evalf(vWind · abs(cos(Altitude)));

# ArmA: Cable OUT is coaxial cable
#       Cable IN is single-mode optic fiber

# ArmB: Cable OUT is single-mode optic fiber
#       Cable IN is coaxial cable

n1 := 1.19;
n2 := 1.44975;

unitXcomponent := abs(cos( $\theta$ )2);

unitYcomponent := abs(sin( $\theta$ )2);

 $\gamma := \text{evalf}\left(\frac{1}{\text{sqrt}\left(1 - \left(\frac{v}{c}\right)^2\right)}\right)$ ;

FractionOfTimeLightIsHeldByMolecules :=  $\frac{(n - 1)}{n}$ ;

```

$$TimeLightIsHeldByMolecules := \gamma \cdot FractionOfTimeLightIsHeldByMolecules \cdot \frac{L \cdot n}{c};$$

$$Eqdtn := dtDiagonal = \gamma \cdot TimeLightIsHeldByMolecules + \frac{\gamma L}{c};$$

$$EqdtnOptic := dtDiagonalOptic = TimeLightIsHeldByMolecules + \frac{\gamma L}{c};$$

$$L := unitXcomponent \cdot TotalArmLength;$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$dtTotalArmLengthAout := solve(Eqdtn, dtDiagonal);$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtTotalArmLengthAin := solve(EqdtnOptic, dtDiagonalOptic);$$

$$dtPerpendicularComponentArmA := dtTotalArmLengthAout + dtTotalArmLengthAin;$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtTotalArmLengthBout := solve(EqdtnOptic, dtDiagonalOptic);$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$dtTotalArmLengthBin := solve(Eqdtn, dtDiagonal);$$

$$dtPerpendicularComponentArmB := dtTotalArmLengthBout + dtTotalArmLengthBin;$$

$$L := 'L';$$

$$n := 'n';$$

$$FractionOfTimeLightIsHeldByMoleculesUp := \frac{(n - 1)}{n};$$

$$TimeLightIsHeldByMoleculesInMovingFrameUp := FractionOfTimeLightIsHeldByMoleculesUp \cdot \frac{L \cdot n}{c};$$

$$TimeLightIsHeldByMoleculesInAetherFrameUp := \gamma \cdot TimeLightIsHeldByMoleculesInMovingFrameUp;$$

$$opticalPathLengthUp := \frac{L}{\gamma} + v \cdot dtup - v \cdot TimeLightIsHeldByMoleculesInAetherFrameUp;$$

$$dtupEqn := dtup = \frac{opticalPathLengthUp}{c} + TimeLightIsHeldByMoleculesInAetherFrameUp;$$

$$dtup := solve(dtupEqn, dtup);$$

$$FractionOfTimeLightIsHeldByMoleculesDown := \frac{(n - 1)}{n};$$

$$TimeLightIsHeldByMoleculesInMovingFrameDown := FractionOfTimeLightIsHeldByMoleculesDown \cdot \frac{L \cdot n}{c};$$

$$TimeLightIsHeldByMoleculesInAetherFrameDown := \gamma \cdot TimeLightIsHeldByMoleculesInMovingFrameDown;$$

$$opticalPathLengthDown := \frac{L}{\gamma} - v \cdot dtdown + v \cdot TimeLightIsHeldByMoleculesInAetherFrameDown;$$

$$dtdownEqn := dtdown = \frac{opticalPathLengthDown}{c} + TimeLightIsHeldByMoleculesInAetherFrameDown;$$

$$dtdown := solve(dtdownEqn, dtdown);$$

$$L := unitYcomponent \cdot TotalArmLength;$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$dtArmAout := dtup;$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtArmAin := dtdown;$$

$$dtParallelComponentArmA := dtArmAout + dtArmAin;$$

$$dtArmA := \frac{1}{\gamma} \cdot (dtPerpendicularComponentArmA + dtParallelComponentArmA);$$

$$L := unitYcomponent \cdot TotalArmLength;$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtArmBout := dtup;$$

$n := n1;$  # Coaxial cable

$dtArmBin := dtdown;$

$dtParallelComponentArmB := dtArmBout + dtArmBin;$

$dtArmB := \frac{1}{\gamma} \cdot (dtPerpendicularComponentArmB + dtParallelComponentArmB);$

$L := 'L';$

$Lcontracted := 'Lcontracted';$

$v := 'v';$

$n := 'n';$

$TimeDifference := \frac{Shift \cdot \lambda}{c};$

$dtDiff := dtArmA - dtArmB;$

$dtSum := dtArmA + dtArmB;$

$dtEq := TimeDifference = dtSum;$

$FringeShift := evalf(solve(dtEq, Shift));$

$plot1a := plot(dtArmA \cdot 1E12, \theta = 0 .. 2 \pi);$

$plot1b := plot(dtArmB \cdot 1E12, \theta = 0 .. 2 \pi);$

$plot3a := plot(dtDiff \cdot 1E12, \theta = 0 .. 2 \pi);$

$plot3b := plot(dtSum \cdot 1E12, \theta = 0 .. 2 \pi);$

$plot4 := plot(FringeShift, \theta = 0 .. 2 \pi);$

$plot5 := plot(FringeShift \cdot \lambda, \theta = 0 .. 2 \pi);$

$display([plot1a]);$

$display([plot1b]);$

$display([plot3a]);$

$display([plot3b]);$

$display([plot4]);$

$display([plot5]);$

$\theta := \frac{\pi}{2};$

```
evalf(dtArmA·1E12);
evalf(dtArmB·1E12);
evalf(dtdiff·1E12);
```

```
dtsum1 := dtsum;
θ := 0;
dtsum2 := dtsum;
```

```
MaximumTimeDifferenceInPicosecondsOnRotation := evalf((dtsum2 - dtsum1)·1E12);
```

```
[animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d,
conformal, conformal3d, contourplot, contourplot3d, coordplot, coordplot3d, densityplot,
display, dualaxisplot, fieldplot, fieldplot3d, gradplot, gradplot3d, implicitplot,
implicitplot3d, inequal, interactive, interactiveparams, intersectplot, listcontplot,
listcontplot3d, listdensityplot, listplot, listplot3d, loglogplot, logplot, matrixplot, multiple,
odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot, polygonplot, polygonplot3d,
polyhedra_supported, polyhedraplot, rootlocus, semilogplot, setcolors, setoptions,
setoptions3d, spacecurve, sparsematrixplot, surfdata, textplot, textplot3d, tubeplot]
```

```
Digits := 50
```

```
c := 299792458
```

```
λ := 29.9792458000000000000000000000000000000000000000000000000000000000000
```

```
NumberOfLoops := 1
```

```
SingleLoopLength := 5
```

```
TotalArmLength := 5
```

```
Altitude := 0.21388888888888888888888888888888888888888888888888888888888889 π
```

```
Azimuth := 180
```

```
vWind := 486000
```

```
v := 3.8034756423027316205818256525838243232074718555285 105
```

```
n1 := 1.19
```

```
n2 := 1.44975
```

```
unitXcomponent := |cos(θ)|2
```

```
unitYcomponent := |sin(θ)|2
```

```
γ := 1.0000008048045100498508985031648230002429281949252
```

```
FractionOfTimeLightIsHeldByMolecules :=  $\frac{n-1}{n}$ 
```

```
TimeLightIsHeldByMolecules :=
```

```
3.3356436365204025574615973266573070368665785278868 10-9 (n - 1) L
```

```
Eqdtn := dtDiagonal = 3.335643210614451481671149541911901072427441025571 10-9 (n
```

```
- 1) L + 3.3356436365204025574615973266573070368665785278868 10-9 L
```

```
EqdtnOptic := dtDiagonalOptic
```

$$= 3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} (n - 1) L$$

$$+ 3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} L$$

$$L := 5 |\cos(\theta)|^2$$

$$n := 1.19$$

$$dtTotalArmLengthAout :=$$

$$1.9847082187610385678066745839768165786213499536863 \cdot 10^{-8} |\cos(\theta)|^2$$

$$n := 1.44975$$

$$dtTotalArmLengthAin :=$$

$$2.4179246810227268038399753621607154383486611104019 \cdot 10^{-8} |\cos(\theta)|^2$$

$$dtPerpendicularComponentArmA :=$$

$$4.4026328997837653716466499461375320169700110640882 \cdot 10^{-8} |\cos(\theta)|^2$$

$$n := 1.44975$$

$$dtTotalArmLengthBout :=$$

$$2.4179246810227268038399753621607154383486611104019 \cdot 10^{-8} |\cos(\theta)|^2$$

$$n := 1.19$$

$$dtTotalArmLengthBin :=$$

$$1.9847082187610385678066745839768165786213499536863 \cdot 10^{-8} |\cos(\theta)|^2$$

$$dtPerpendicularComponentArmB :=$$

$$4.4026328997837653716466499461375320169700110640882 \cdot 10^{-8} |\cos(\theta)|^2$$

$$L := L$$

$$n := n$$

$$FractionOfTimeLightIsHeldByMoleculesUp := \frac{n - 1}{n}$$

$$TimeLightIsHeldByMoleculesInMovingFrameUp := \frac{1}{299792458} (n - 1) L$$

$$TimeLightIsHeldByMoleculesInAetherFrameUp :=$$

$$3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} (n - 1) L$$

$$opticalPathLengthUp := 0.99999919519613765992721832675925233925960096448827 L$$

$$+ 3.8034756423027316205818256525838243232074718555285 \cdot 10^5 dtup$$

$$- 0.0012687039322907457567106966447231441160374258781798 (n - 1) L$$

$$dtupEqn := dtup = 3.3356382674447989613108223248206342110834588256662 \cdot 10^{-9} L$$

$$+ 0.0012687029112329208830803294099492737483100631756148 dtup$$

$$+ 3.3314116957279135557645943398619449463498203448701 \cdot 10^{-9} (n - 1) L$$

$$dtup := 4.2319407924890016970029867953620905167581830164953 \cdot 10^{-12} L$$

$$+ 3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} L n$$

$$FractionOfTimeLightIsHeldByMoleculesDown := \frac{n - 1}{n}$$

$$TimeLightIsHeldByMoleculesInMovingFrameDown := \frac{1}{299792458} (n - 1) L$$

*TimeLightIsHeldByMoleculesInAetherFrameDown :=*

$$3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} (n - 1) L$$

*opticalPathLengthDown :=* 0.99999919519613765992721832675925233925960096448827 L

$$- 3.8034756423027316205818256525838243232074718555285 \cdot 10^5 \text{ dtdown}$$

$$+ 0.0012687039322907457567106966447231441160374258781798 (n - 1) L$$

*dtdownEqn := dtdown =* 3.3356382674447989613108223248206342110834588256662  $\cdot 10^{-9} L$

$$- 0.0012687029112329208830803294099492737483100631756148 \text{ dtdown}$$

$$+ 3.3398755773128915591586003134526691273833367109035 \cdot 10^{-9} (n - 1) L$$

*dtdown :=* -4.2319407924890016970029867953620905167581830169042  $\cdot 10^{-12} L$

$$+ 3.3356436365204025574615973266573070368665785278868 \cdot 10^{-9} L n$$

$$L := 5 |\sin(\theta)|^2$$

$$n := 1.19$$

$$\text{dtArmAout} := 1.9868239341258840225381519027587787321939933156008 \cdot 10^{-8} |\sin(\theta)|^2$$

$$n := 1.44975$$

$$\text{dtArmAin} := 2.4158087106264823029914738687630343930902820188934 \cdot 10^{-8} |\sin(\theta)|^2$$

*dtParallelComponentArmA :=*

$$4.4026326447523663255296257715218131252842753344942 \cdot 10^{-8} |\sin(\theta)|^2$$

*dtArmA :=* 4.4026293565278031601976970274571022898217078513625  $\cdot 10^{-8} |\cos(\theta)|^2$

$$+ 4.4026291014966093643356431601758307075223353350667 \cdot 10^{-8} |\sin(\theta)|^2$$

$$L := 5 |\sin(\theta)|^2$$

$$n := 1.44975$$

$$\text{dtArmBout} := 2.4200406514189713046884768555583964836070402019101 \cdot 10^{-8} |\sin(\theta)|^2$$

$$n := 1.19$$

$$\text{dtArmBin} := 1.9825919933333950208411489159634166416772351325841 \cdot 10^{-8} |\sin(\theta)|^2$$

*dtParallelComponentArmB :=*

$$4.4026326447523663255296257715218131252842753344942 \cdot 10^{-8} |\sin(\theta)|^2$$

*dtArmB :=* 4.4026293565278031601976970274571022898217078513625  $\cdot 10^{-8} |\cos(\theta)|^2$

$$+ 4.4026291014966093643356431601758307075223353350667 \cdot 10^{-8} |\sin(\theta)|^2$$

$$L := L$$

$$L_{\text{contracted}} := L_{\text{contracted}}$$

$$v := v$$

$$n := n$$

*TimeDifference :=* 1.000  $\cdot 10^{-7} \text{ Shift}$

$$\text{dtdiff} := 0.$$

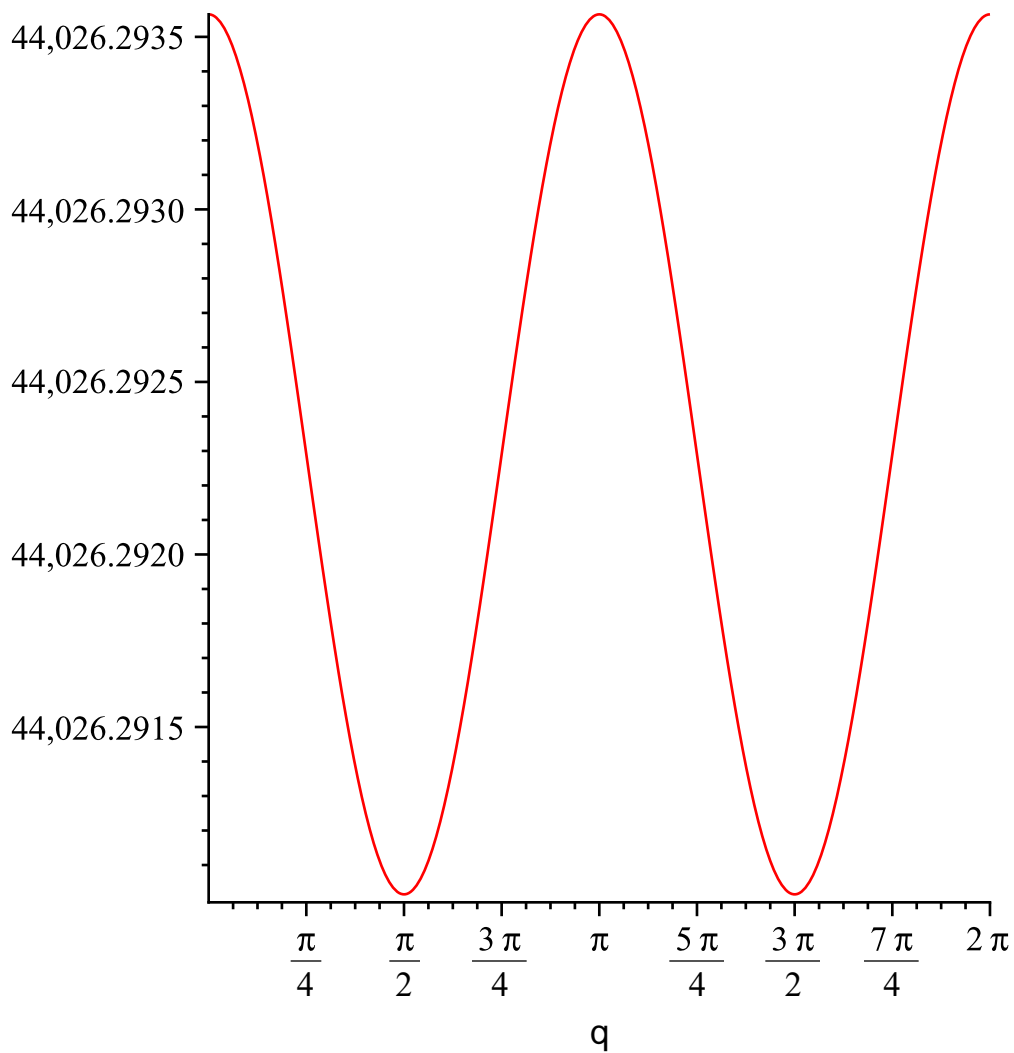
*dtsum :=* 8.8052587130556063203953940549142045796434157027250  $\cdot 10^{-8} |\cos(\theta)|^2$

$$+ 8.8052582029932187286712863203516614150446706701334 \cdot 10^{-8} |\sin(\theta)|^2$$

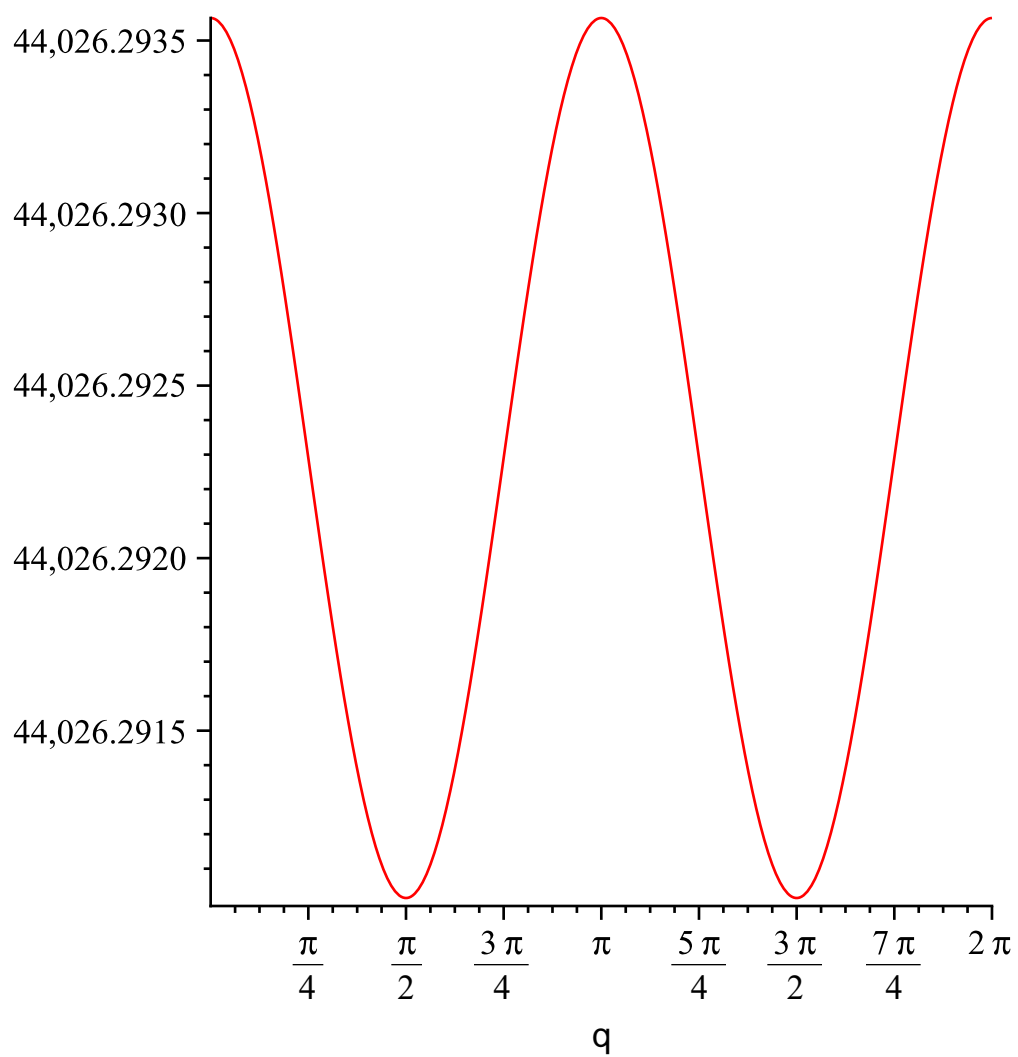
```

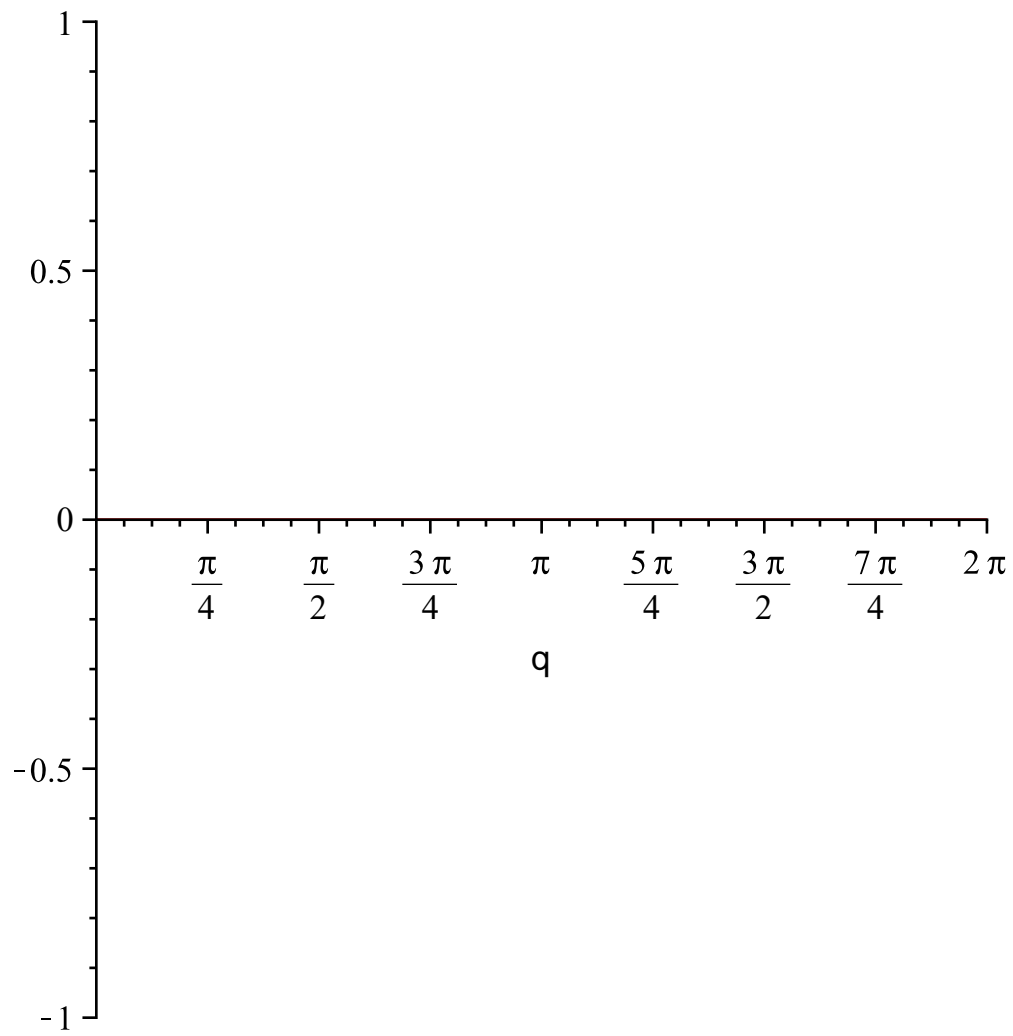
dtEq := 1.00000000000000000000000000000000000000000000000000000000000000000000 10-7 Shift
      = 8.8052587130556063203953940549142045796434157027250 10-8 |cos(θ)|2
      + 8.8052582029932187286712863203516614150446706701334 10-8 |sin(θ)|2
FringeShift := 0.88052587130556063203953940549142045796434157027250 |cos(θ)|2
              + 0.88052582029932187286712863203516614150446706701334 |sin(θ)|2
plot1a := PLOT(...)
plot1b := PLOT(...)
plot3a := PLOT(...)
plot3b := PLOT(...)
plot4 := PLOT(...)
plot5 := PLOT(...)

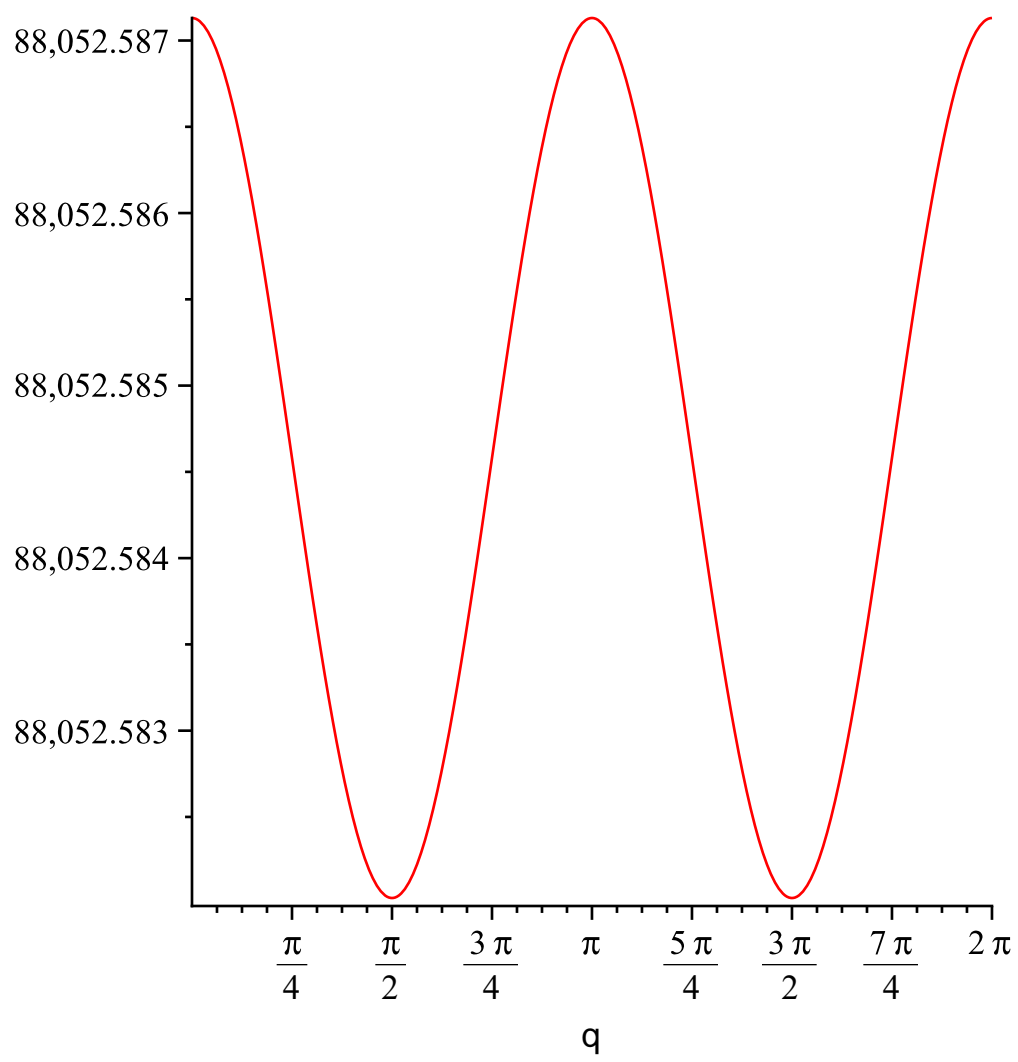
```

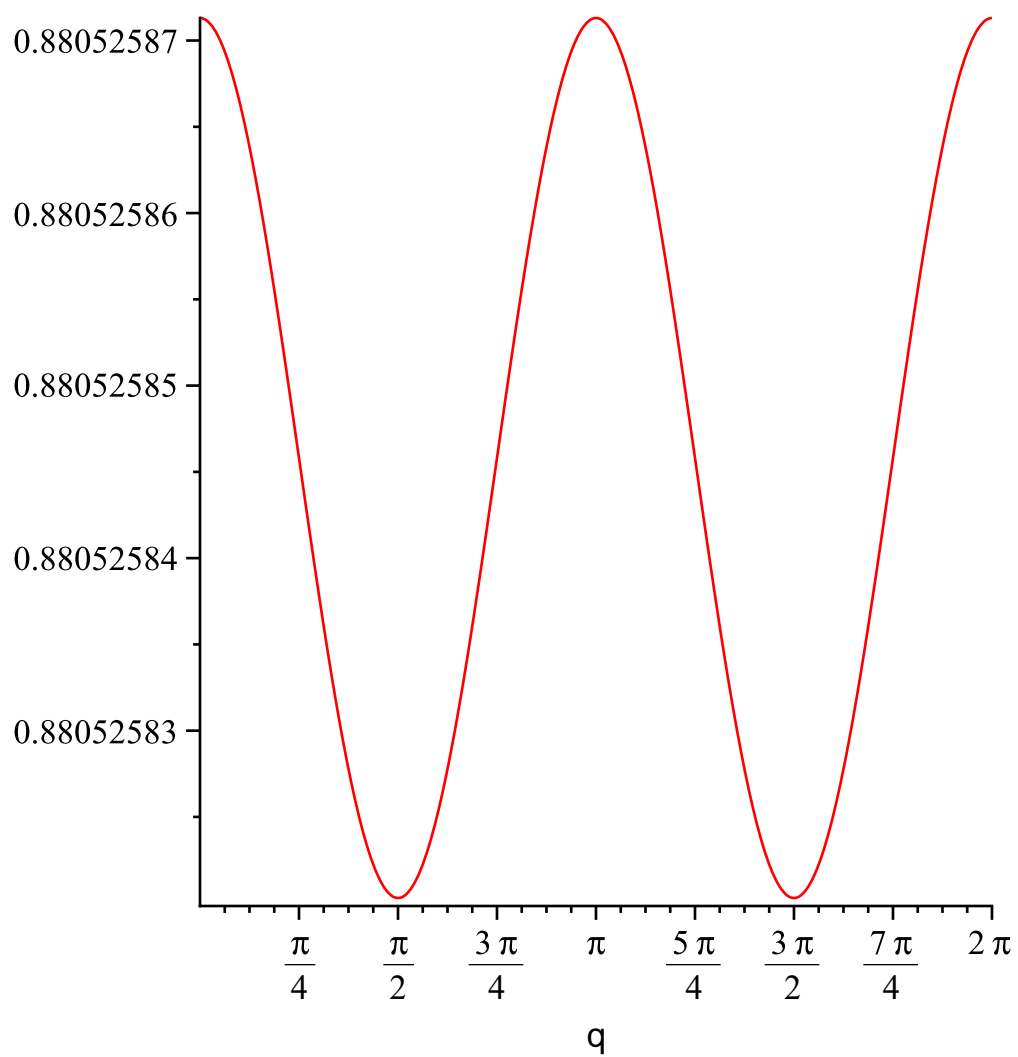


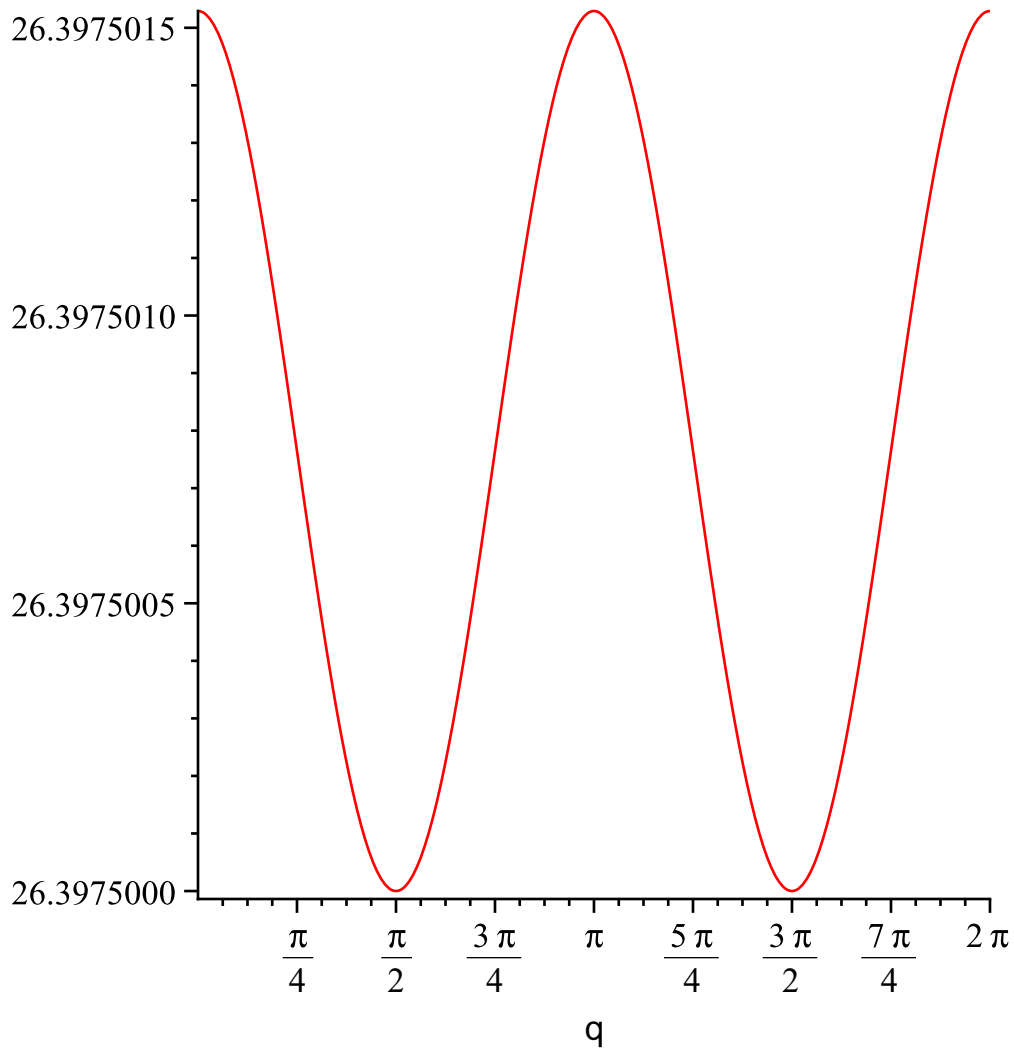












$$\theta := \frac{1}{2} \pi$$

44026.291014966093643356431601758307075223353350667

44026.291014966093643356431601758307075223353350667

0.

$dtsum1 := 8.8052582029932187286712863203516614150446706701334 \cdot 10^{-8}$

$\theta := 0$

$dtsum2 := 8.8052587130556063203953940549142045796434157027250 \cdot 10^{-8}$

*MaximumTimeDifferenceInPicosecondsOnRotation :=*

0.005100623875917241077345625431645987450325916

(1)