restart

Photoelectron momentum distribution under the influence of circularly polarized laser

local Γ, γ

with(*plots*);

[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] **(1)**

Momentum distribution of photoelectrons

$$\Gamma := \exp\left(-\frac{2\cdot I_p}{\omega}\cdot f\right)$$

$$e^{-\frac{2 I_p f}{\omega}} \qquad \textbf{(1.1)}$$

$$f := \left(1+\frac{1}{\gamma^2}+\frac{k^2}{2\cdot I_p}\right)\cdot \operatorname{arccosh}(\alpha) - \frac{\operatorname{sqrt}(\alpha^2-1)}{\gamma}\cdot k\cdot \sin(\theta)\cdot \operatorname{sqrt}\left(\frac{2}{I_p}\right)$$

$$\left(1+\frac{1}{\gamma^2}+\frac{1}{2}\frac{k^2}{I_p}\right)\operatorname{arccosh}(\alpha) - \frac{\sqrt{\alpha^2-1}\, k \sin(\theta)\,\sqrt{2}\,\sqrt{\frac{1}{I_p}}}{\gamma} \qquad \textbf{(1.2)}$$

$$\alpha := \gamma\cdot\left(1+\frac{1}{\gamma^2}+\frac{k^2}{2\cdot I_p}\right)\cdot\frac{1}{k\cdot\sin(\theta)}\cdot \operatorname{sqrt}\left(\frac{I_p}{2}\right)$$

$$\frac{1}{2}\,\frac{\gamma\left(1+\frac{1}{\gamma^2}+\frac{1}{2}\frac{k^2}{I_p}\right)\sqrt{2}\,\sqrt{I_p}}{k\sin(\theta)} \qquad \textbf{(1.3)}$$

(*series*(*f*, $\gamma = 0, 3$)) assuming $I_p > 0$ **and** $k > 0$ **and** $\gamma > 0$;

$$\frac{\ln\left(\frac{\sqrt{2}\,\sqrt{I_p}}{k\sin(\theta)}\right) - \ln(\gamma) - \sqrt{\frac{I_p}{\sin(\theta)^2}}\,\sin(\theta)\,\sqrt{\frac{1}{I_p}}}{\gamma^2} + 1 + \frac{1}{2}\frac{k^2}{I_p} - \frac{1}{2}\frac{k^2\sin(\theta)^2}{I_p} \qquad \textbf{(1.4)}$$

$$+\left(1+\frac{1}{2}\,\frac{k^2}{I_p}\right)\left(\ln\left(\frac{\sqrt{2}\,\sqrt{I_p}}{k\sin(\theta)}\right)-\ln(\gamma)\right)$$

$$-\frac{1}{2}\,\frac{\sqrt{\frac{I_p}{\sin(\theta)^2}}\,\left(-2\,k^2\sin(\theta)^2+k^2+2\,I_p\right)\sin(\theta)\,\sqrt{\frac{1}{I_p}}}{I_p}+\mathrm{O}\left(\gamma^2\right)$$

The peak occurs at

$Kmax := \frac{\mathrm{sqrt}(2\cdot I_p)}{\sin(\theta)\cdot\gamma};$

$$\frac{\sqrt{2}\,\sqrt{I_p}}{\sin(\theta)\,\gamma} \qquad \textbf{(1.5)}$$

$series\left(simplify\left(subs\left(k=Kmax,\theta=\frac{\pi}{2},f\right)\right),\gamma\right)$ assuming $I_p > 0$ **and** $\gamma > 0$;

$$\frac{2}{3}\,\gamma-\frac{1}{60}\,\gamma^3+\mathrm{O}\left(\gamma^5\right) \qquad \textbf{(1.6)}$$

Keldysh parameter

$\gamma := \frac{\omega\cdot\mathrm{sqrt}(2\cdot I_p)}{F}$

$$\frac{\omega\,\sqrt{2}\,\sqrt{I_p}}{F} \qquad \textbf{(1.7)}$$

Illustration

Define the laser parameters

$\omega := 0.0569532;$ #λ = *800 nm*

$$0.0569532 \qquad \textbf{(2.1)}$$

$F := 0.1$ #*0.1307*

$$0.1 \qquad \textbf{(2.2)}$$

$\frac{F}{\omega}\cdot\mathrm{sqrt}(2.);$

$$2.483115193 \qquad \textbf{(2.3)}$$

Ionization potential

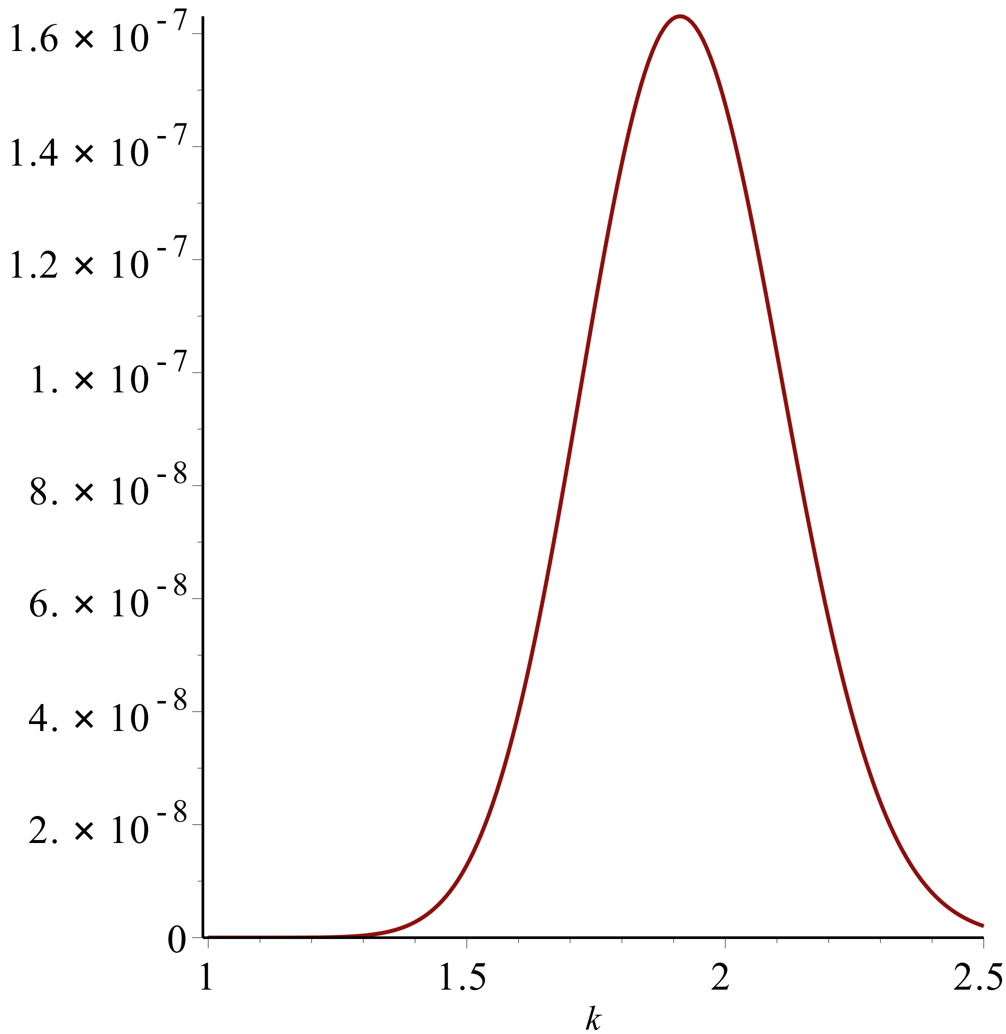
$I_p := 0.9036$

$$0.9036 \qquad (2.4)$$

$\theta := \frac{\text{Pi}}{2};$

$$\frac{1}{2}\pi \qquad (2.5)$$

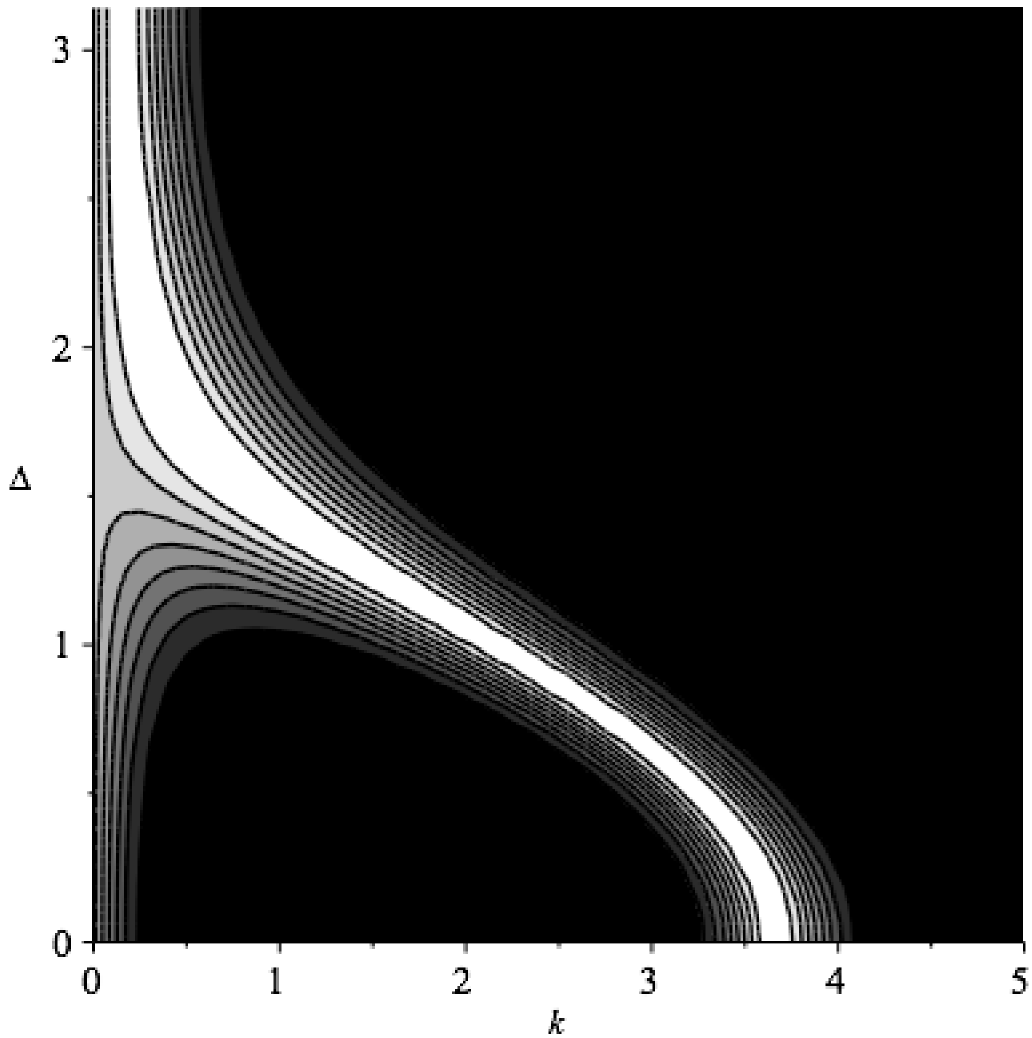
$plot(\Gamma, k = 1\,..2.5);$



Time resolved

$\text{TimeResolvedGamma} := subs\left(k = \text{sqrt}\left(k^2 + \frac{2 \cdot I_p}{\gamma^2} - \frac{2 \cdot k \cdot \sin(\theta) \cdot \text{sqrt}(2 \cdot I_p)}{\gamma} \cdot \cos(\Delta)\right), \Gamma\right) :$

$contourplot(\text{TimeResolvedGamma}, \text{k} = 0\,..5, \Delta = 0\,..\,\text{Pi}, \mathit{filledregions} = \mathit{true}, \mathit{coloring} = [\mathit{black}, \mathit{white}])$



3
2
Δ
1
0
0
1
2
3
4
5
k