

Aufbau und Justage eines Leckstrahlmikroskopes zum Nachweis des plasmonischen Spin-Hall-Effektes

Bachelorarbeit

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2021

Gliederung

Theorie

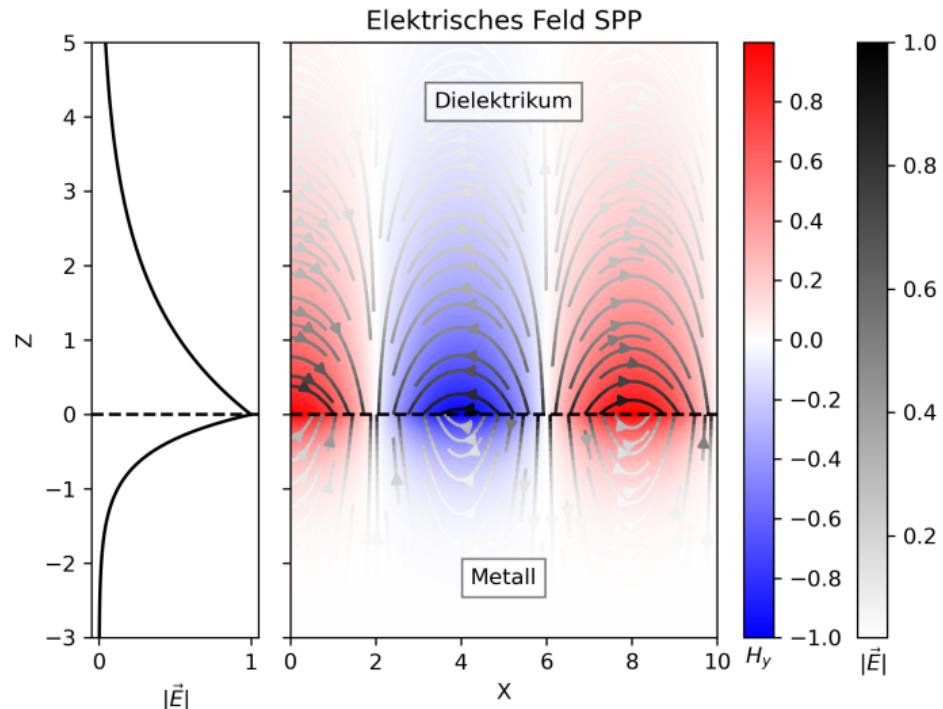
- Surface Plasmon Polariton (SPP)
- Plasmonischer Spin-Hall-Effekt (PSHE)

Experimenteller Aufbau

Messung und Ergebnisse

- Kontrollmessung
- Experimenteller Nachweis des PSHE

Surface Plasmon Polariton (SPP)



Orientierung der Felder

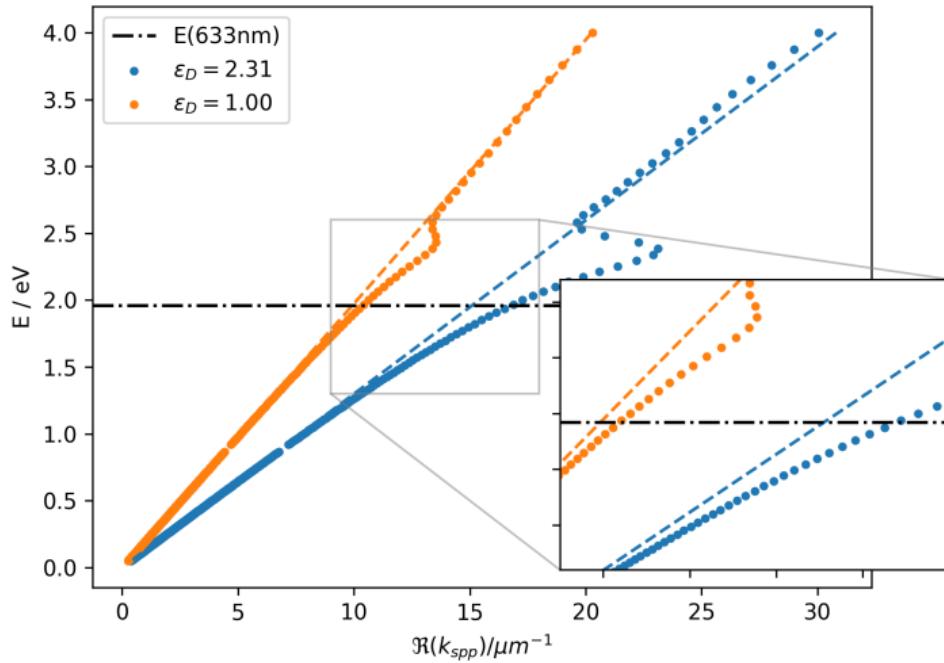
$$\vec{E}_n = \begin{pmatrix} 1 \\ 0 \\ \pm k_{\text{spp}} / k_{z,n} \end{pmatrix} E_0 \exp(i(k_{\text{spp}}x + k_{z,n}|z| - \omega t)) \quad (1a)$$

$$\vec{H}_n = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} H_0 \exp(i(k_{\text{spp}}x + k_{z,n}|z| - \omega t)) \quad (1b)$$

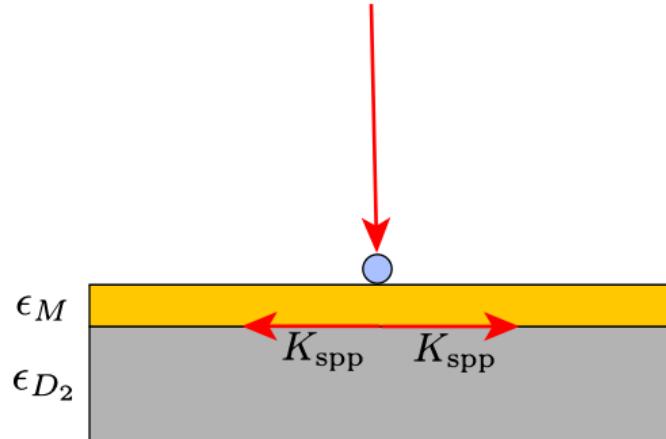
Dispersion SPP

$$k_{\text{spp}}(\omega) = \frac{\omega}{c} \sqrt{\frac{\epsilon_D \epsilon_M(\omega)}{\epsilon_D + \epsilon_M(\omega)}} = k_0(\omega) n_{\text{eff}}(\omega) \quad (2)$$

Dispersion SPP



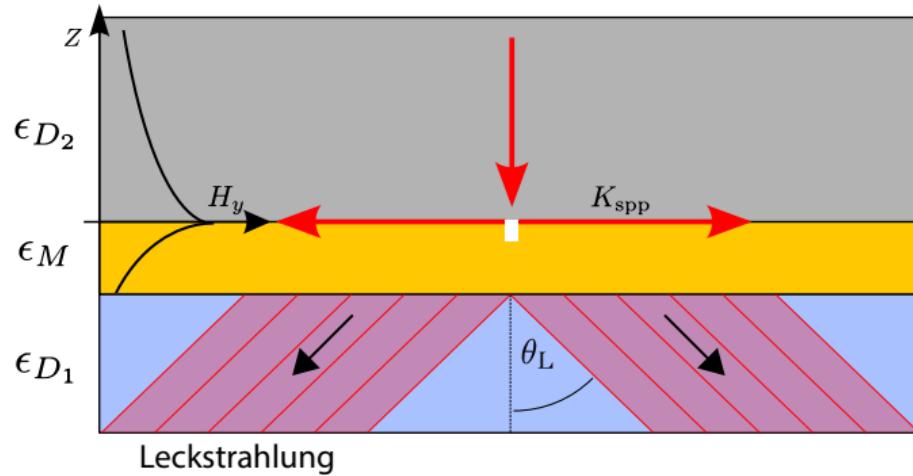
Kretschmann-Konfiguration



$$\sin(\theta_E) = \frac{\text{Re}\{k_{\text{spp}}\}}{k_{D_1}} \quad (3)$$

$$\Rightarrow \text{Re}\{k_{\text{SPP}}\} = \sin(\theta_E) k_0 \sqrt{\epsilon_{D_1}} \quad (4)$$

Leckstrahlung

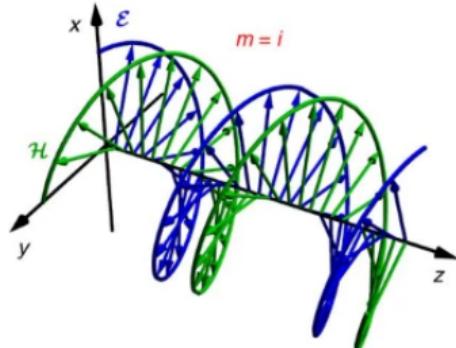


$$\Re\{k_{\text{spp}}\} = \sin(\theta_L) k_0 \sqrt{\epsilon_{D_1}}$$

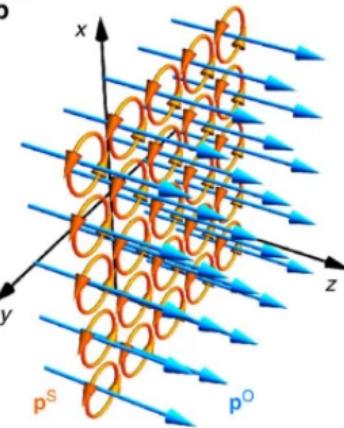
(5)

Spin von elektromagnetischer Strahlung

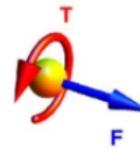
a



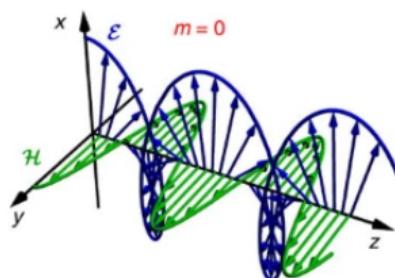
b



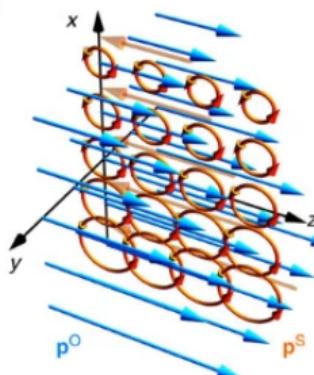
c



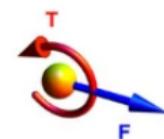
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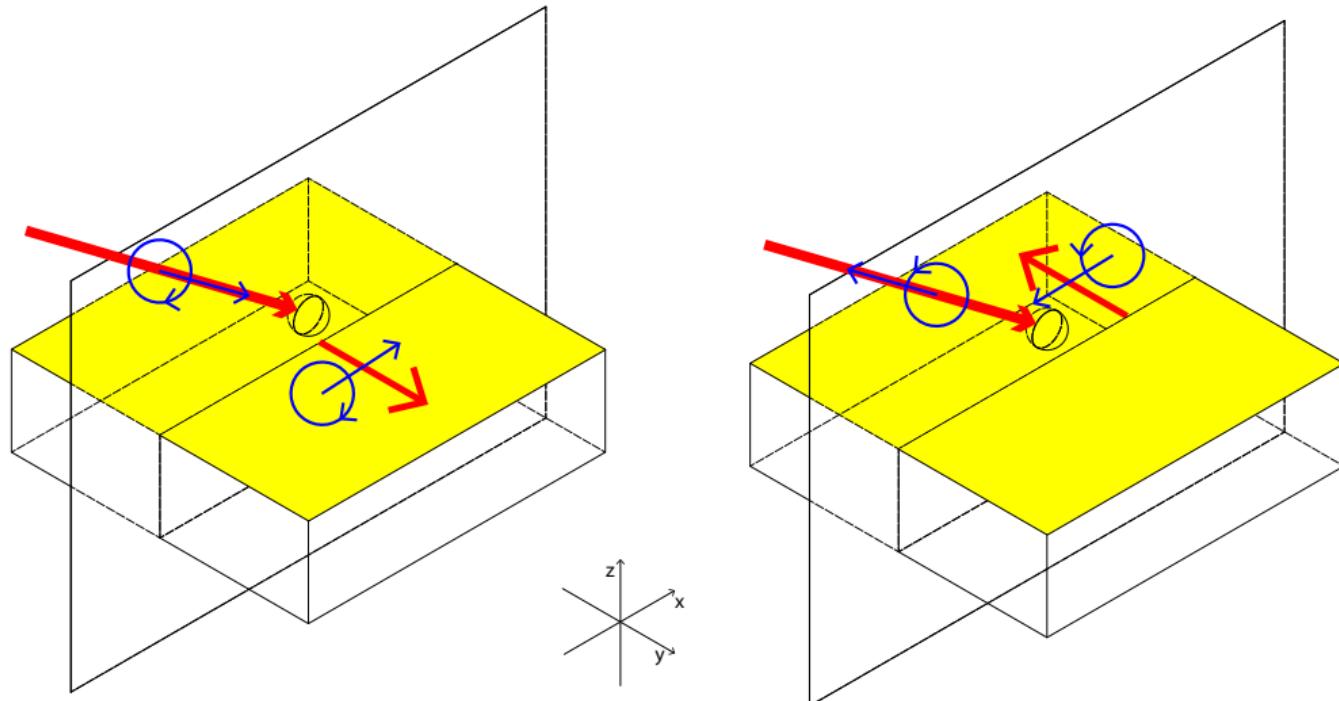
b



c



Drehimpulserhaltung beim PSHE



Raumfrequenzdarstellung Elektromagnetischer Strahlung

$$\vec{E}(x, z) = \int_{-\infty}^{\infty} dk_x \hat{\vec{E}}(k_x, z) \exp(ik_x x) \quad (6)$$

$$\hat{\vec{E}}(k_x, z) = \frac{1}{2\pi} \int_{-\infty}^{\infty} dx \vec{E}(x, z) \exp(-ik_x x) \quad (7)$$

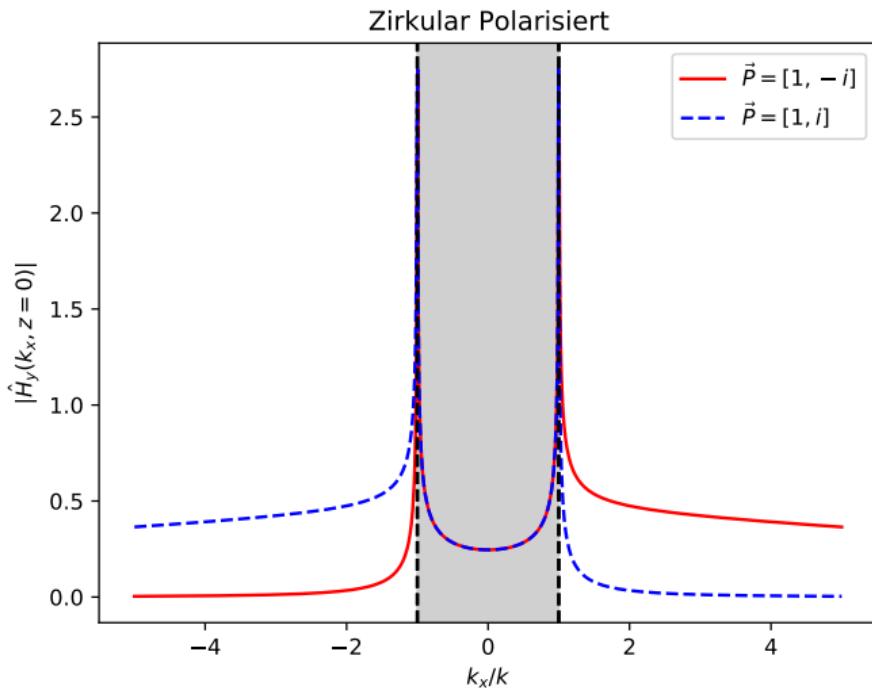
Medium entlang der x -Achse homogen, isotrop, linear und quellfrei:

$$\hat{\vec{E}}(k_x, z) = \hat{\vec{E}}(k_x, z = 0) \exp(\pm ik_z) \quad (8)$$

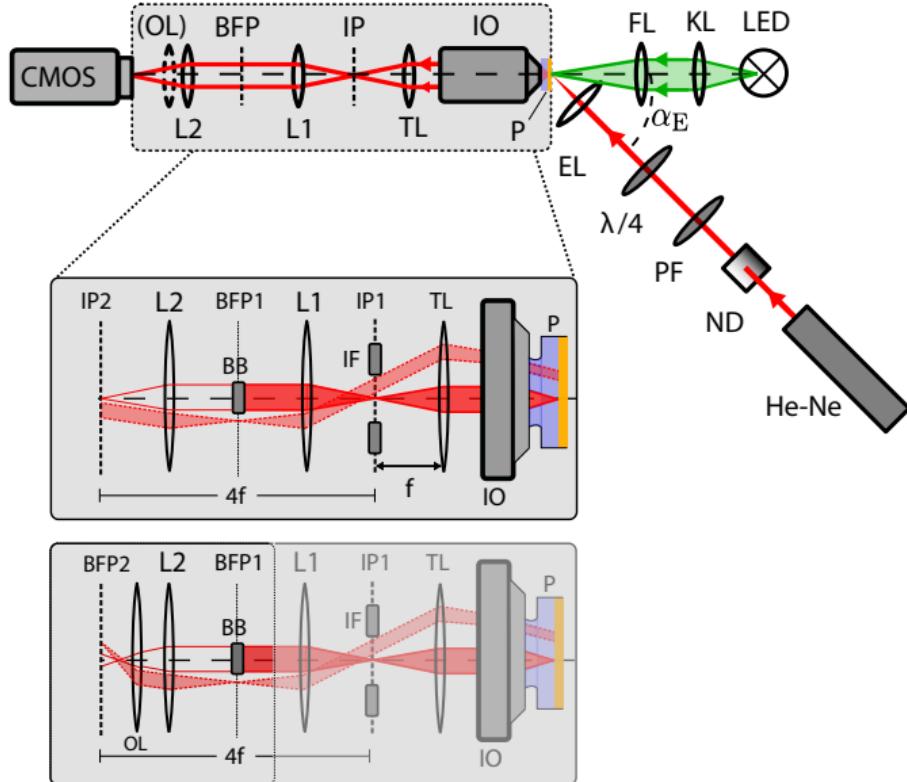
mit:

$$k_z := \sqrt{k^2 - k_x^2} \quad (9)$$

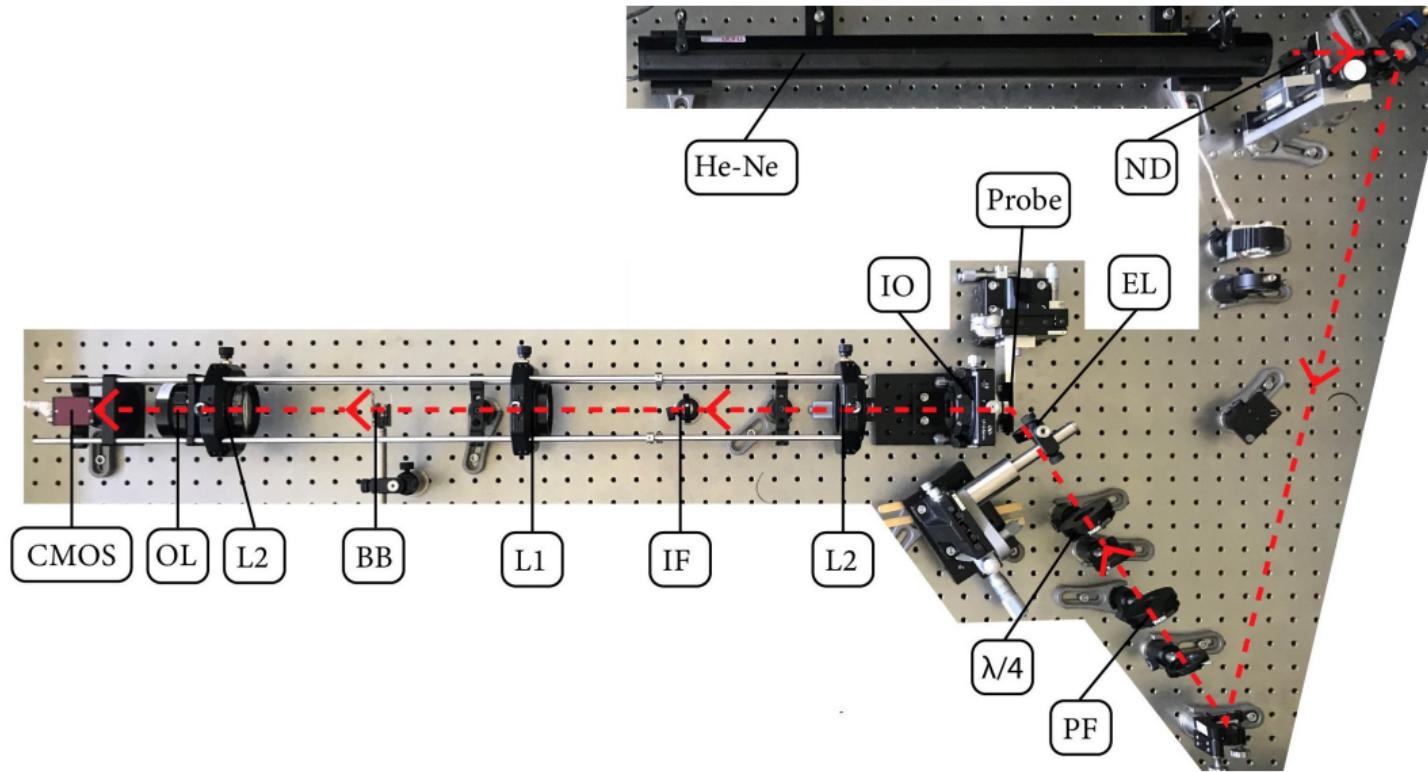
Raumfrequenzspektrum zirkular polarisierter Dipol



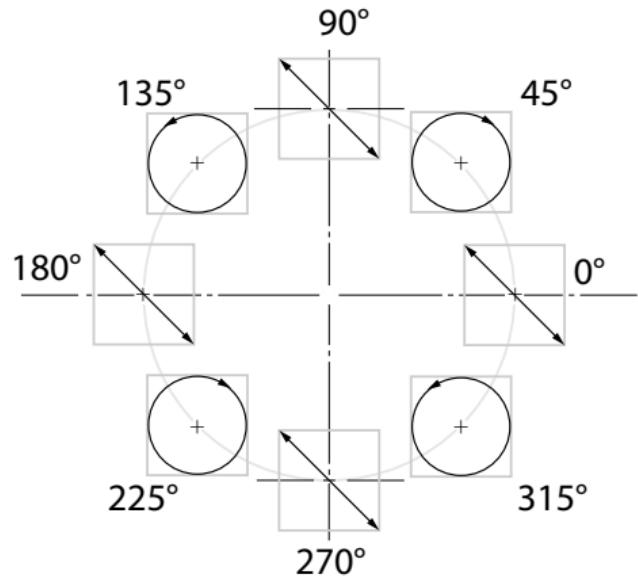
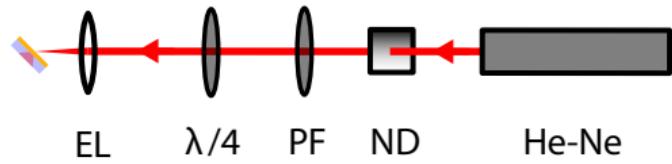
Aufbau



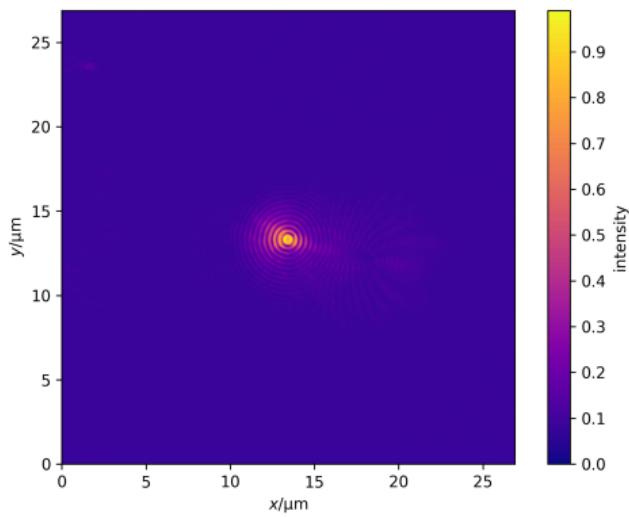
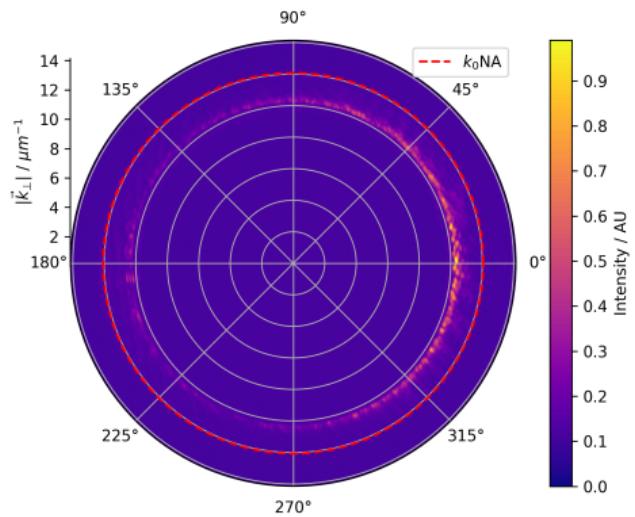
Experimenteller Aufbau



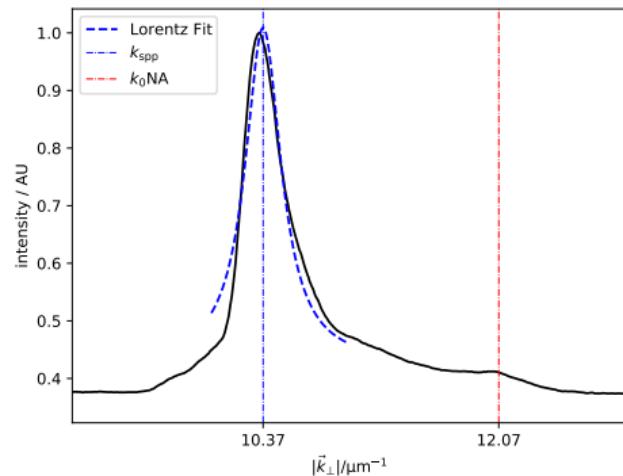
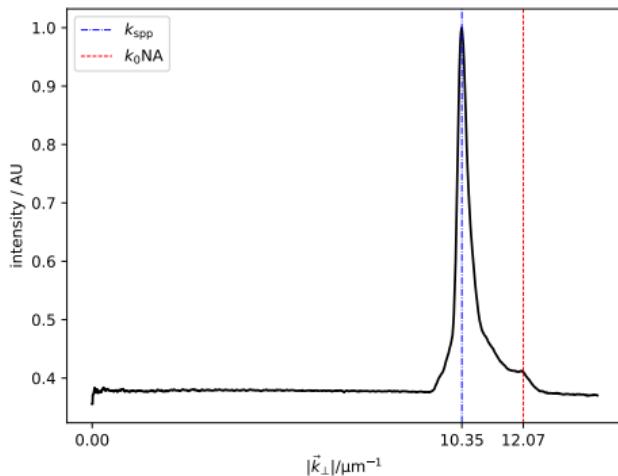
Kontrolle der Polarisation des Anregungslasers



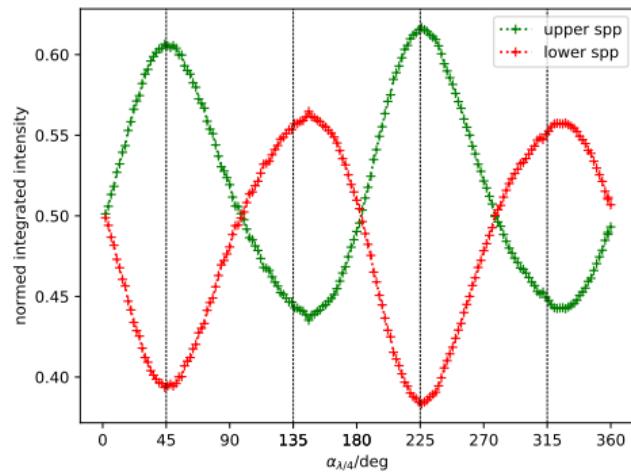
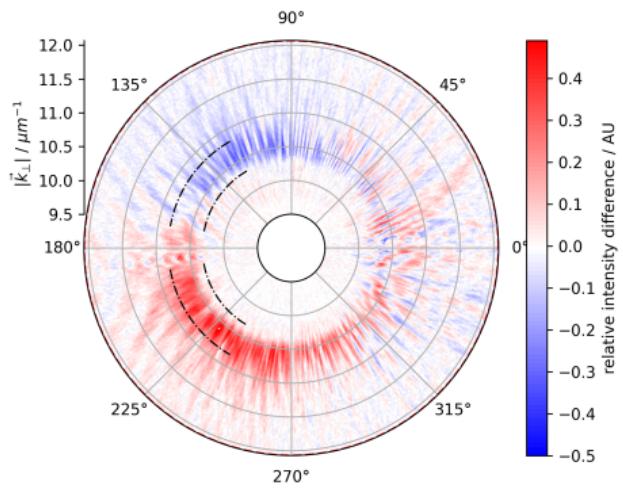
Kontrollmessung an Punktdefekt



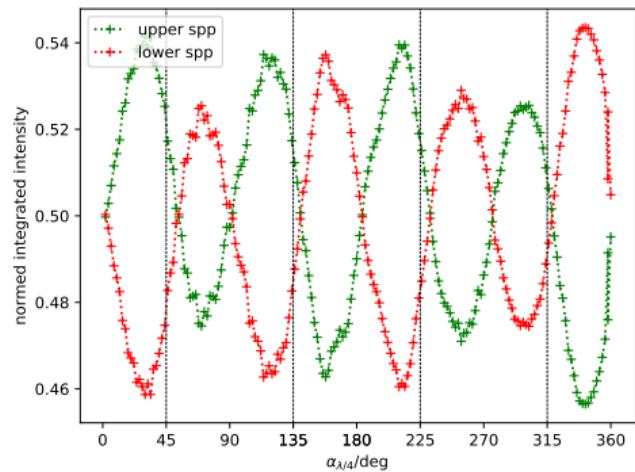
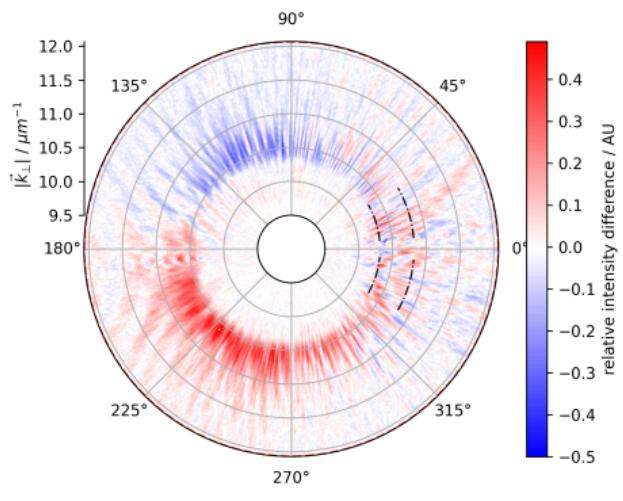
Auswertung der BFP



Rückwärtsrichtung



Vorwärtsrichtung



Senkrecht zur Einfallsebene

