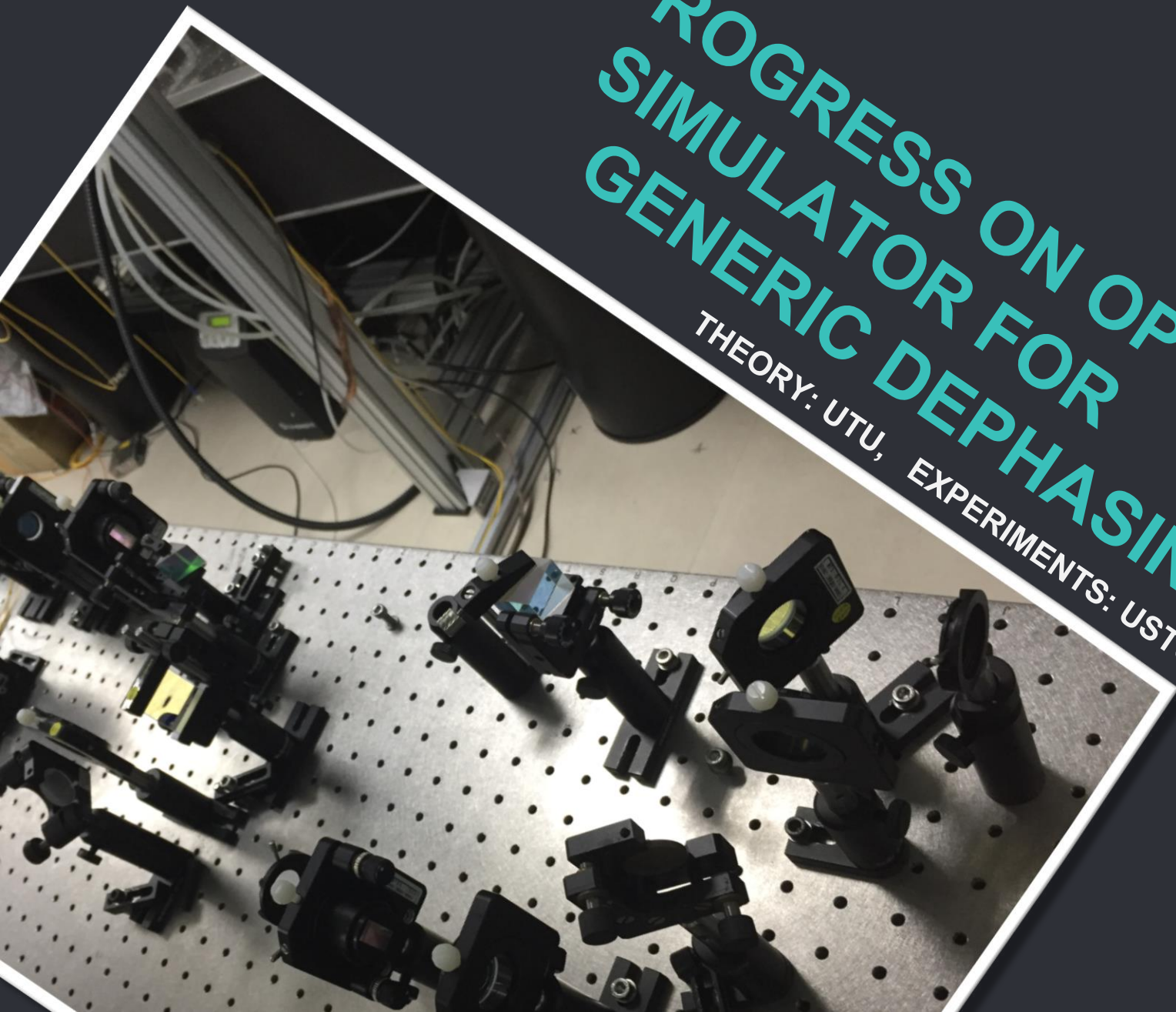


PROGRESS ON OPTICAL SIMULATOR FOR GENERIC DEPHASING

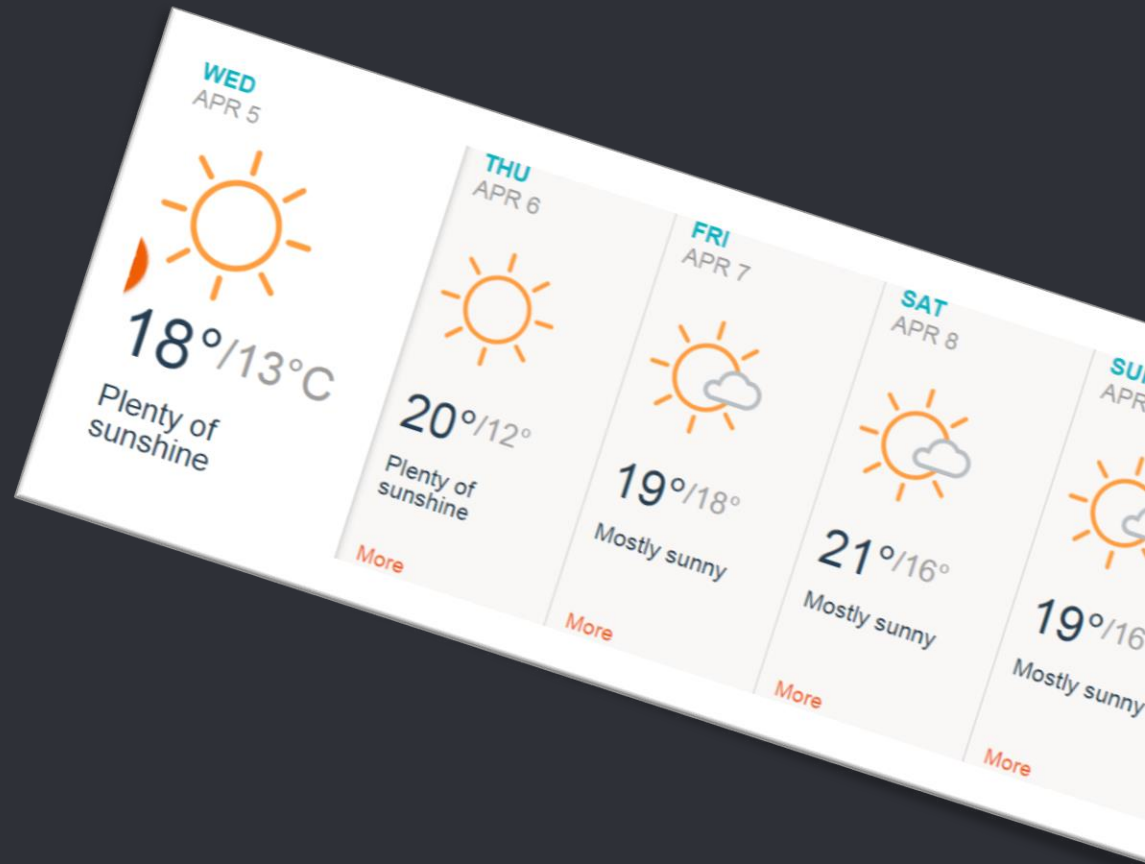
THEORY: UTU, EXPERIMENTS: USTC



SIMULATORS



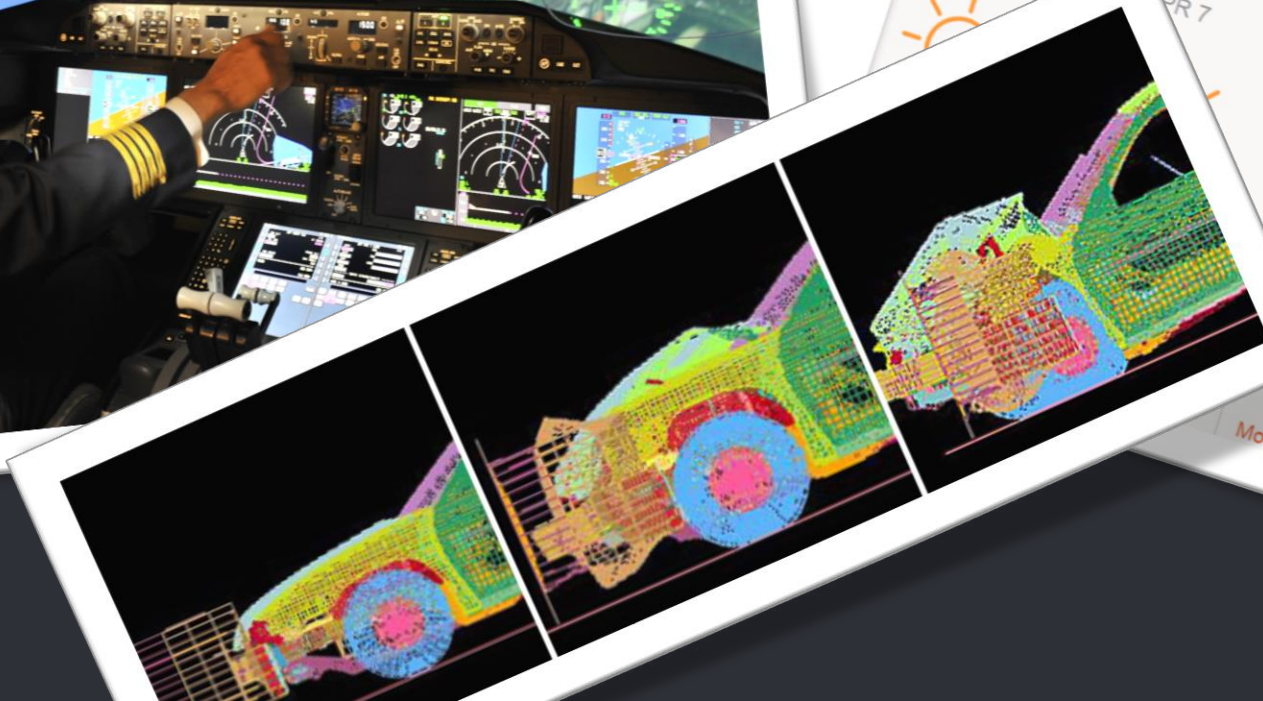
SIMULATORS



SIMULATORS



SIMULATORS



THU
APR 6



FRI
APR 7

SAT
APR 8



21°/16°

Mostly sunny

More

SUN
APR 9



19°/16°

Mostly sunny

More



THE MODEL



THE MODEL

SIMULATOR: THEORY

THE MODEL

SIMULATOR: THEORY

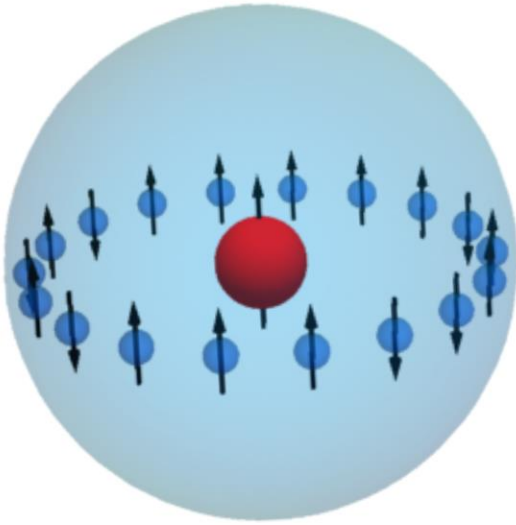
SIMULATOR: EXPERIMENT

THE MODEL



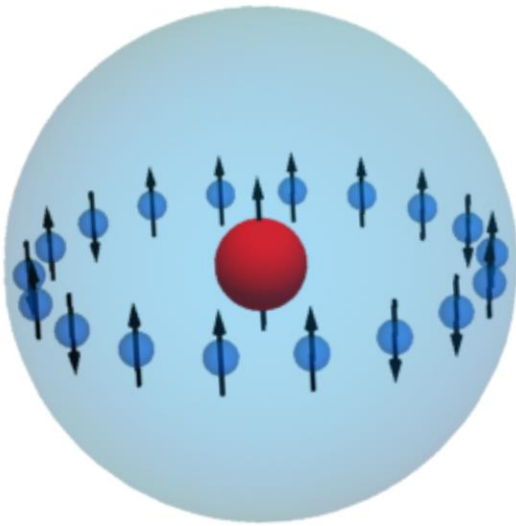
THE MODEL

4000 SPINS



THE MODEL

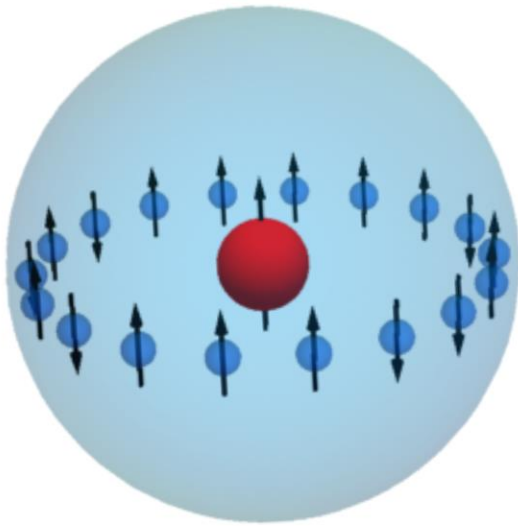
4000 SPINS



$$H_0(\lambda, \delta) = -J \sum_j (\sigma_3^{(j)} \otimes \sigma_3^{(j+1)} + \lambda \sigma_1^{(j)} + \delta |e\rangle\langle e| \otimes \sigma_1^{(j)})$$

THE MODEL

4000 SPINS



$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

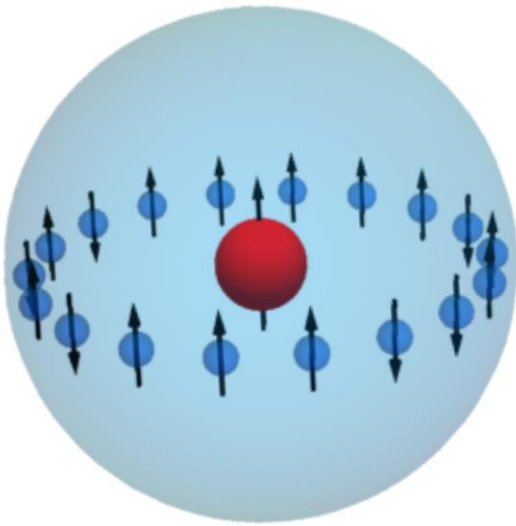
$\xrightarrow{\Lambda t}$

$$\rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$H_0(\lambda, \delta) = -J \sum_j (\sigma_3^{(j)} \otimes \sigma_3^{(j+1)} + \lambda \sigma_1^{(j)} + \delta |e\rangle\langle e| \otimes \sigma_1^{(j)})$$

THE MODEL

4000 SPINS



$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$\xrightarrow{\Lambda t}$$

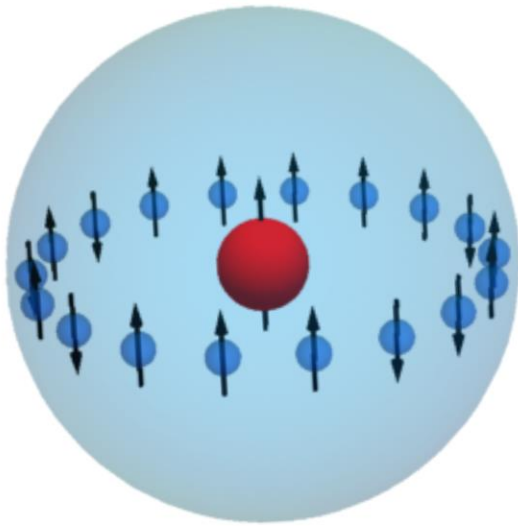
$$\rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$H_0(\lambda, \delta) = -J \sum_j (\sigma_3^{(j)} \otimes \sigma_3^{(j+1)} + \lambda \sigma_1^{(j)} + \delta |e\rangle\langle e| \otimes \sigma_1^{(j)})$$

$$L_{\phi_0}(\lambda, t) = \Pi_{k>0} (1 - \sin^2(2\alpha_k) \sin^2(\varepsilon_k t)),$$

THE MODEL

4000 SPINS



$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$\xrightarrow{\Lambda t} \rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$H_0(\lambda, \delta) = -J \sum_j (\sigma_3^{(j)} \otimes \sigma_3^{(j+1)} + \lambda \sigma_1^{(j)} + \delta |e\rangle\langle e| \otimes \sigma_1^{(j)})$$

$$L_{\phi_0}(\lambda, t) = \Pi_{k>0} (1 - \sin^2(2\alpha_k) \sin^2(\varepsilon_k t)),$$

α_k - Bogoliubov angles,

ε_k - single quasiparticle excitation energies of the system with the qubit in the state $|e\rangle$.

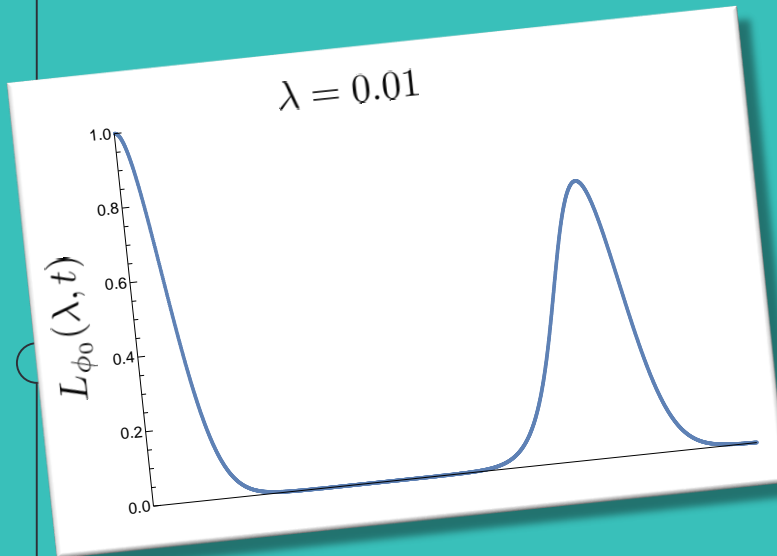
THE MODEL

$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$\xrightarrow{\Lambda t}$

$$\rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

THE MODEL

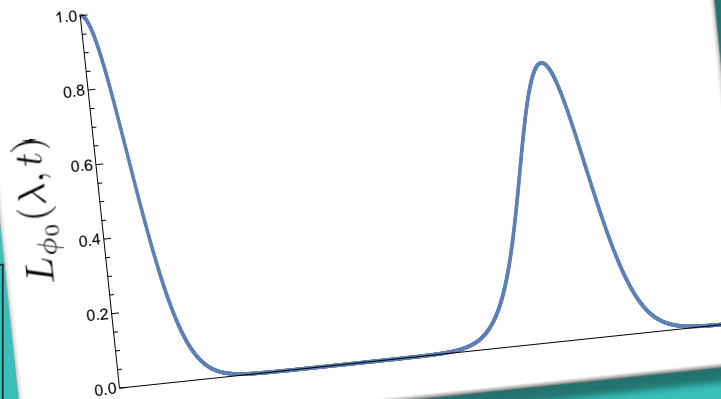


$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

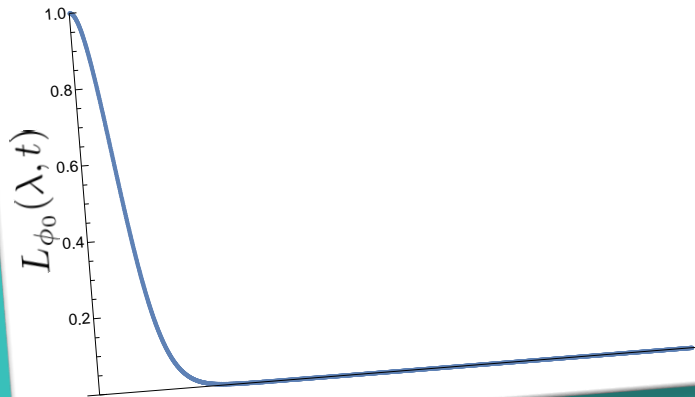
$$\xrightarrow{\Lambda t} \rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

THE MODEL

$\lambda = 0.01$



$\lambda = 0.9$



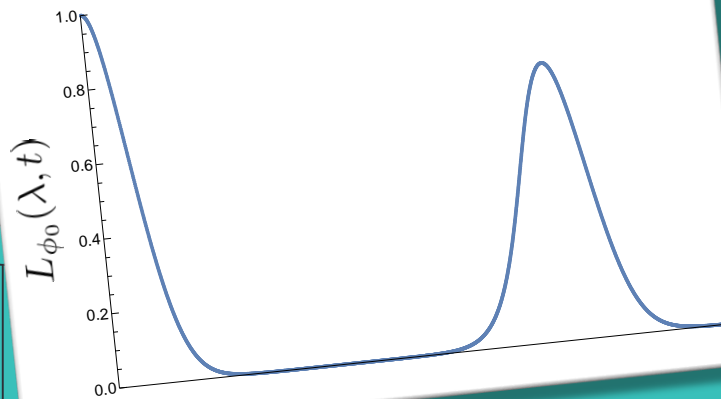
$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

$\xrightarrow{\Lambda t}$

$$\rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t) \rho_{eg} \\ L_{\phi_0}(\lambda, t) \rho_{ge} & \rho_{gg} \end{pmatrix}$$

THE MODEL

$$\lambda = 0.01$$

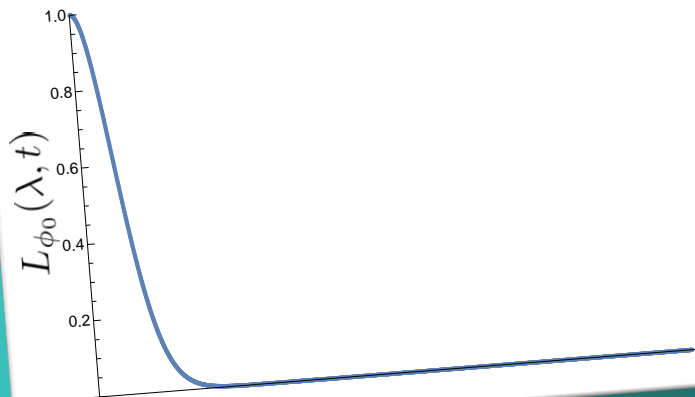


$$\rho^S(0) = \begin{pmatrix} \rho_{ee} & \rho_{eg} \\ \rho_{ge} & \rho_{gg} \end{pmatrix}$$

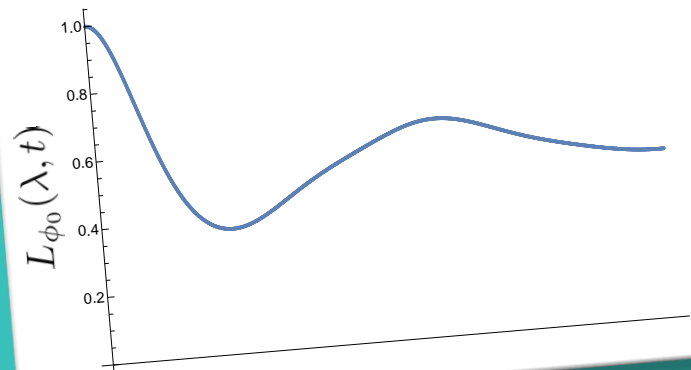
$$\xrightarrow{\Lambda_t}$$

$$\rho^S(t) = \begin{pmatrix} \rho_{ee} & L_{\phi_0}(\lambda, t)\rho_{eg} \\ L_{\phi_0}(\lambda, t)\rho_{ge} & \rho_{gg} \end{pmatrix}$$

$$\lambda = 0.9$$



$$\lambda = 1.8$$



SIMULATOR: THEORY



SIMULATOR: THEORY

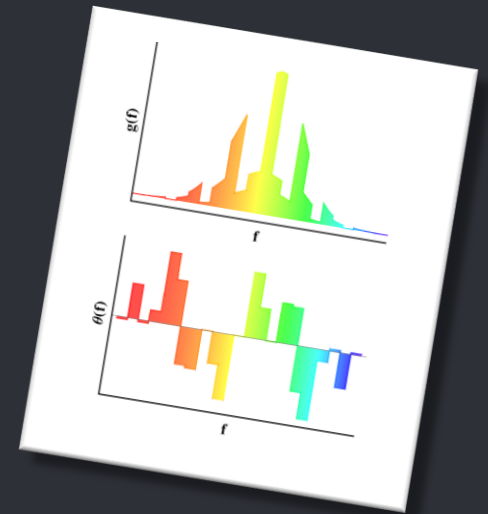
SYSTEM: POLARIZATION



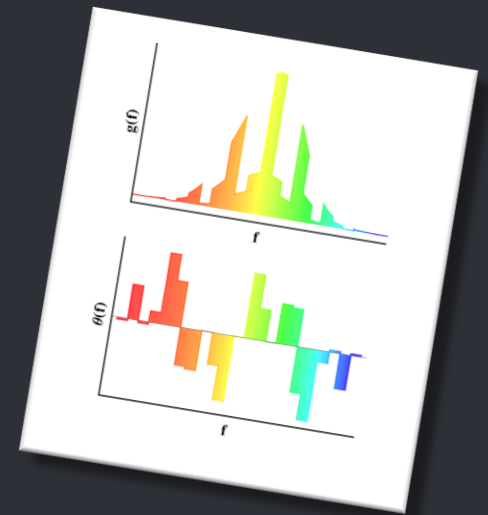
SIMULATOR: THEORY

SYSTEM: POLARIZATION

ENVIRONMENT: FREQUENCY

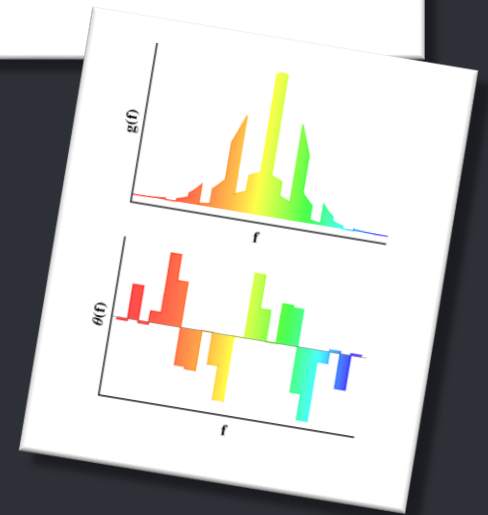


SIMULATOR: THEORY



SIMULATOR: THEORY

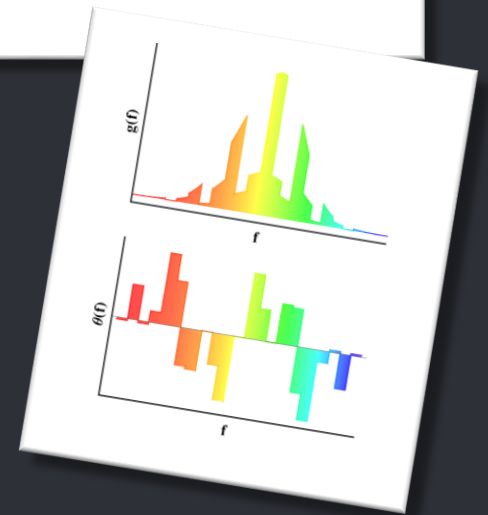
$$|\Psi^{init}\rangle := (C_H |H\rangle + C_V |V\rangle) \int p(f) |f\rangle df$$



SIMULATOR: THEORY

$$|\Psi^{init}\rangle := (C_H |H\rangle + C_V |V\rangle) \int p(f) |f\rangle df$$

$$|\Psi^{init}\rangle \xrightarrow{SLM} |\Psi\rangle$$

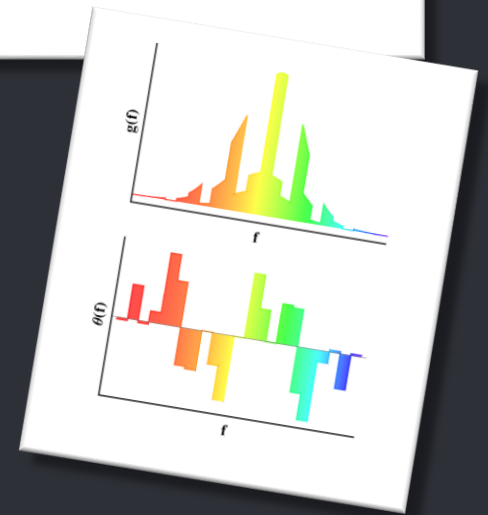


SIMULATOR: THEORY

$$|\Psi^{init}\rangle := (C_H |H\rangle + C_V |V\rangle) \int p(f) |f\rangle df$$

$$|\Psi^{init}\rangle \xrightarrow{SLM} |\Psi\rangle$$

$$|\Psi\rangle = C_H |H\rangle \int g(f) |f\rangle df + C_V |V\rangle \int e^{i\theta(f)} g(f) |f\rangle df$$



SIMULATOR: THEORY

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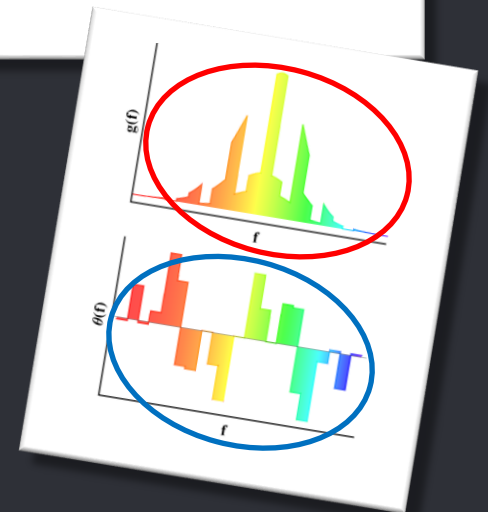


SIMULATOR: THEORY

$$|\Psi^{init}\rangle := (C_H |H\rangle + C_V |V\rangle) \int p(f) |f\rangle df$$

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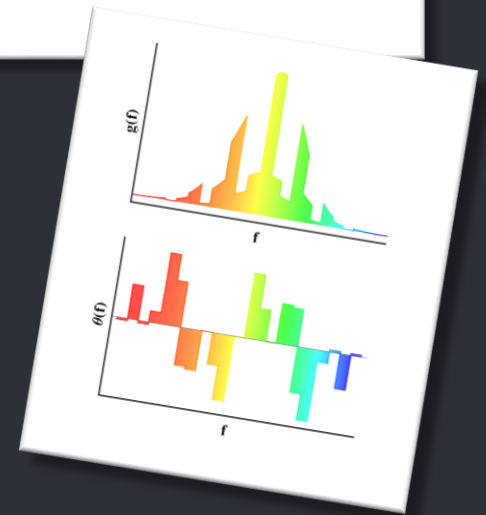


SIMULATOR: THEORY

$$|\Psi^{init}\rangle := (C_H |H\rangle + C_V |V\rangle) \int p(f) |f\rangle df$$

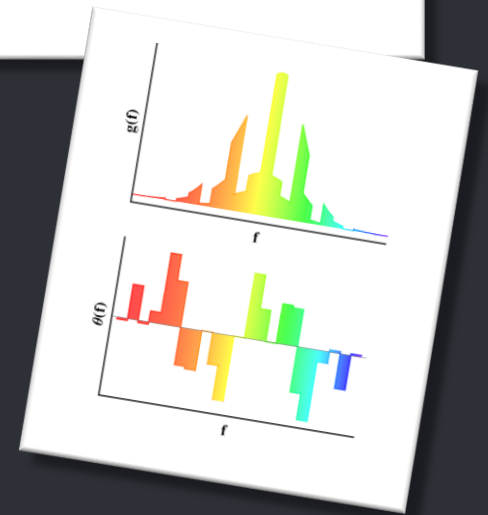
$$|\Psi^{init}\rangle \xrightarrow{SLM} |\Psi\rangle$$

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SIMULATOR: THEORY

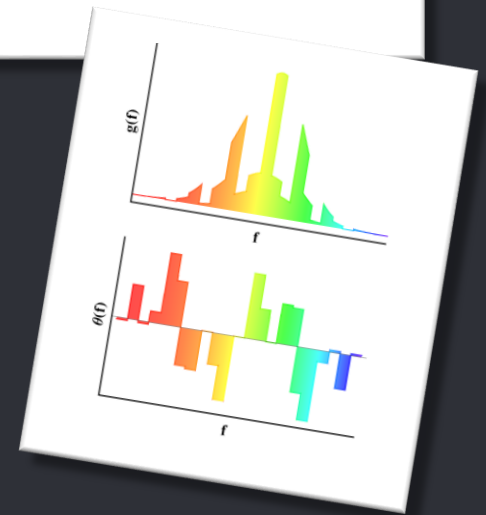
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SIMULATOR: THEORY

$$|\Psi\rangle = C_H |H\rangle \int g(f) |f\rangle df + C_V |V\rangle \int e^{i\theta(f)} g(f) |f\rangle df$$

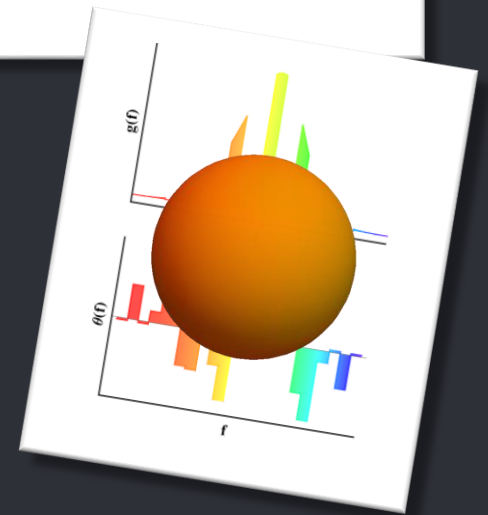
$$U(t) |\mu\rangle |f\rangle := e^{in_\mu ft/2\pi} |\mu\rangle |f\rangle, |\mu\rangle \in \{|H\rangle, |V\rangle\}$$



SIMULATOR: THEORY

$$|\Psi\rangle = C_H |H\rangle \int g(f) |f\rangle df + C_V |V\rangle \int e^{i\theta(f)} g(f) |f\rangle df$$

$$\rho^S(0) = \begin{pmatrix} |C_H|^2 & \kappa^*(0)C_H C_V^* \\ \kappa(0)C_H^* C_V & |C_V|^2 \end{pmatrix} \xrightarrow{\Phi_t} \rho^S(t) = \begin{pmatrix} |C_H|^2 & \kappa^*(t)C_H C_V^* \\ \kappa(t)C_H^* C_V & |C_V|^2 \end{pmatrix},$$

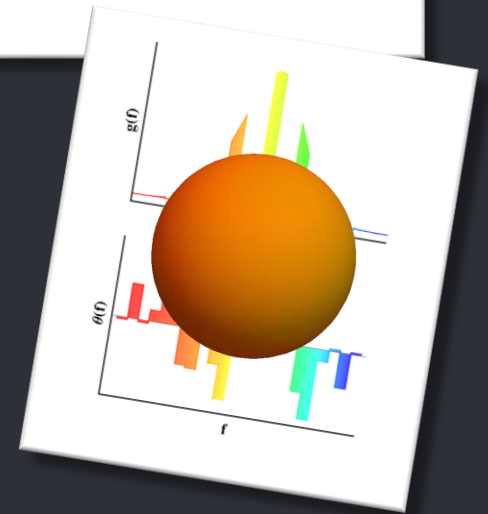


SIMULATOR: THEORY

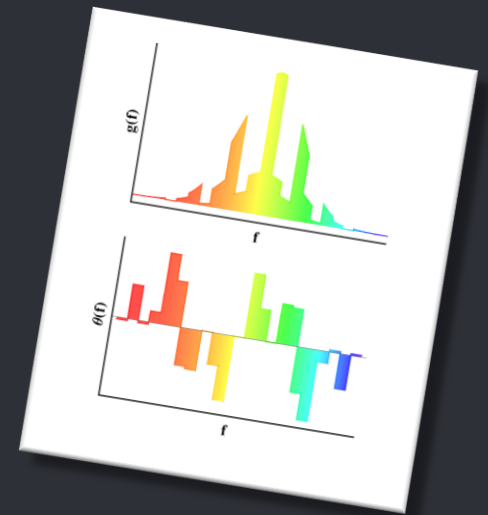
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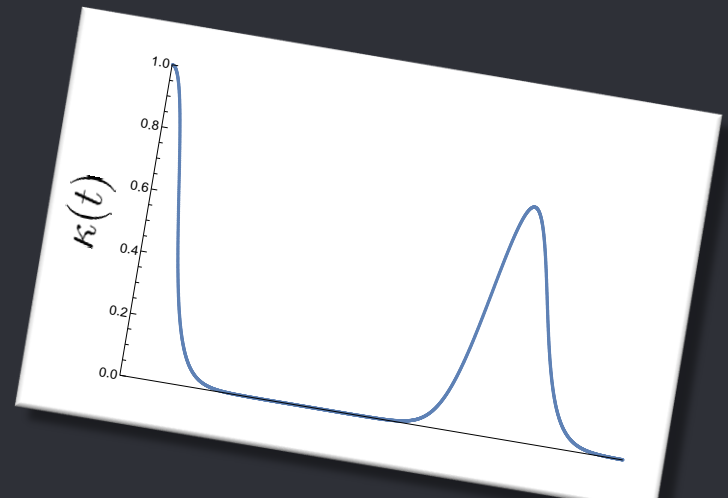
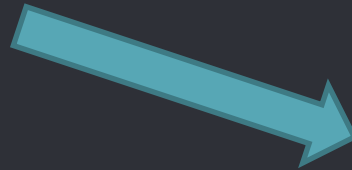
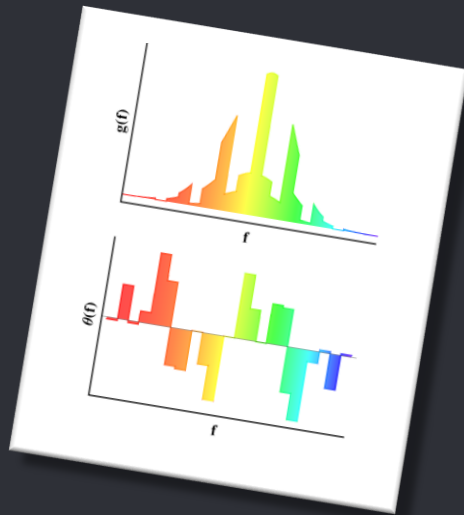
$$\kappa(t) := \int |g(f)|^2 e^{i\theta(f)} e^{i\Delta n f t / 2\pi} df, \quad \Delta n = n_V - n_H$$



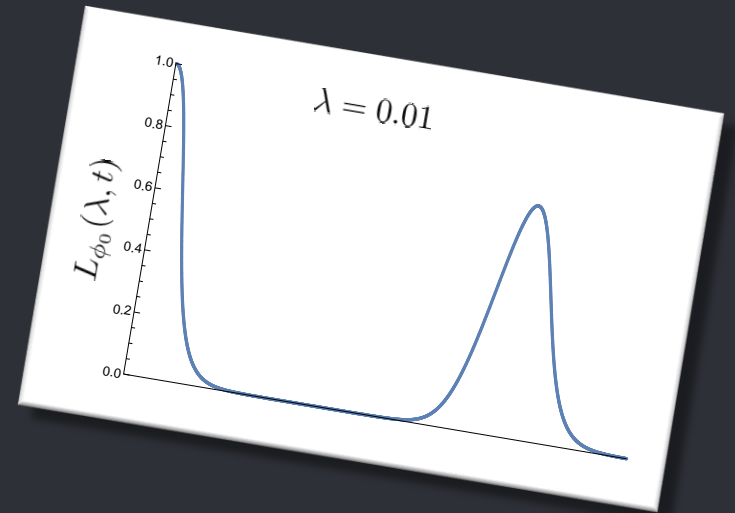
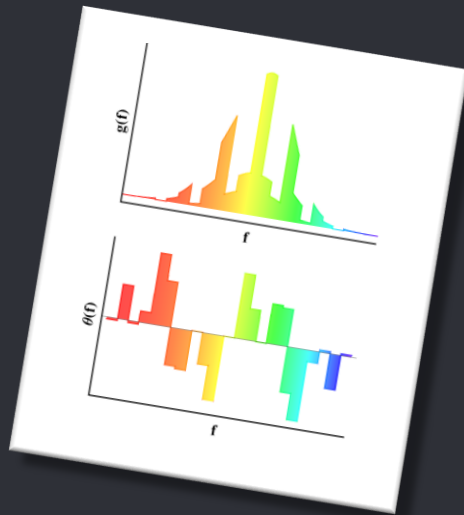
SIMULATOR: THEORY



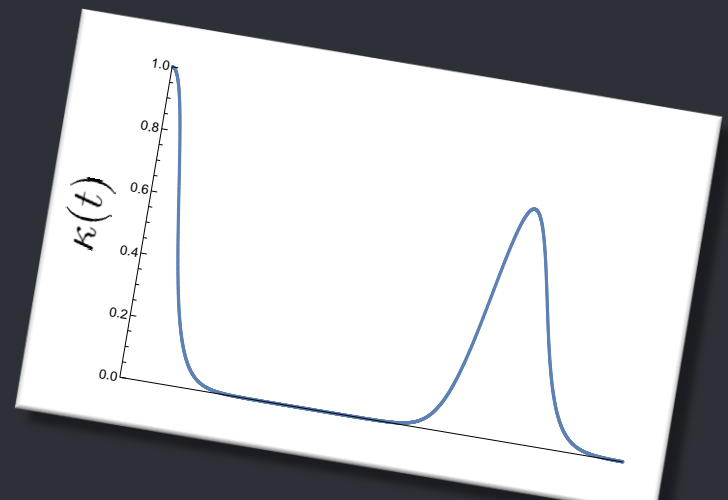
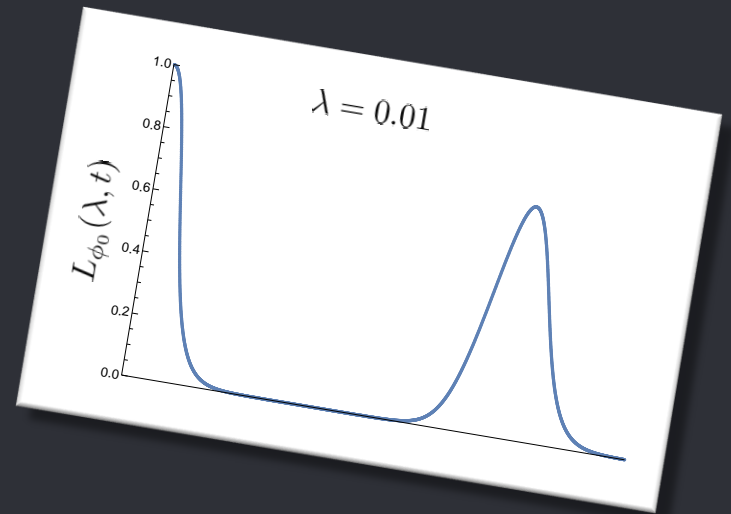
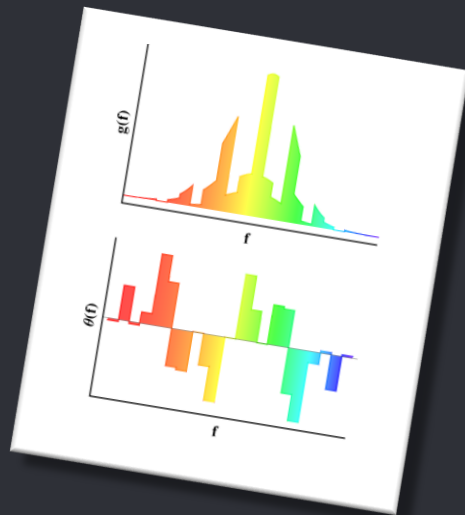
SIMULATOR: THEORY



SIMULATOR: THEORY



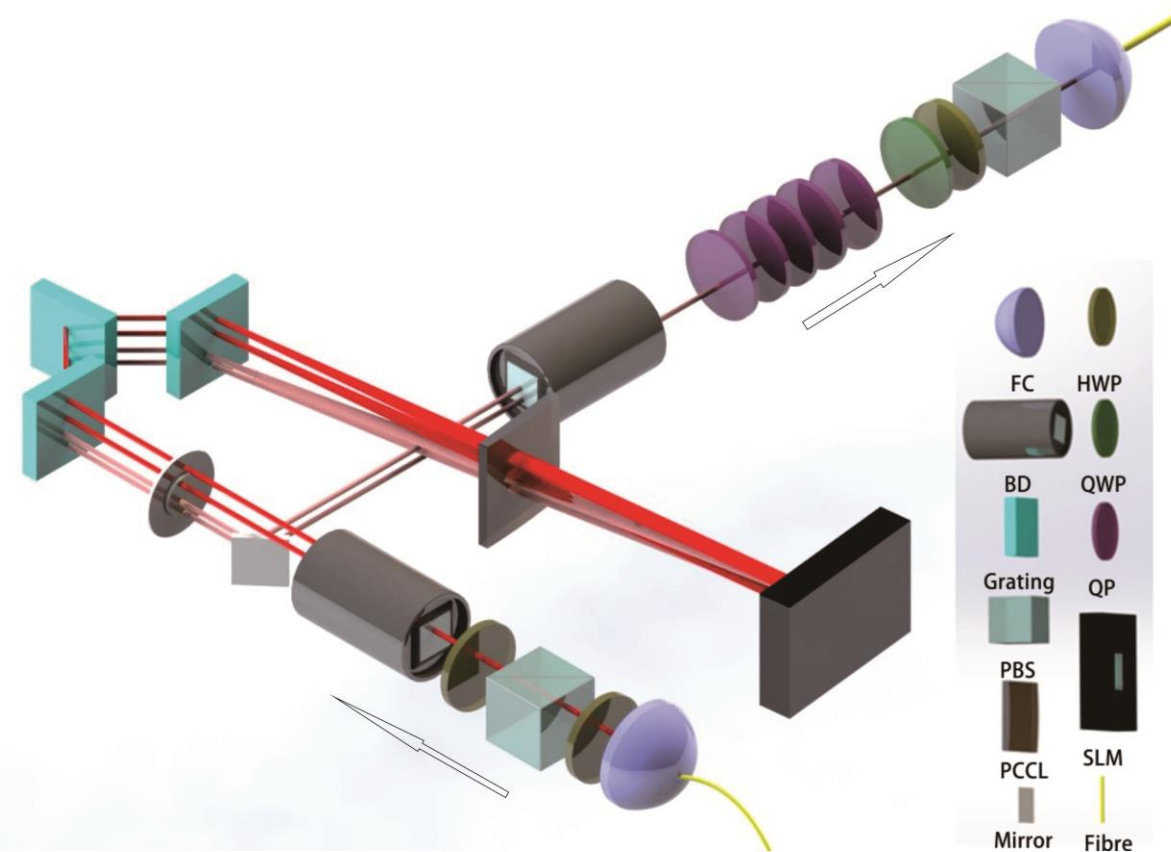
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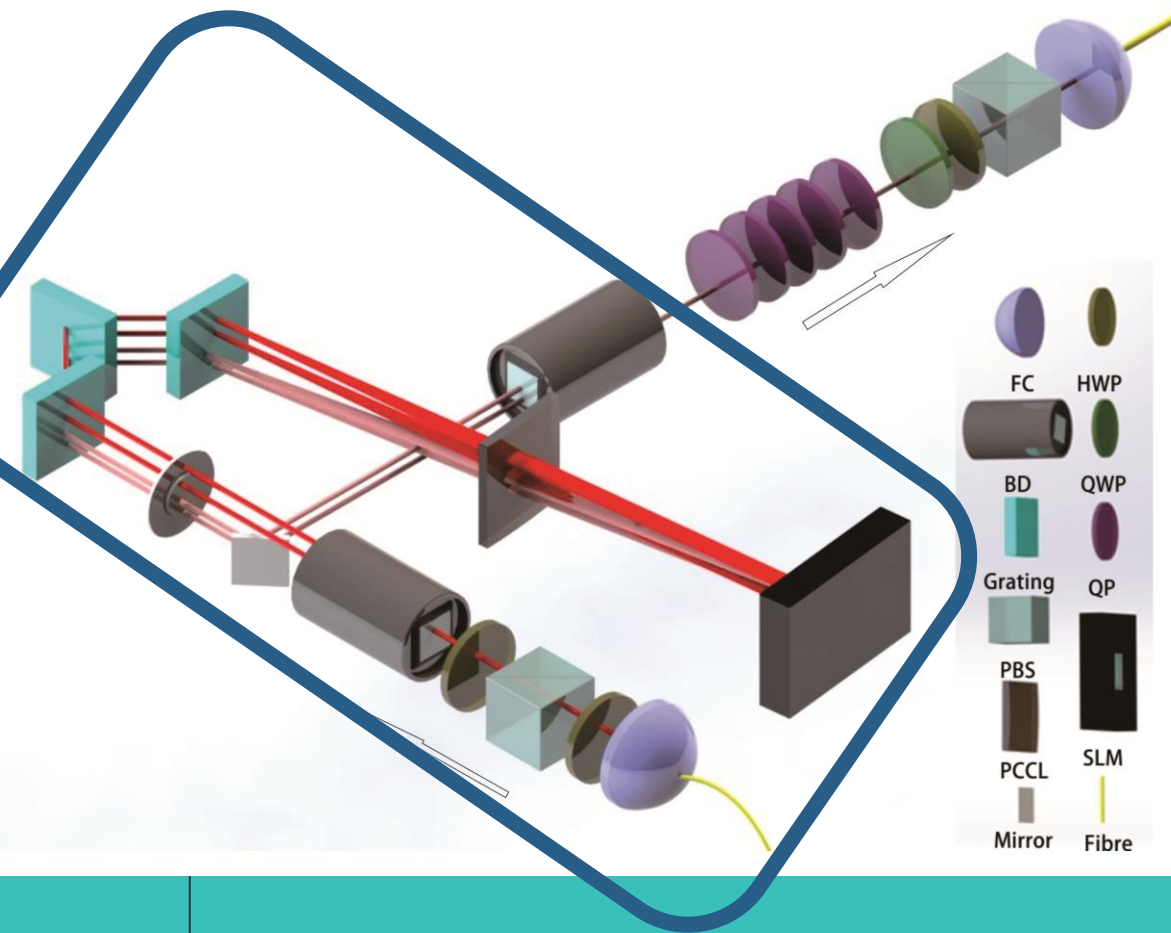
SIMULATOR: EXPERIMENT



SIMULATOR: EXPERIMENT

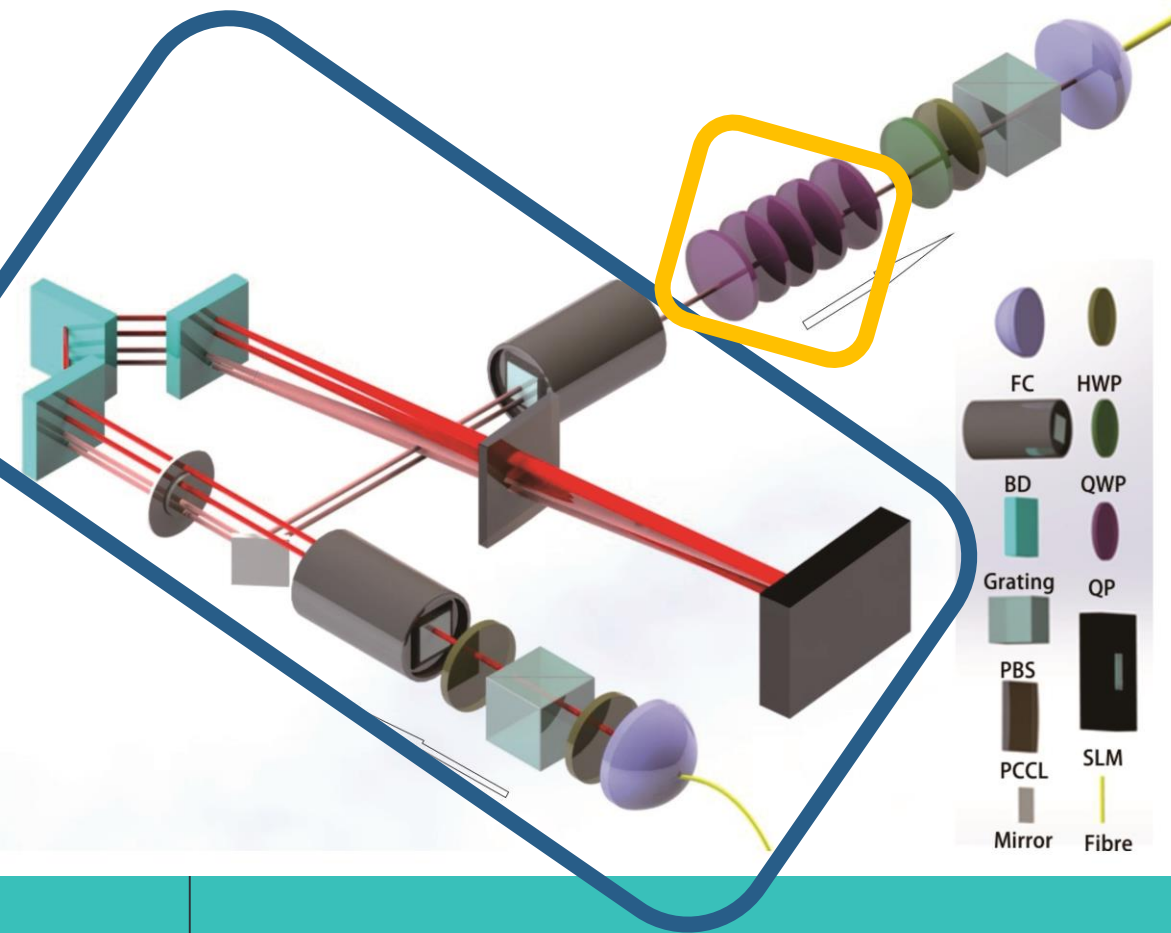


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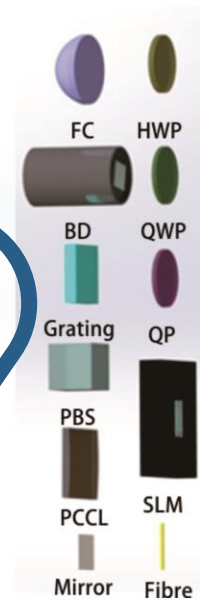
STATE PREPARATION

SIMULATOR: EXPERIMENT

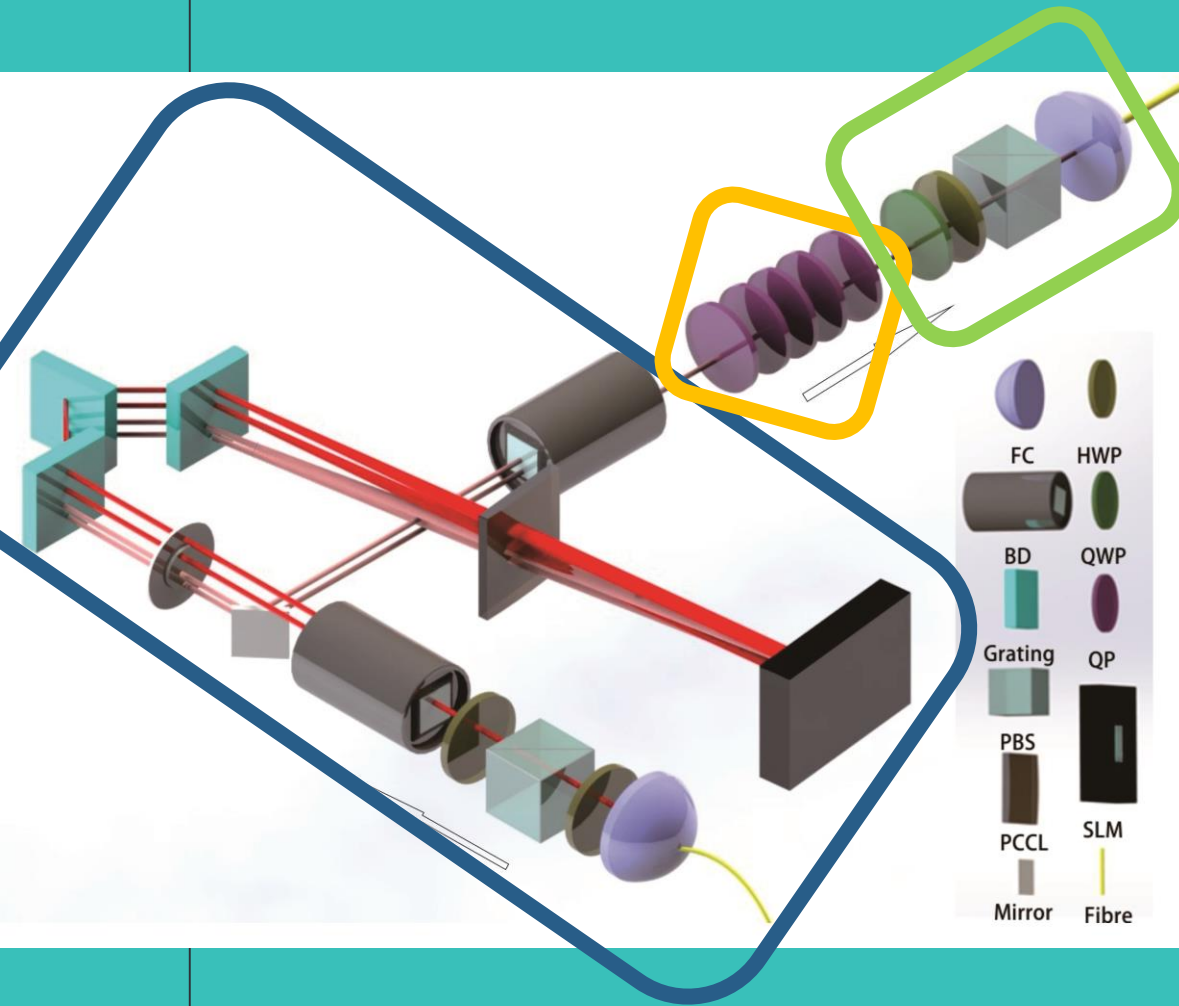


STATE PREPARATION

DYNAMICS



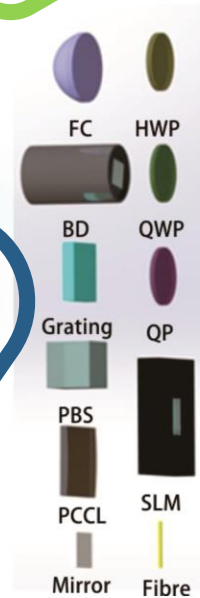
SIMULATOR: EXPERIMENT



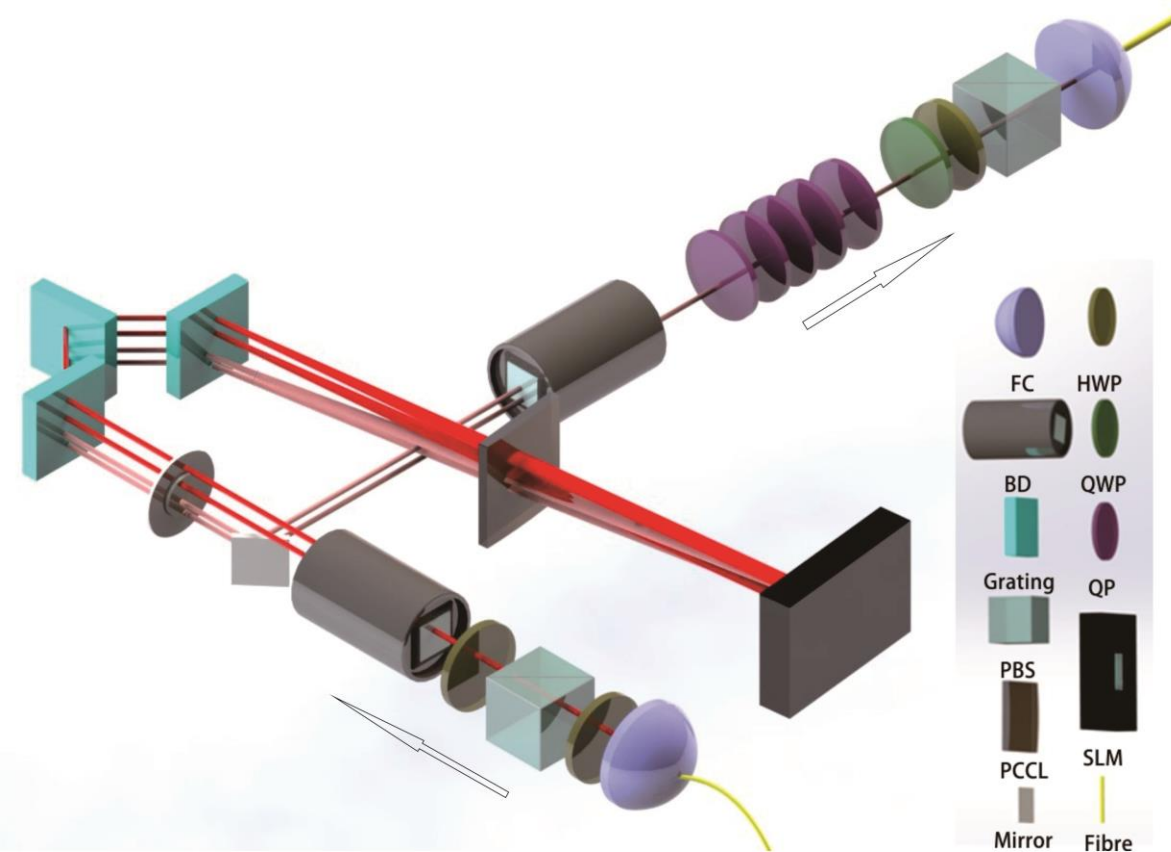
STATE PREPARATION

DYNAMICS

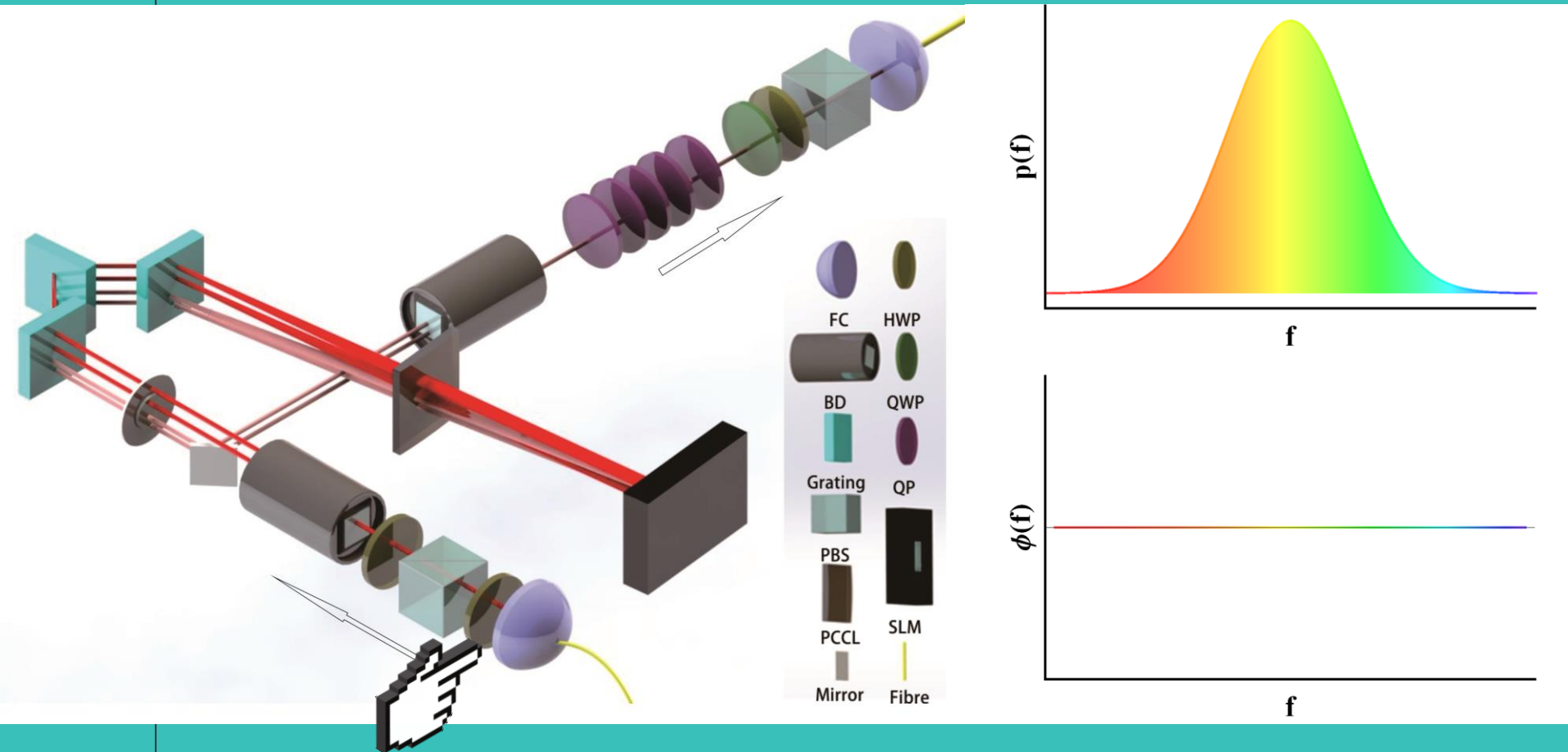
TOMOGRAPHY



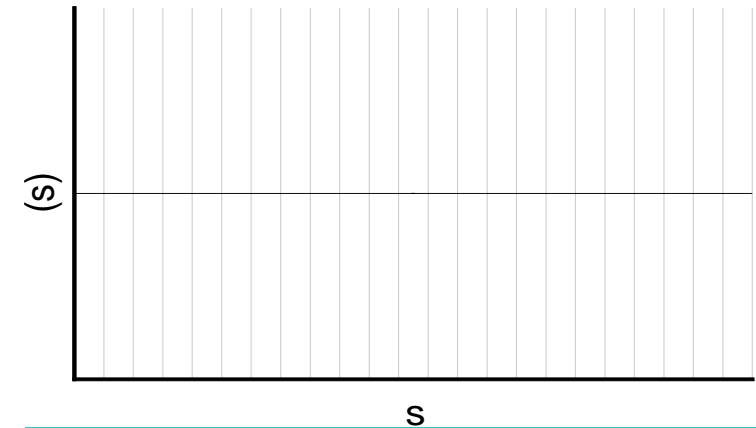
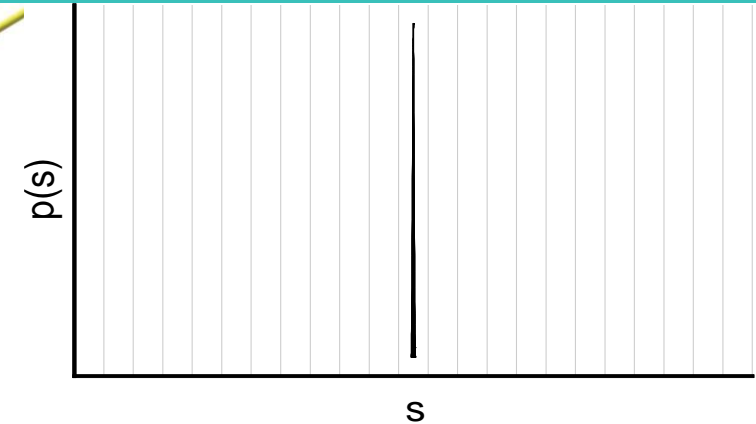
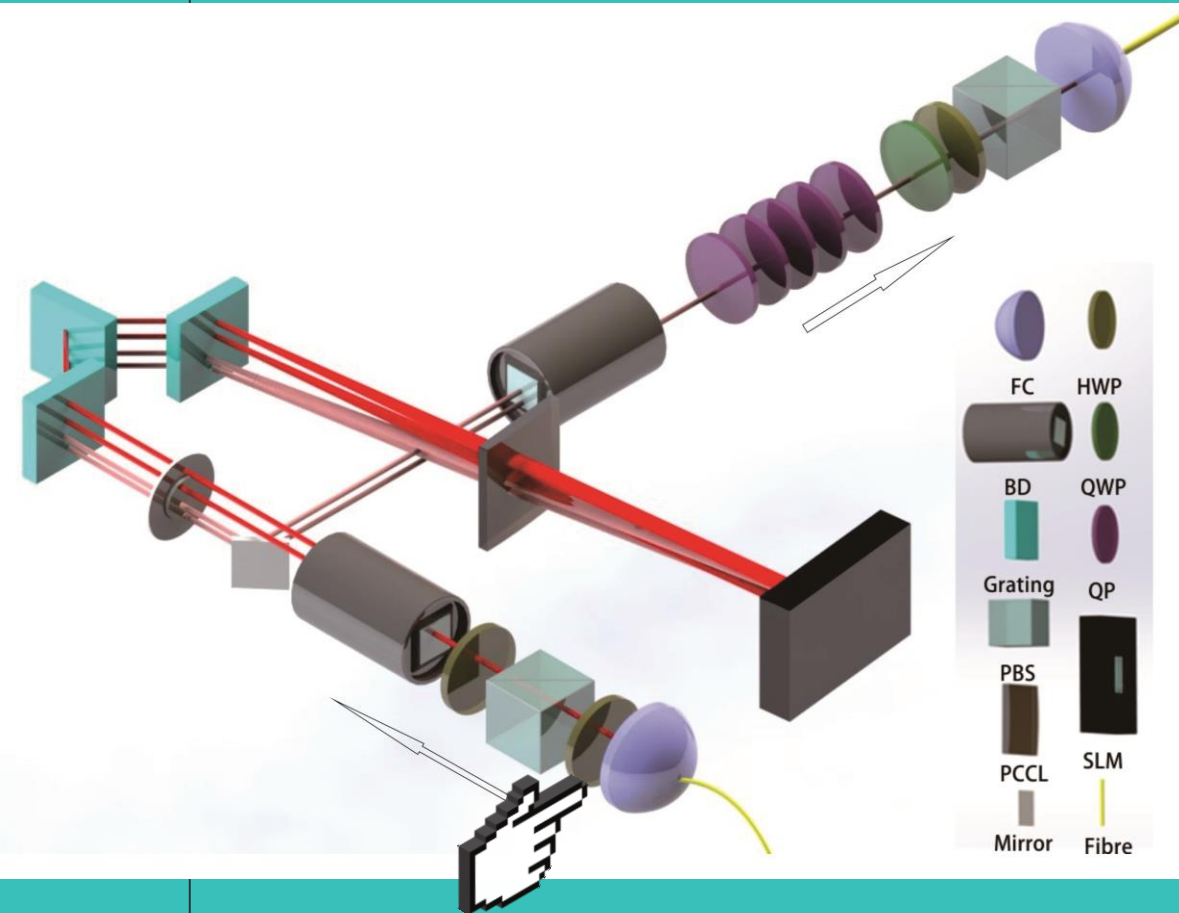
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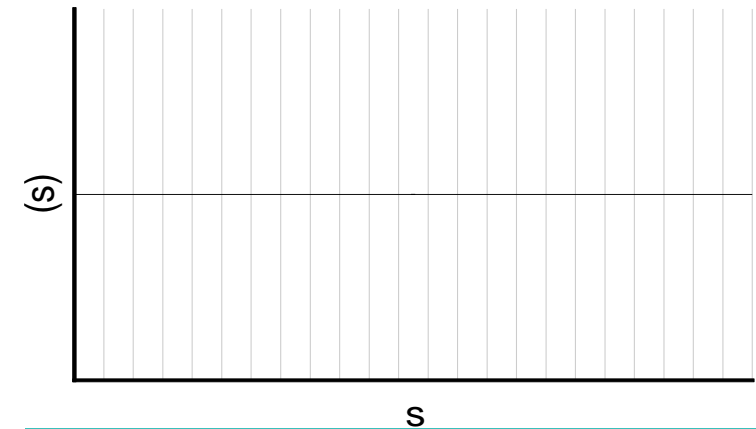
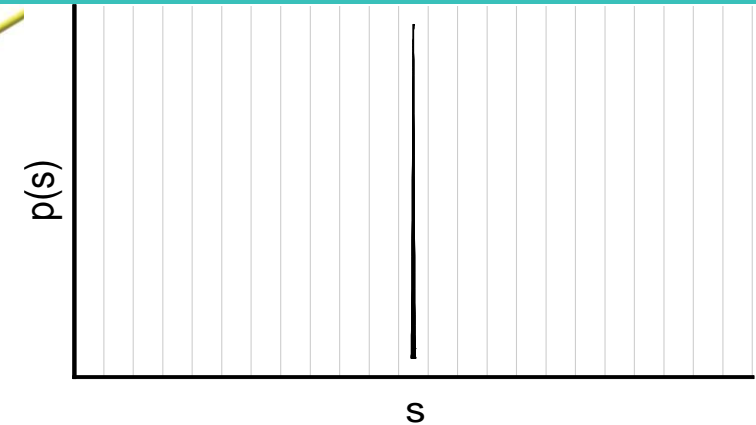
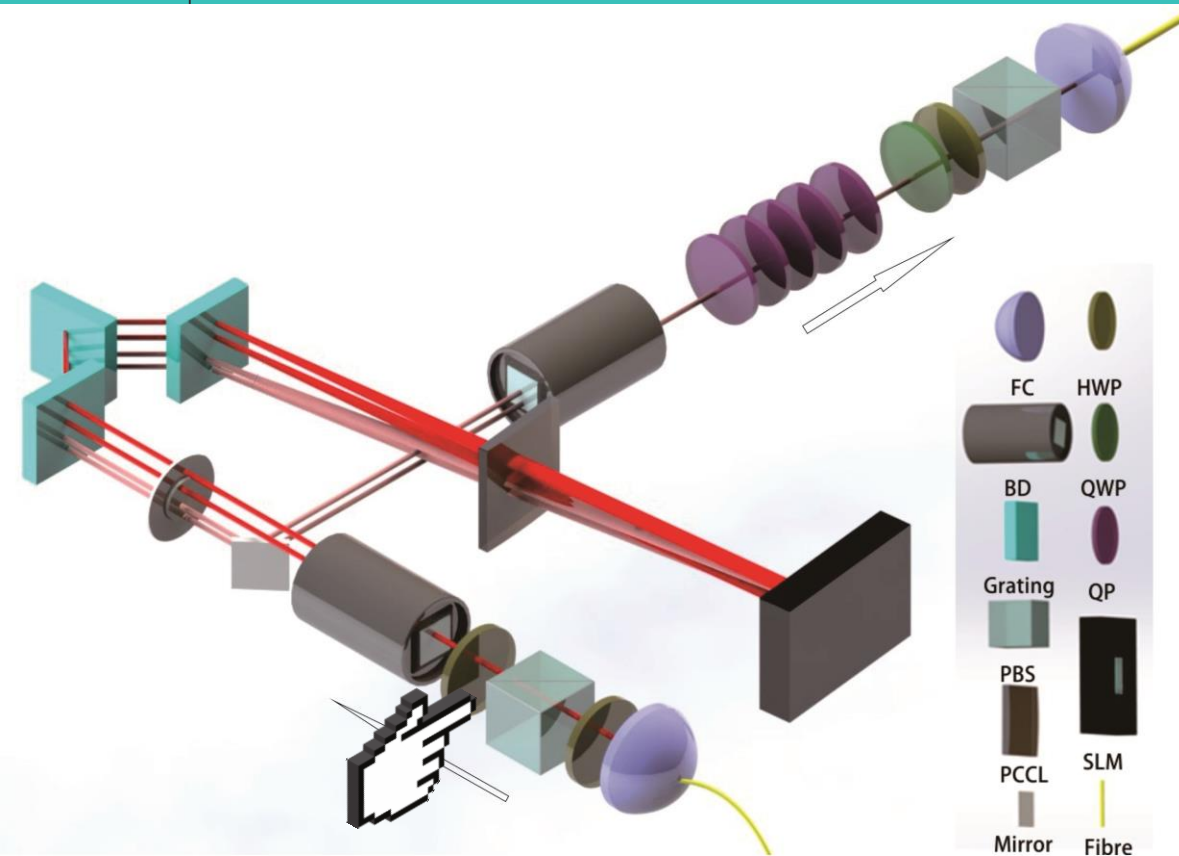
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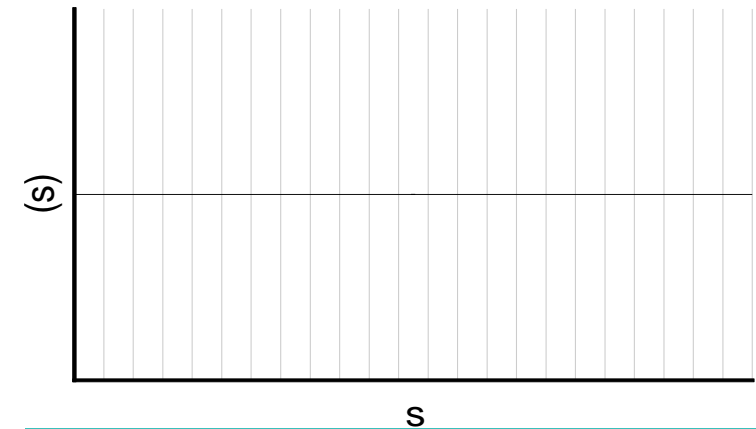
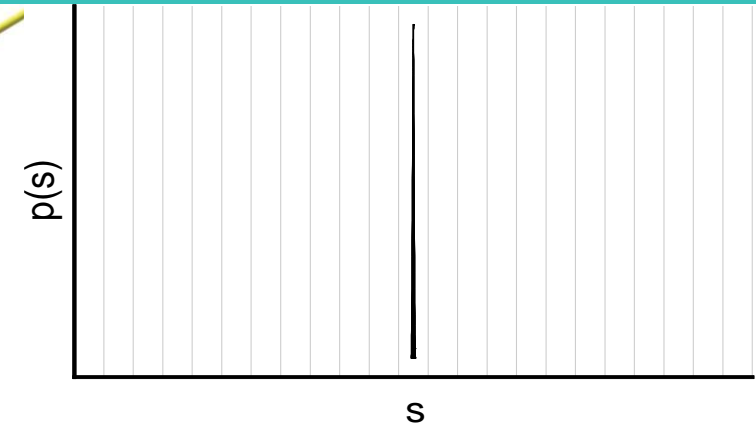
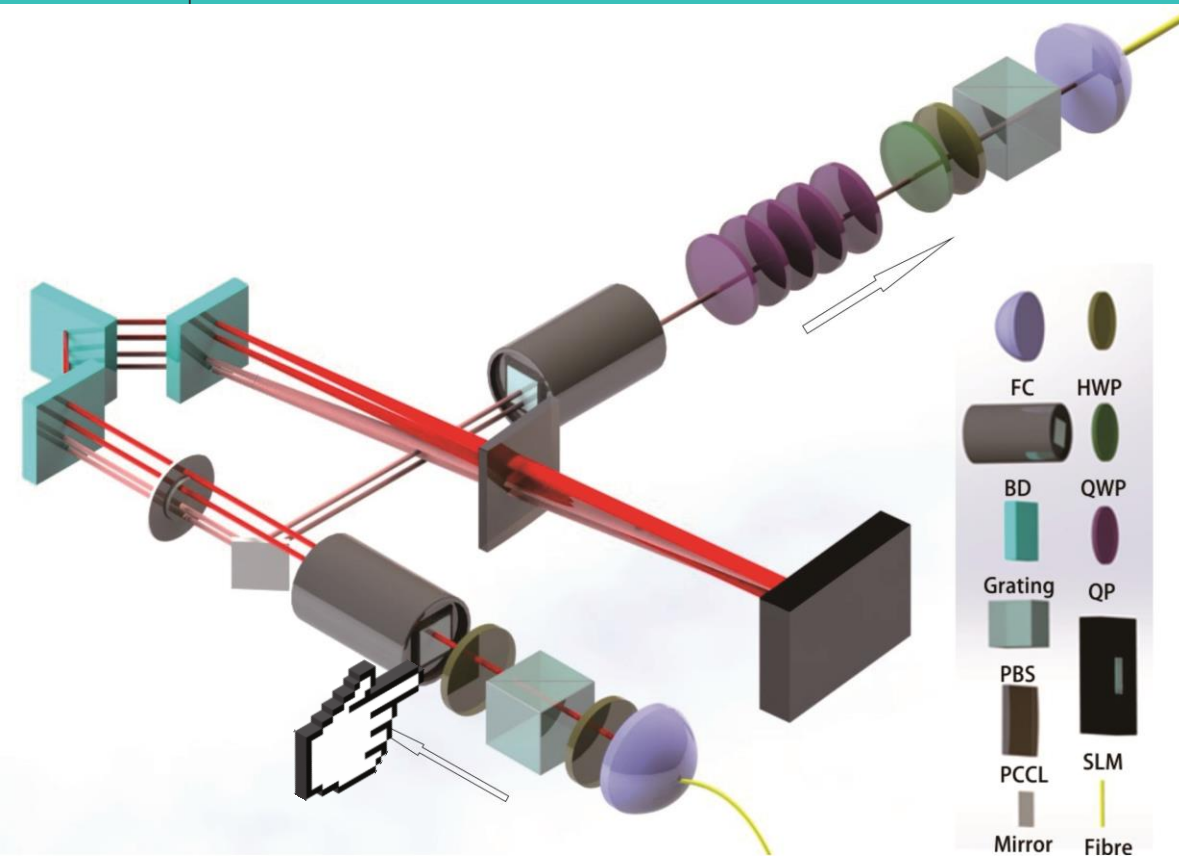
SIMULATOR: EXPERIMENT



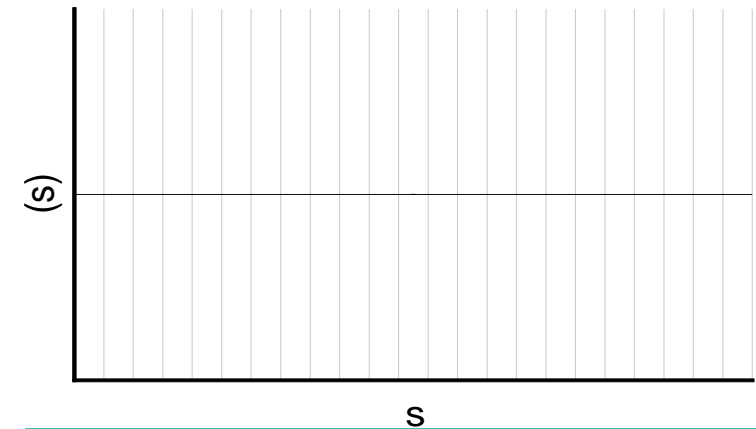
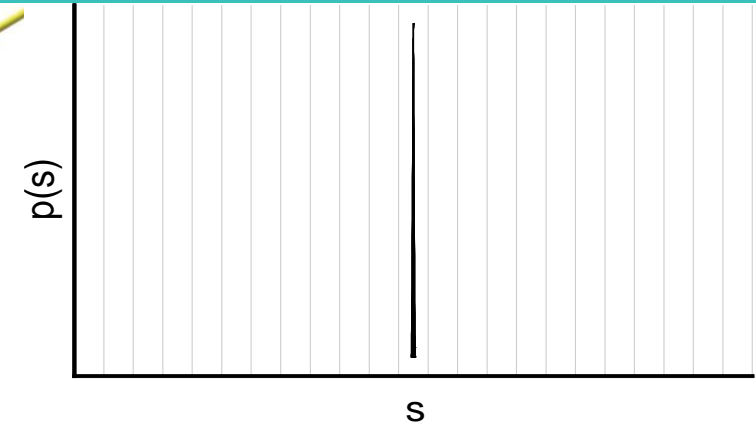
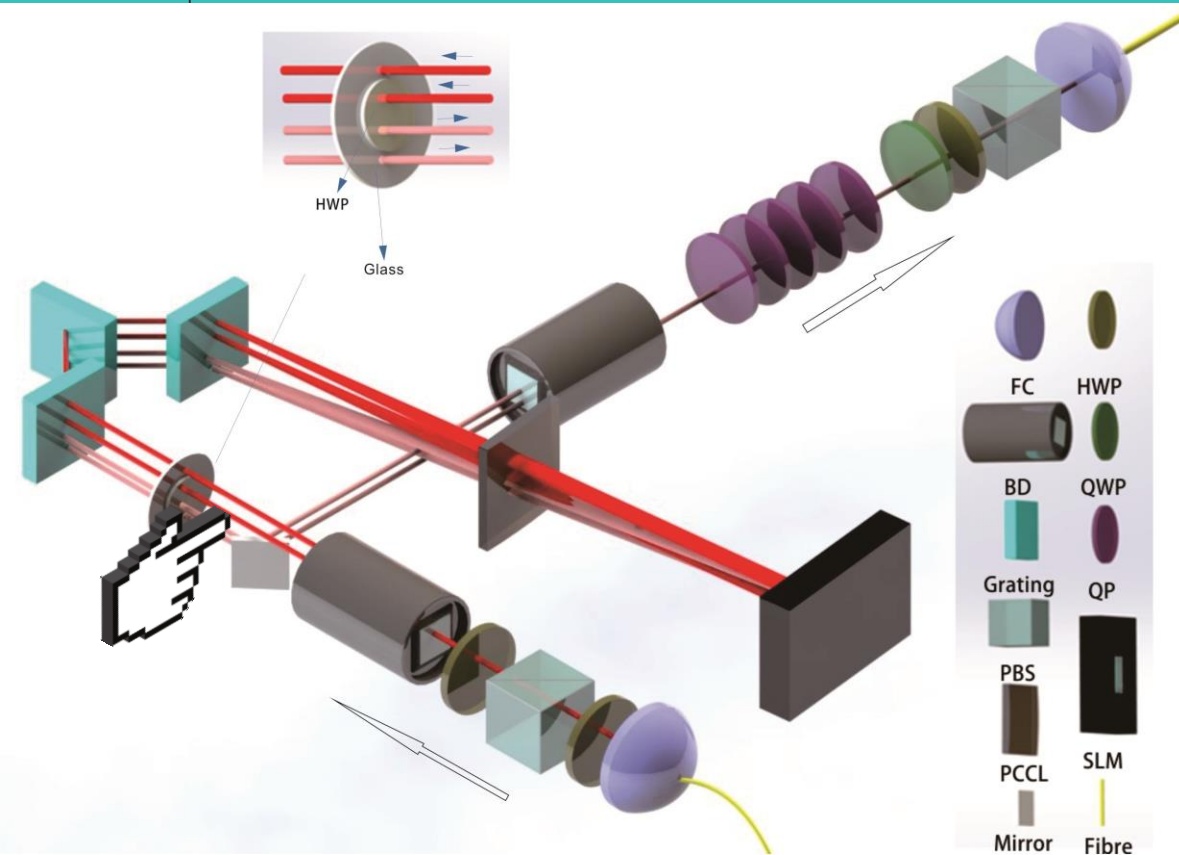
SIMULATOR: EXPERIMENT



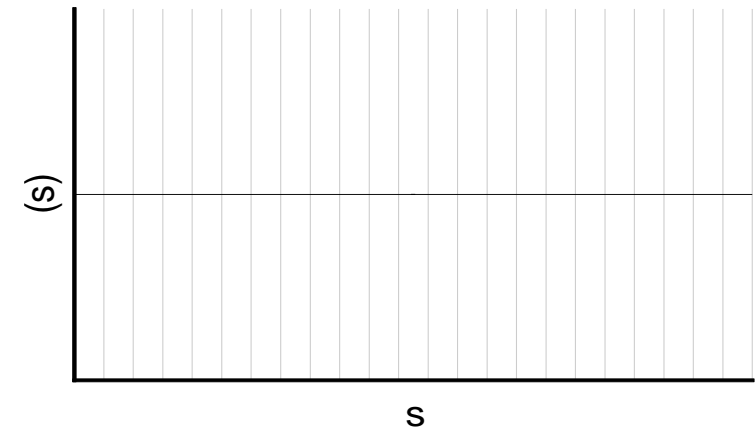
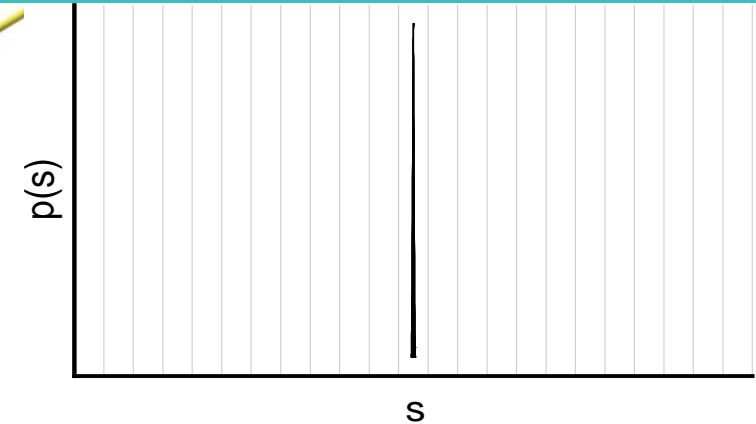
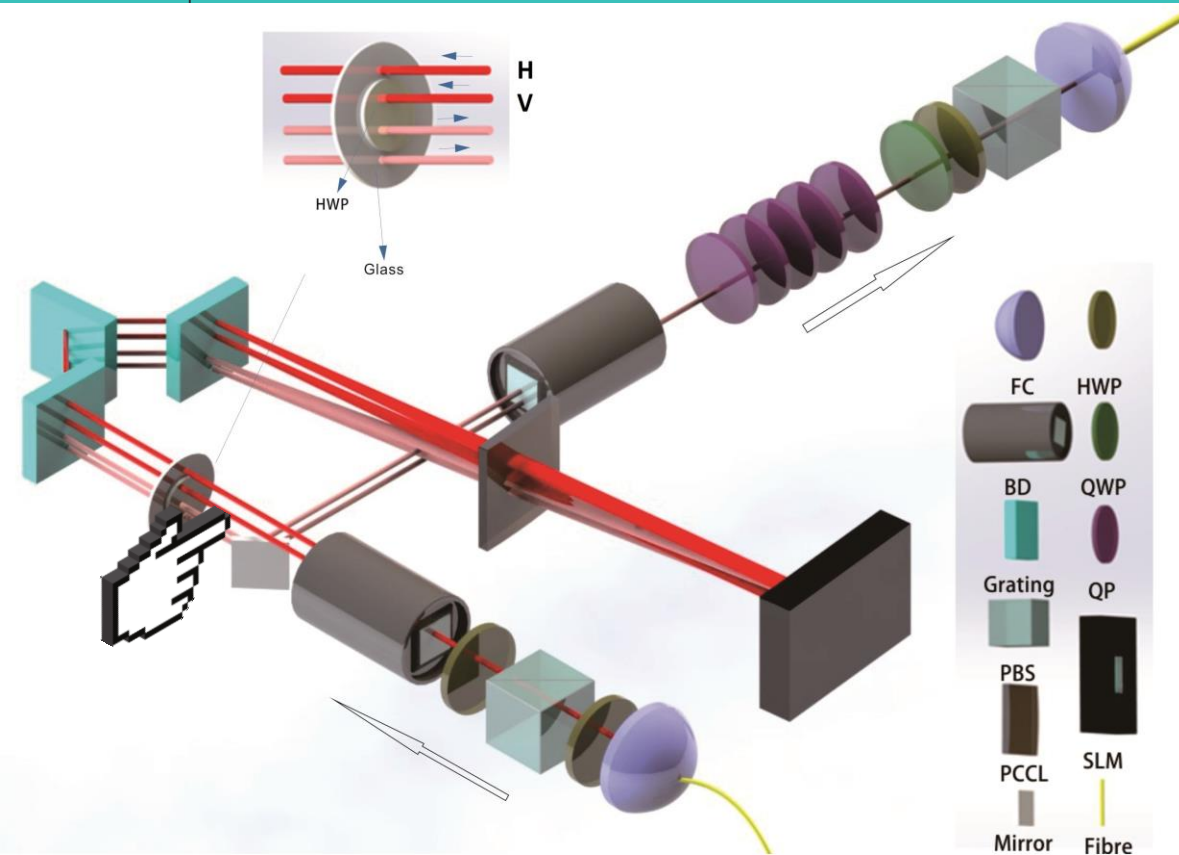
SIMULATOR: EXPERIMENT



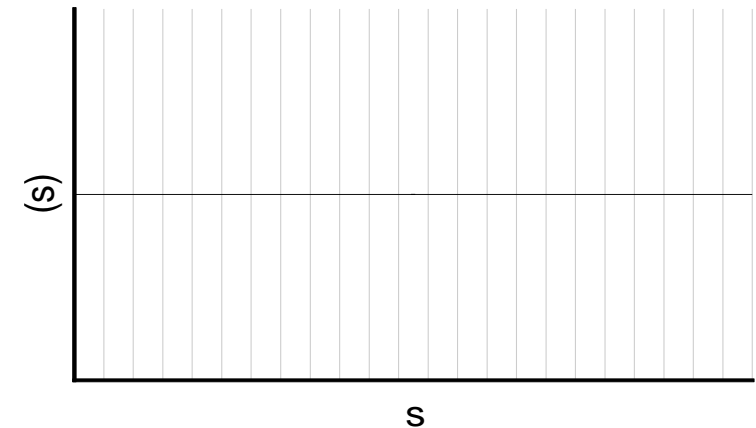
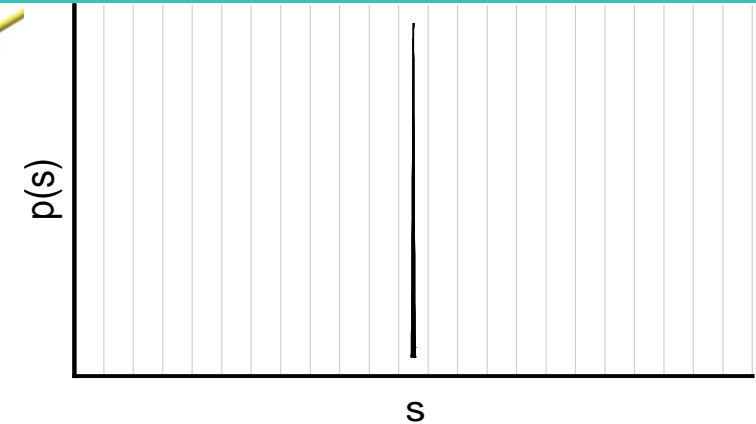
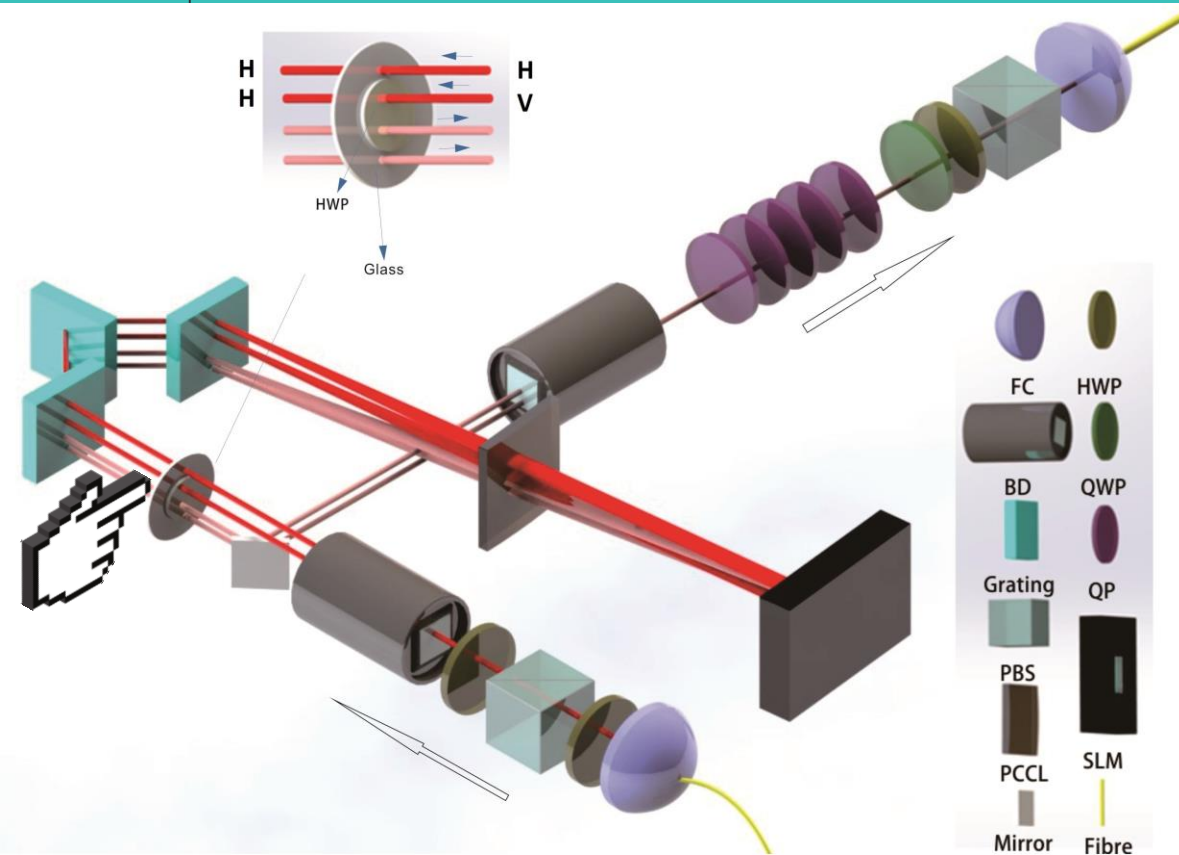
SIMULATOR: EXPERIMENT



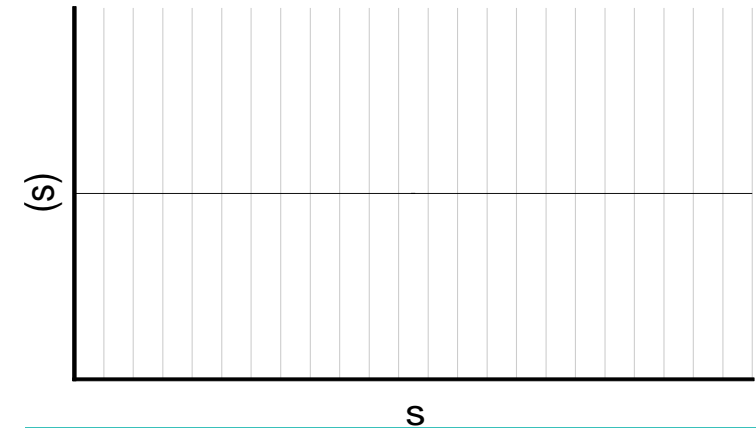
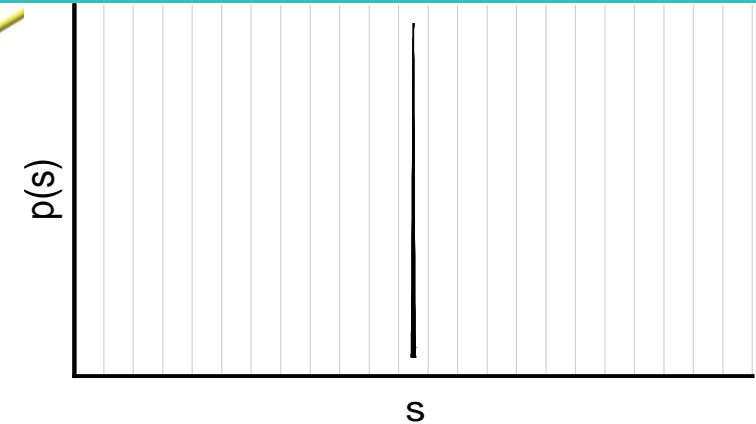
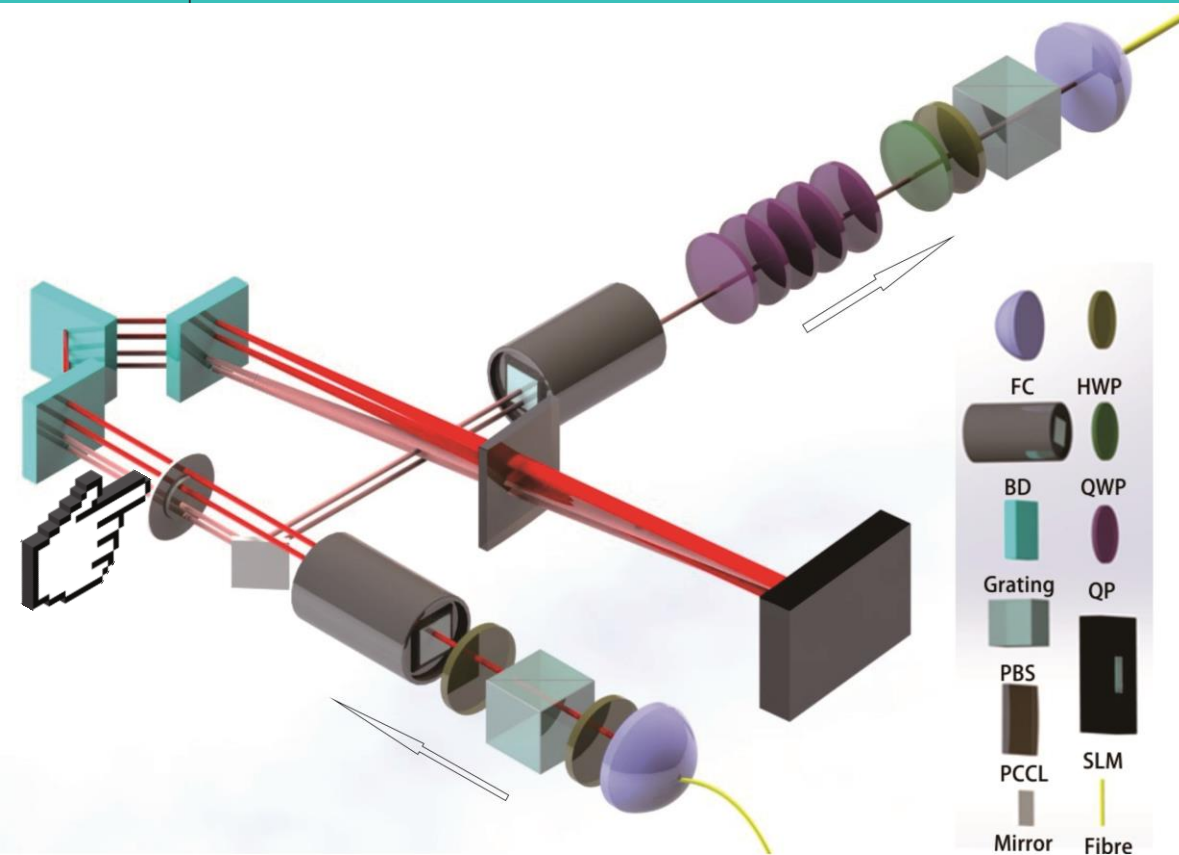
SIMULATOR: EXPERIMENT



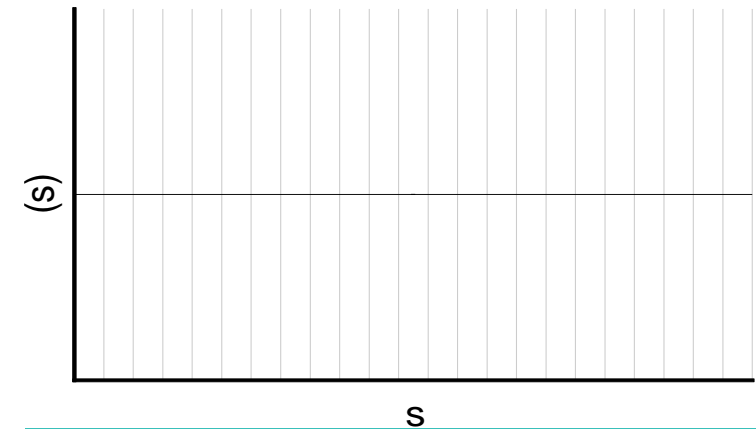
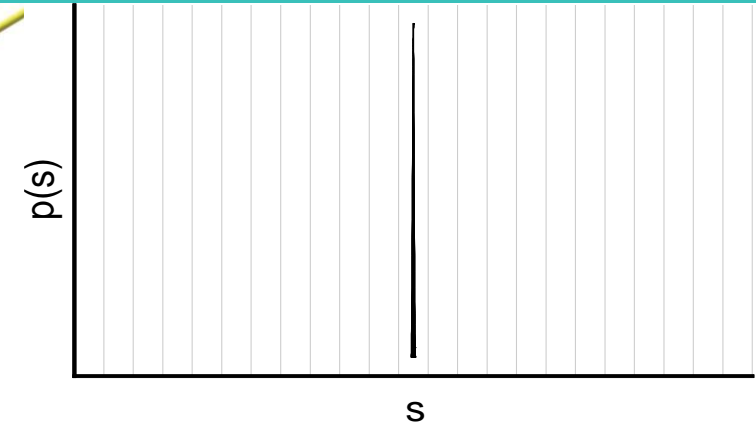
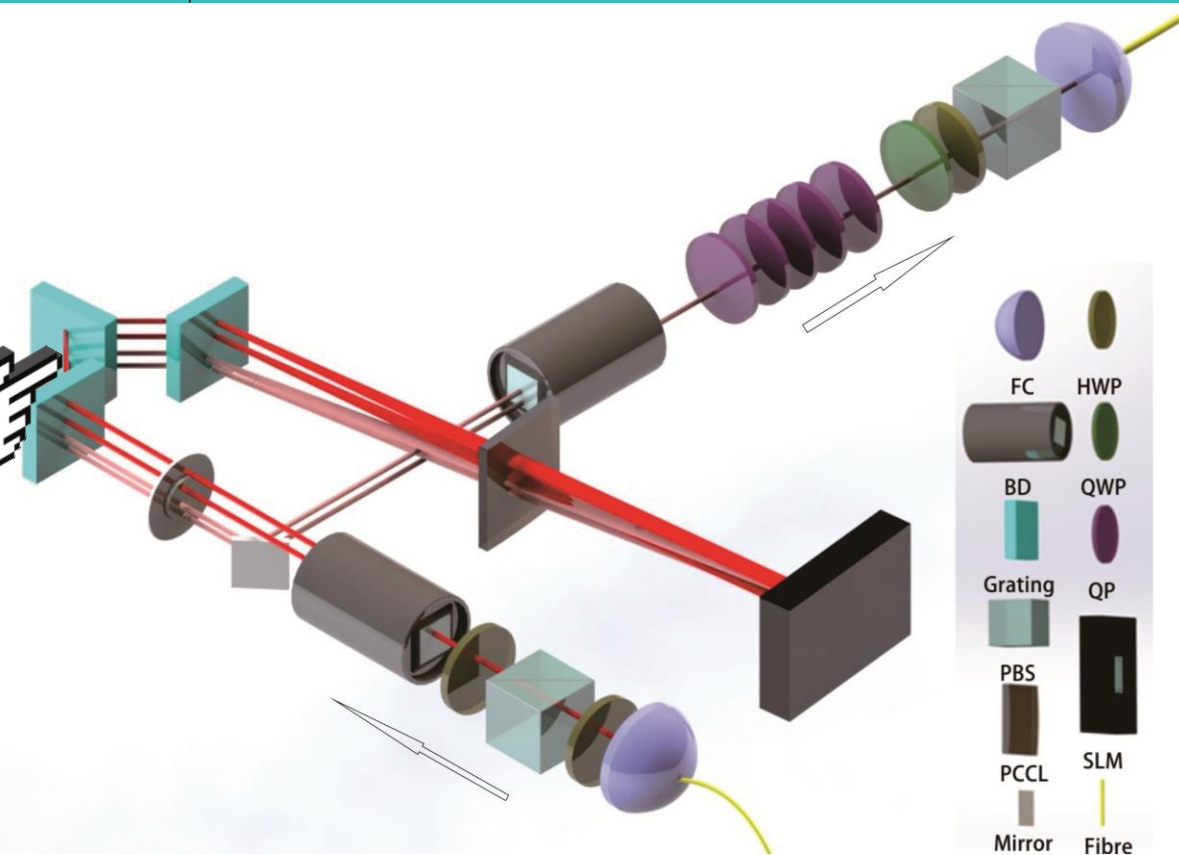
SIMULATOR: EXPERIMENT



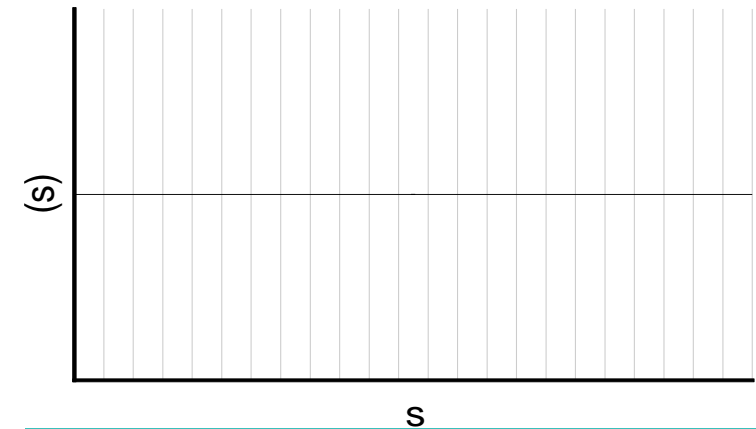
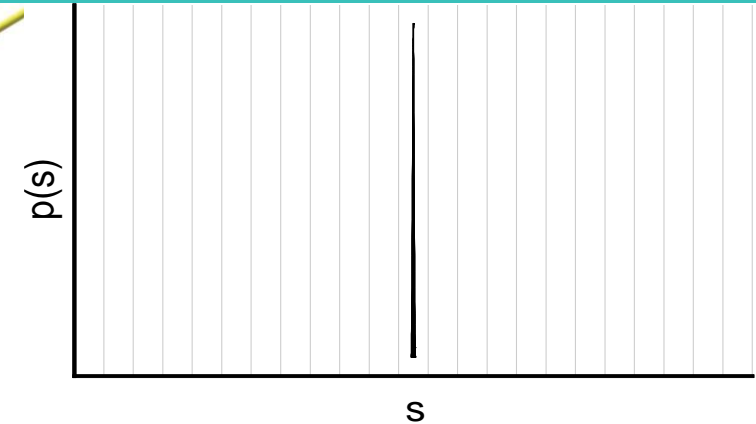
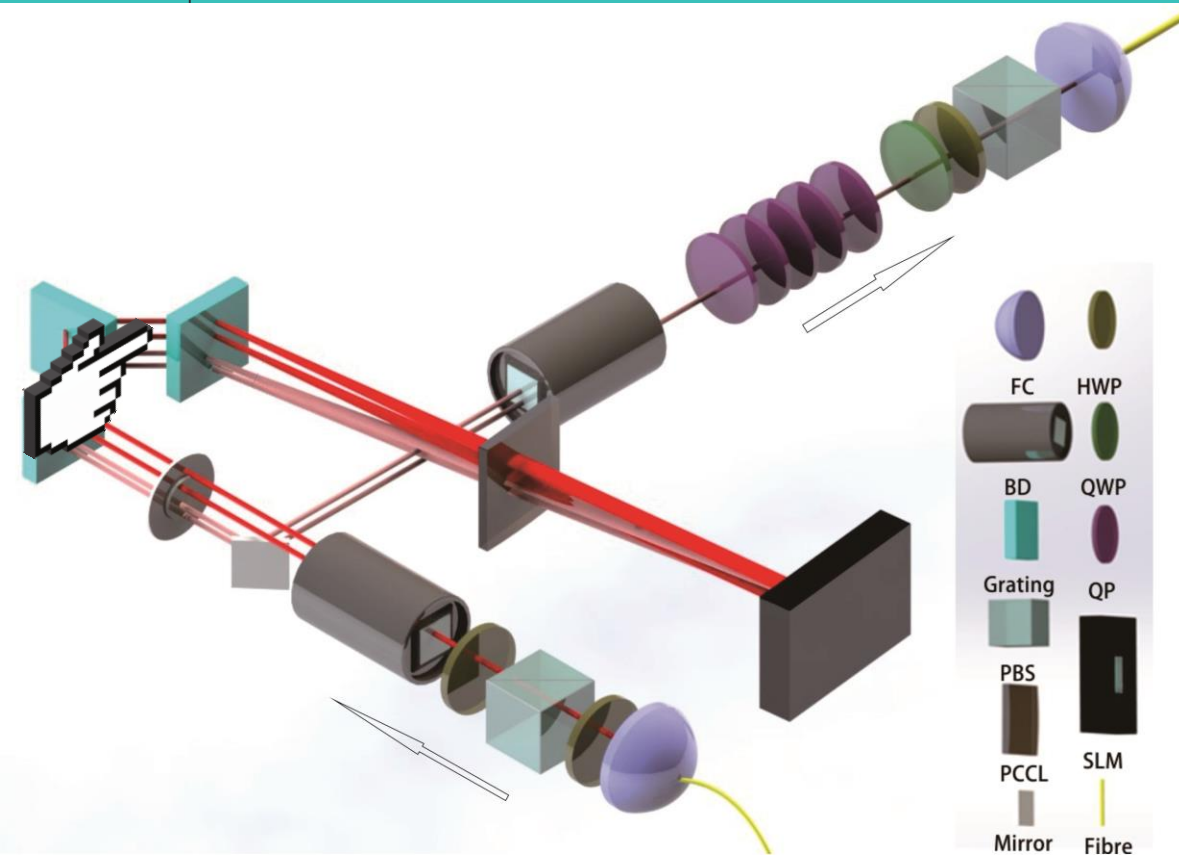
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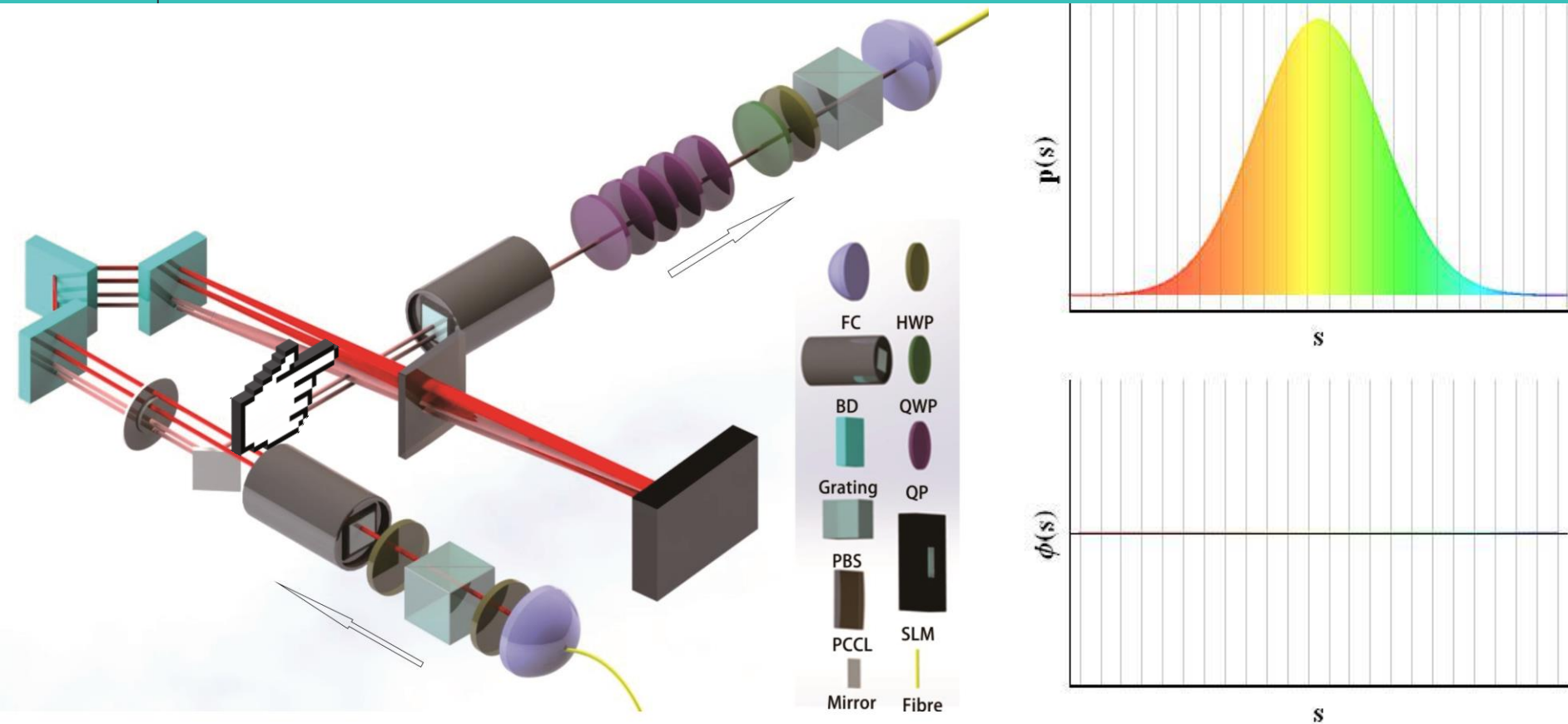
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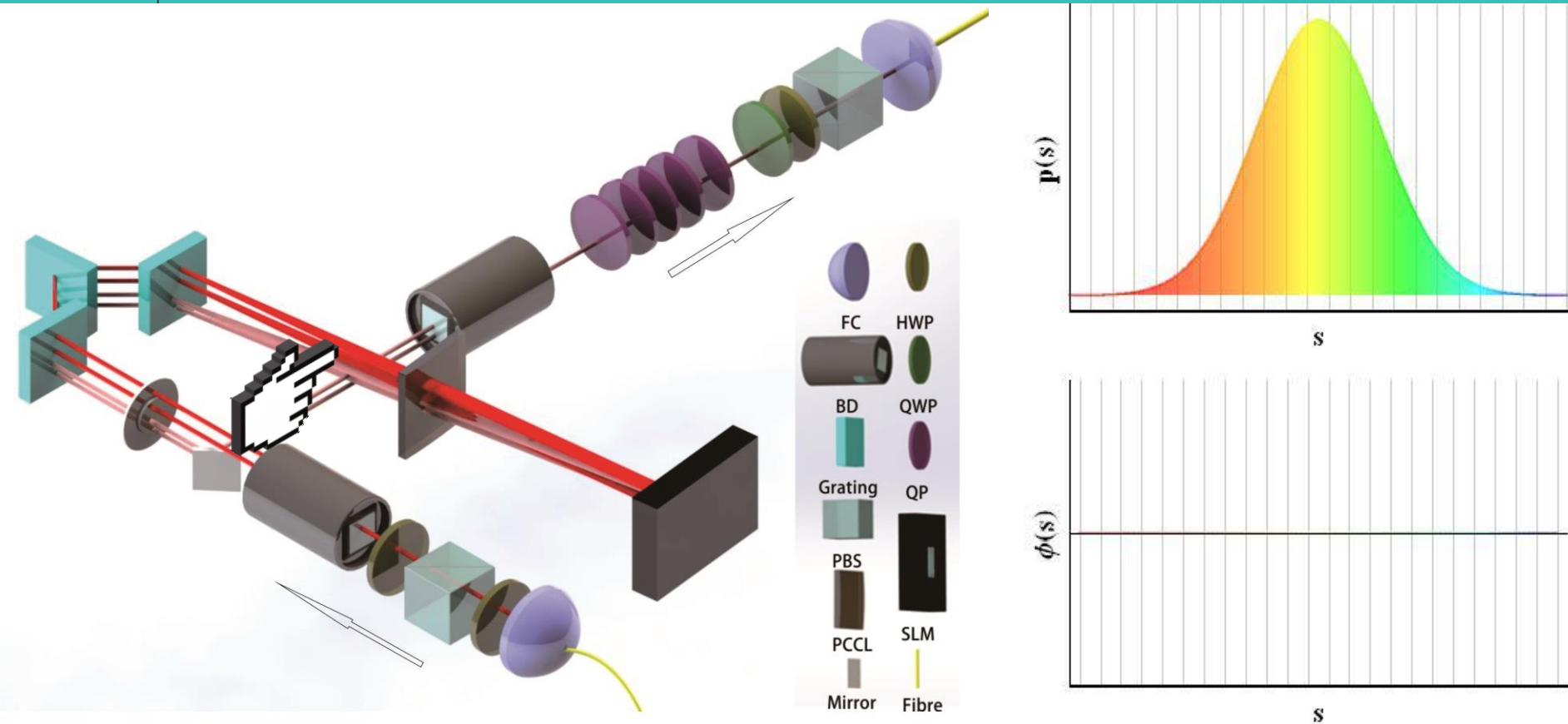
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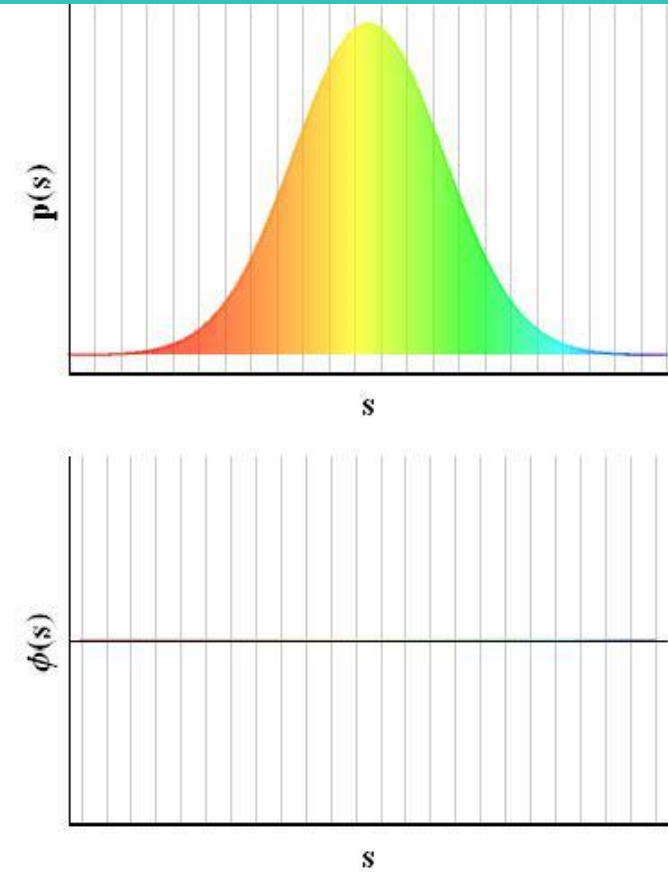
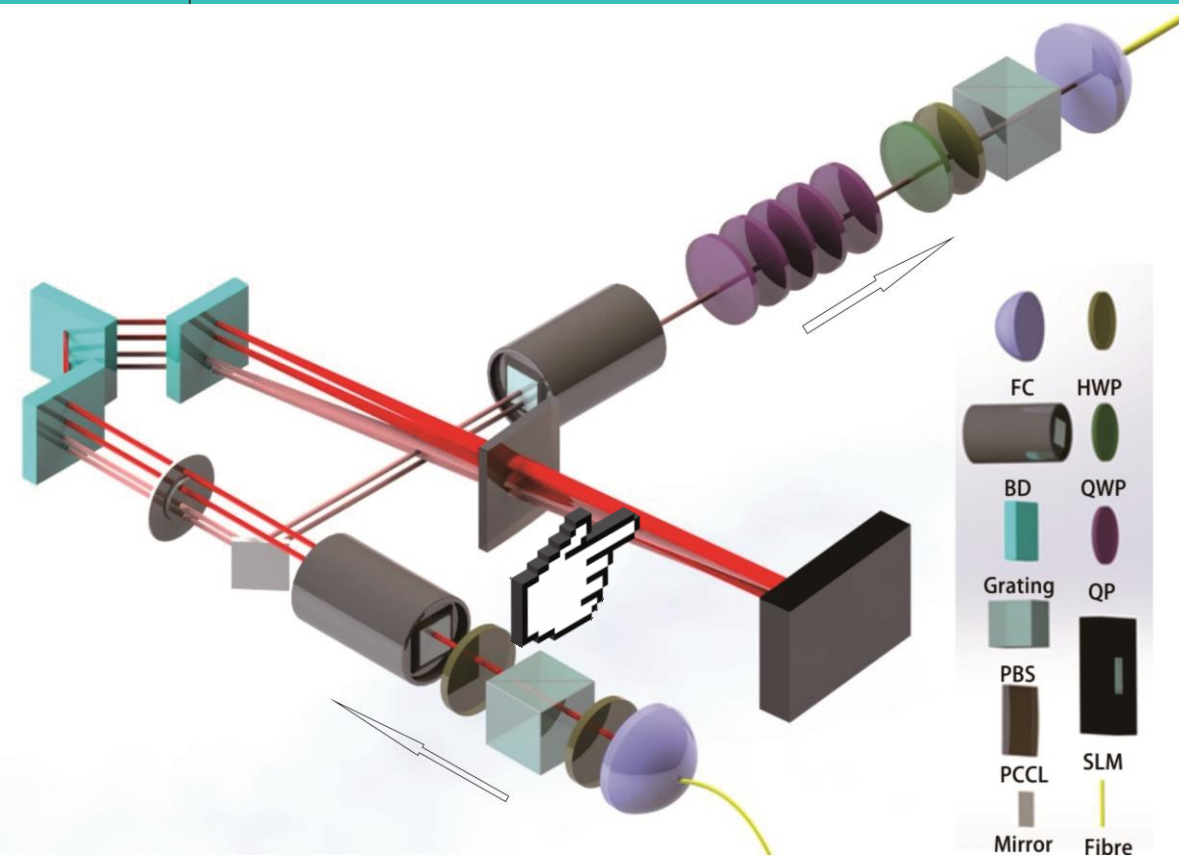
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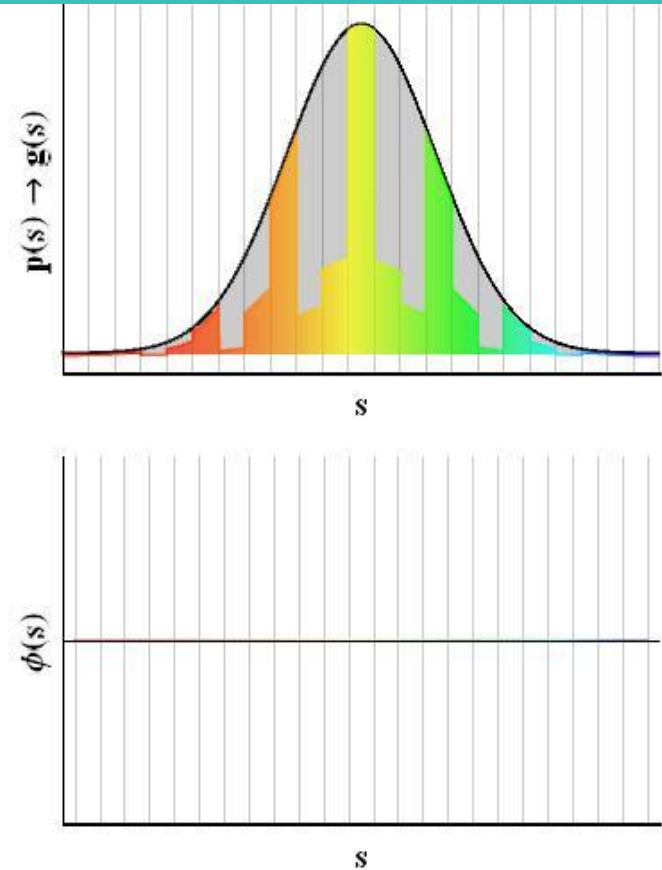
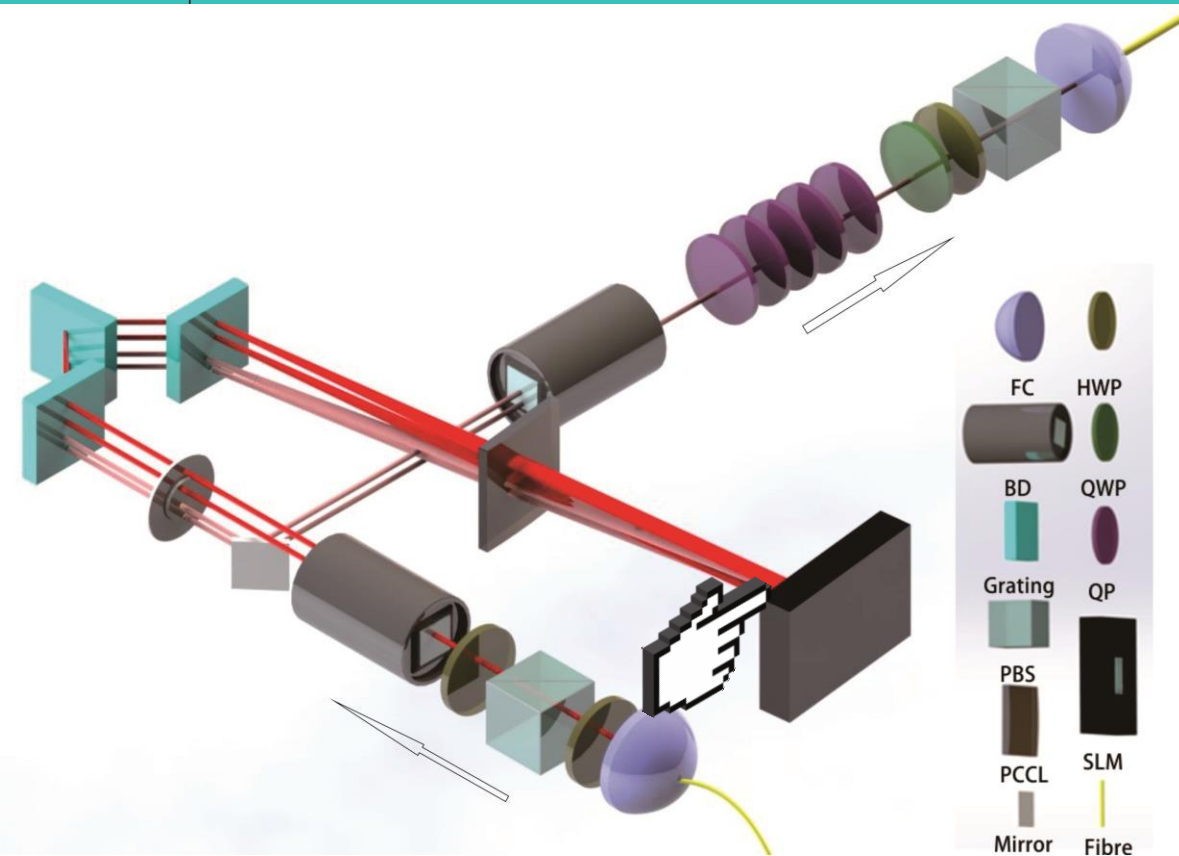
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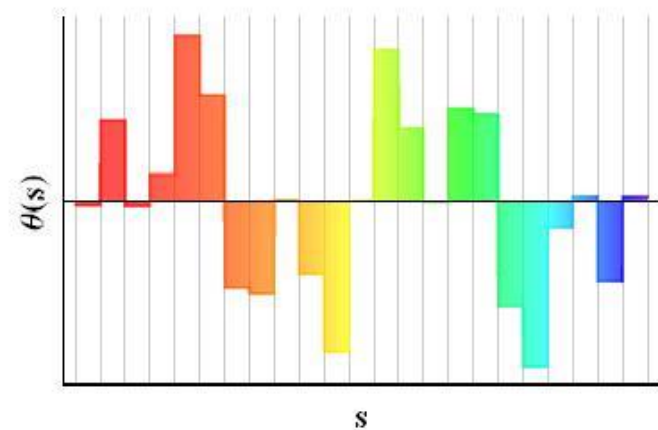
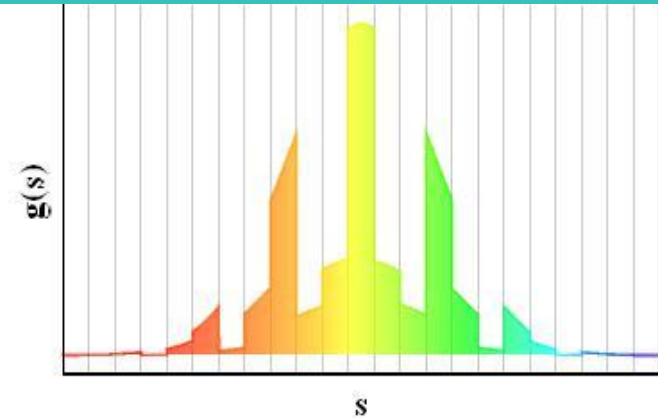
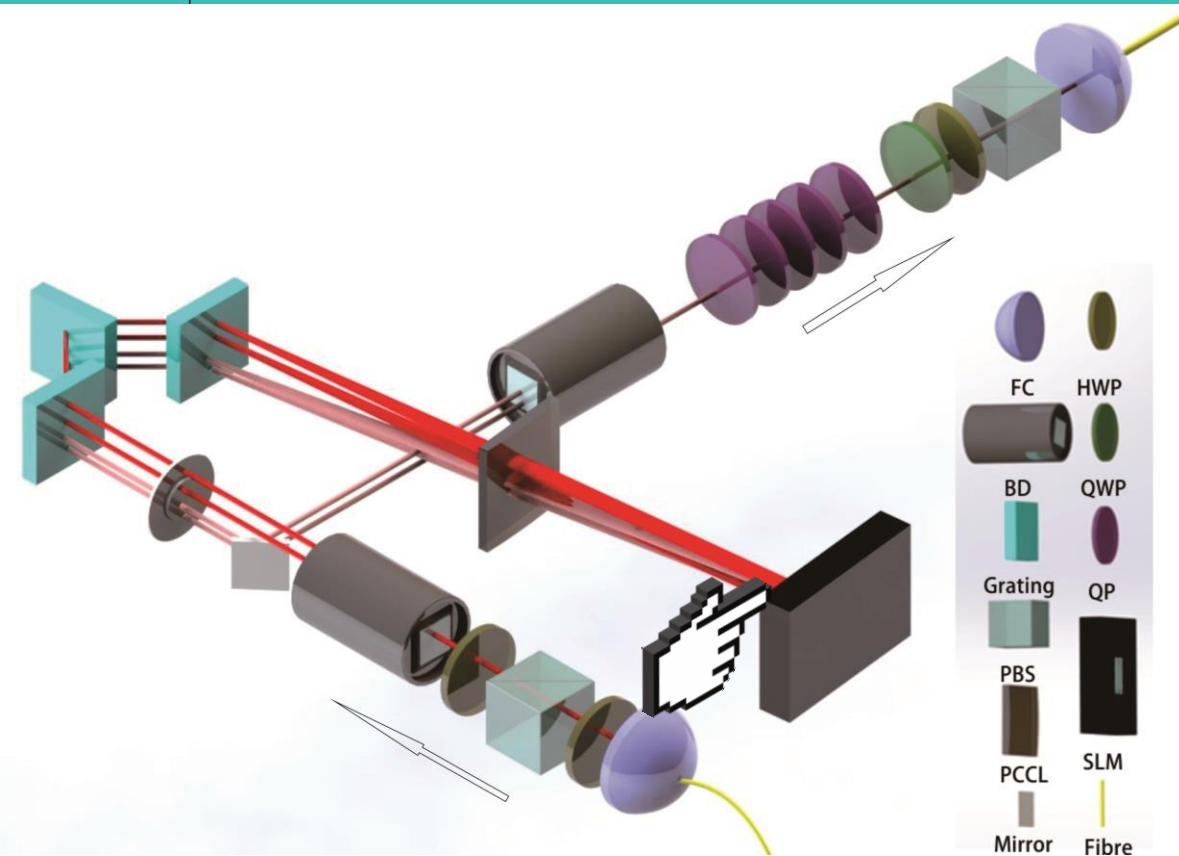
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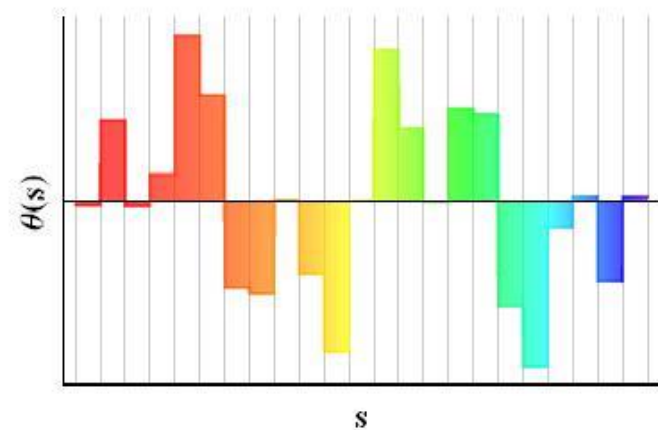
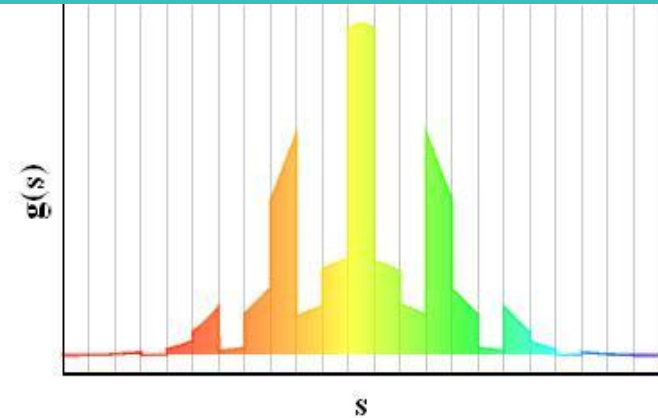
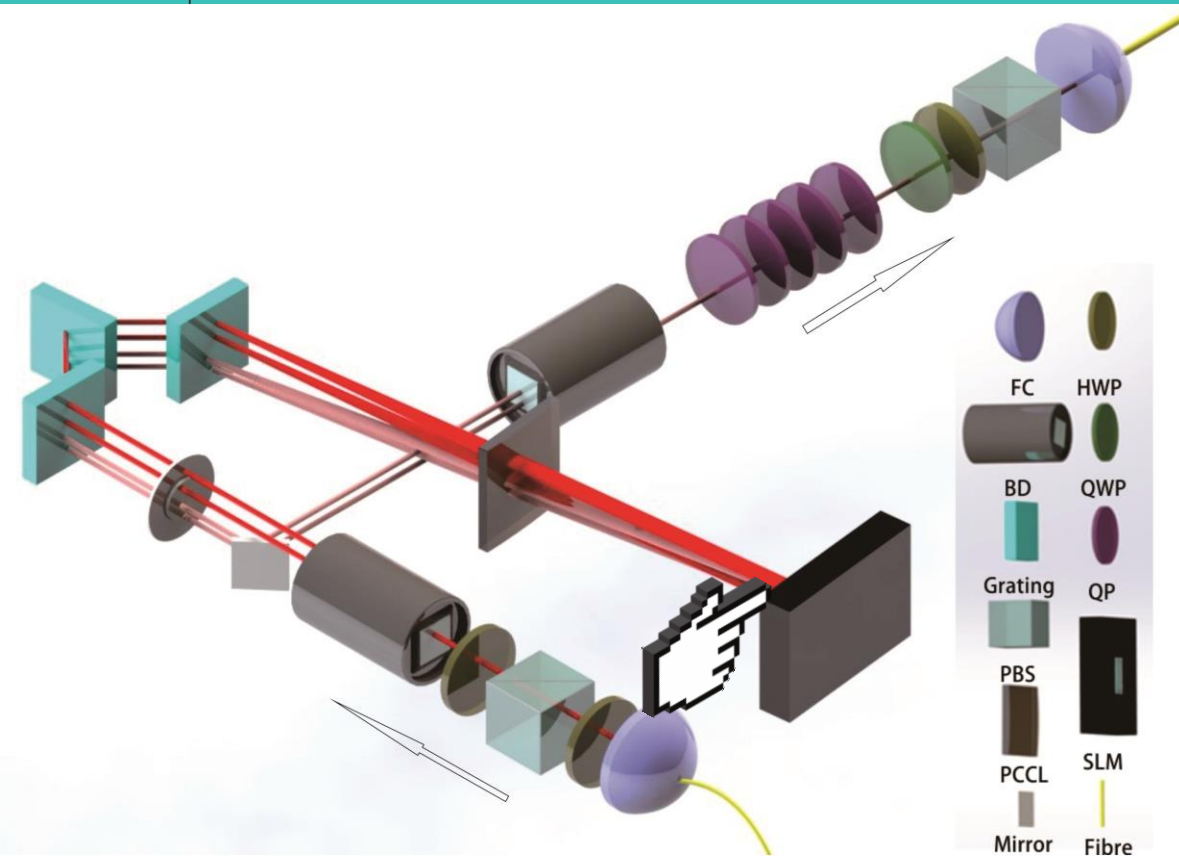
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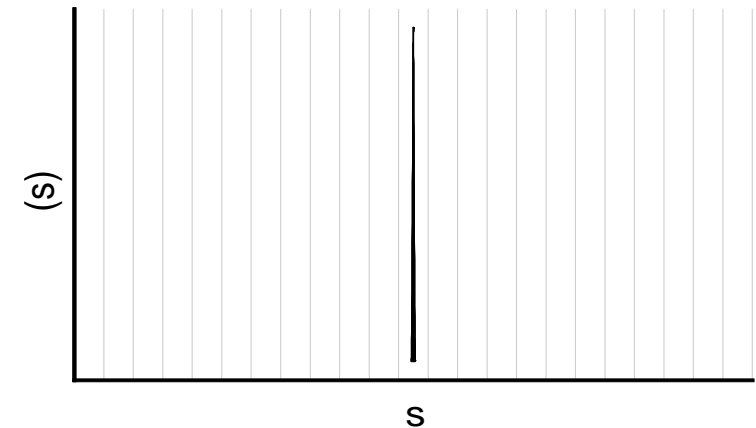
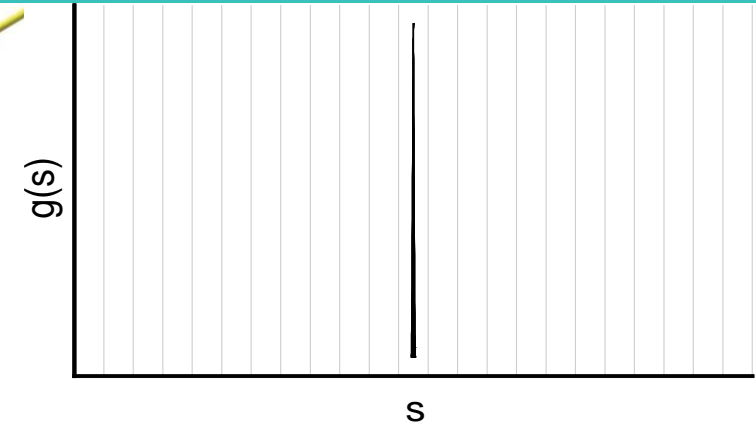
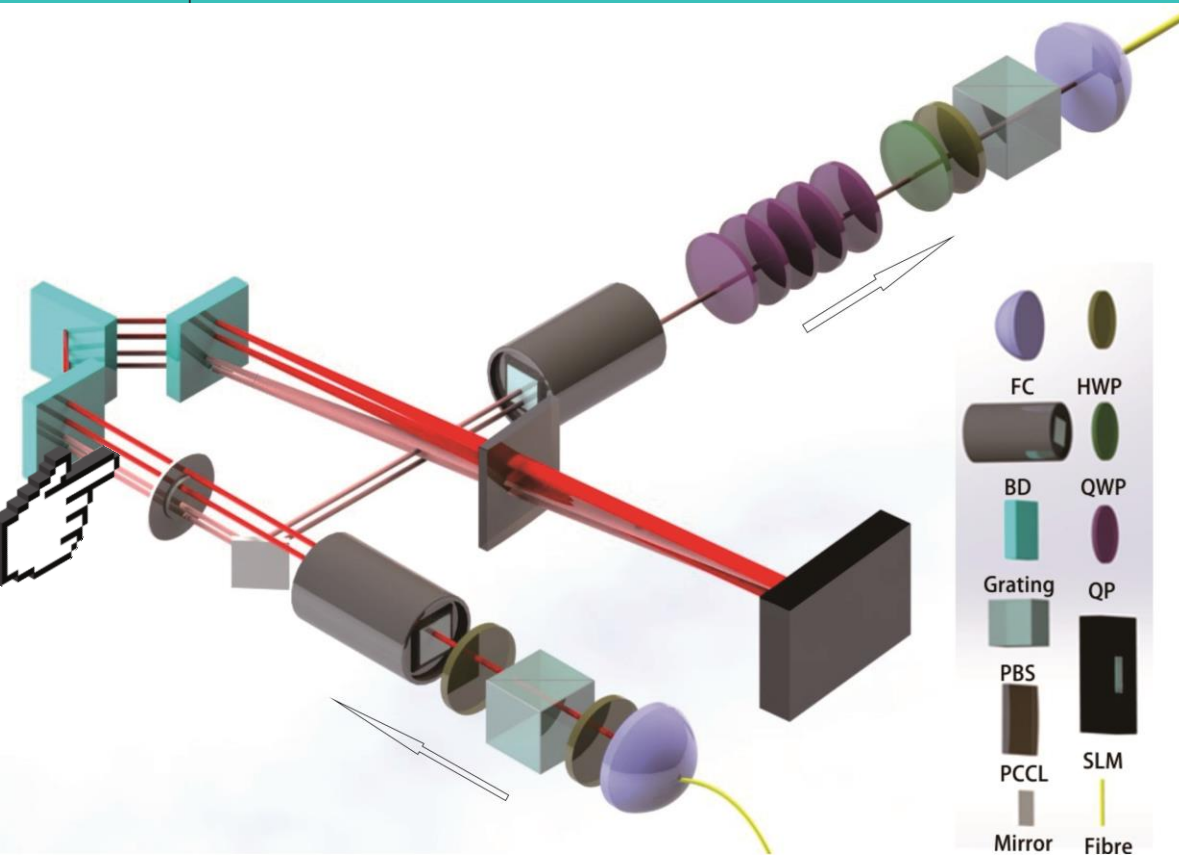
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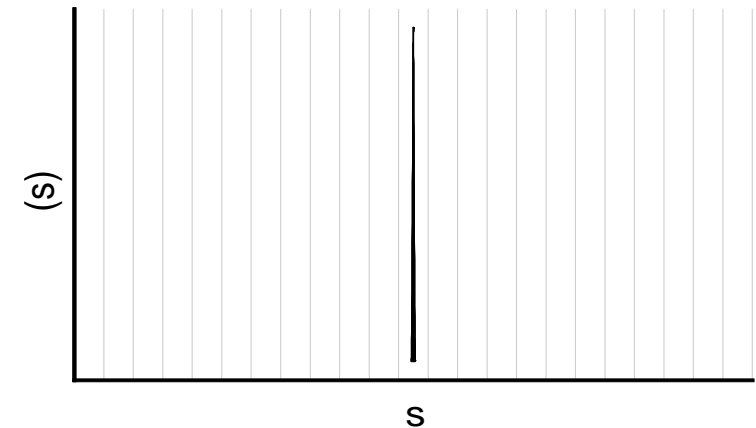
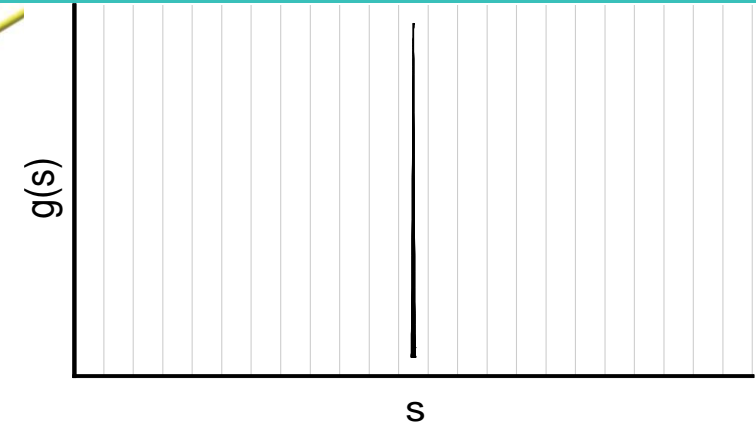
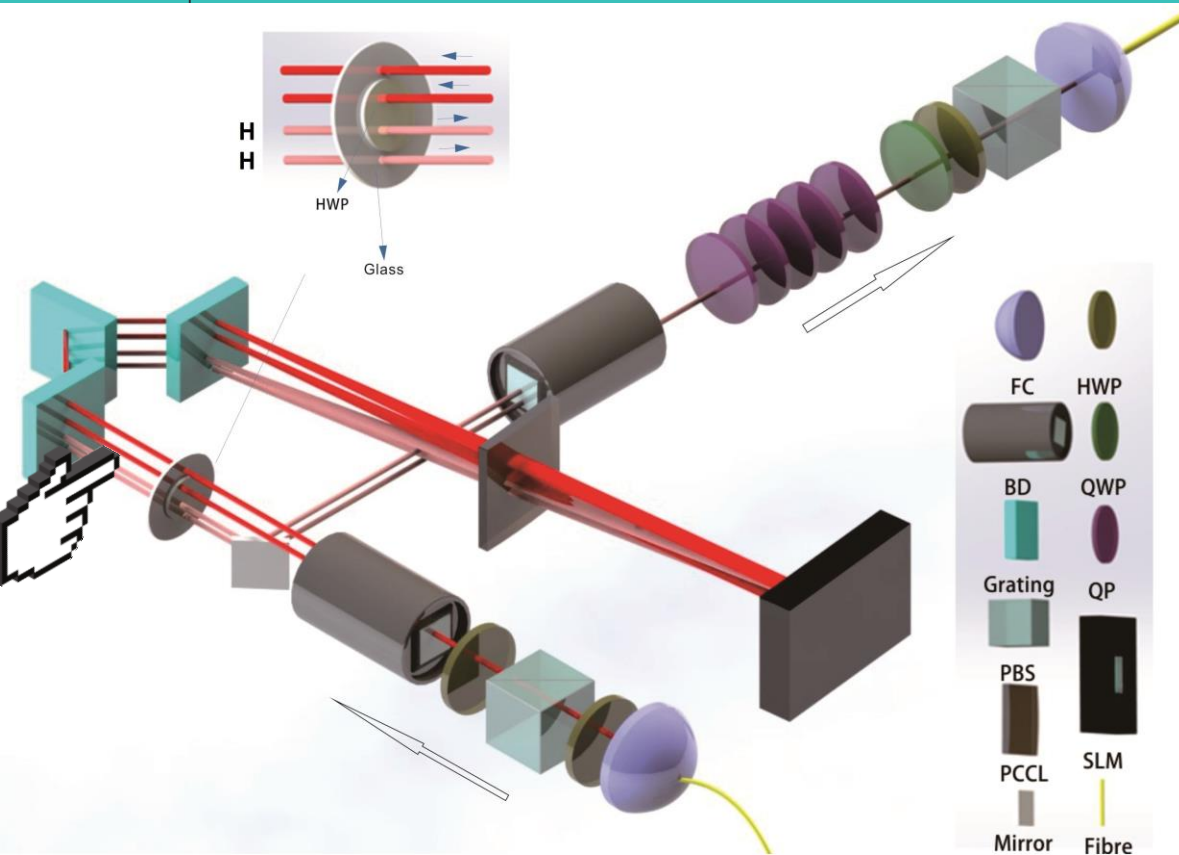
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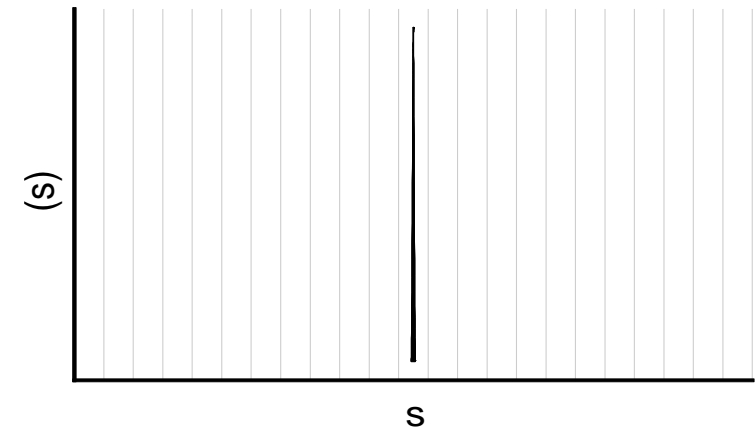
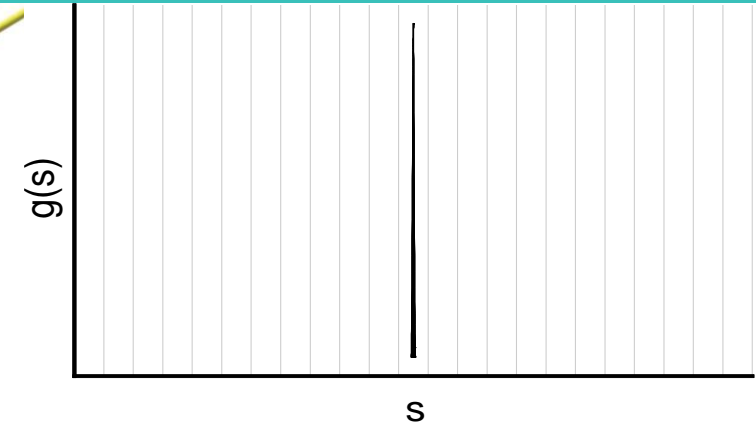
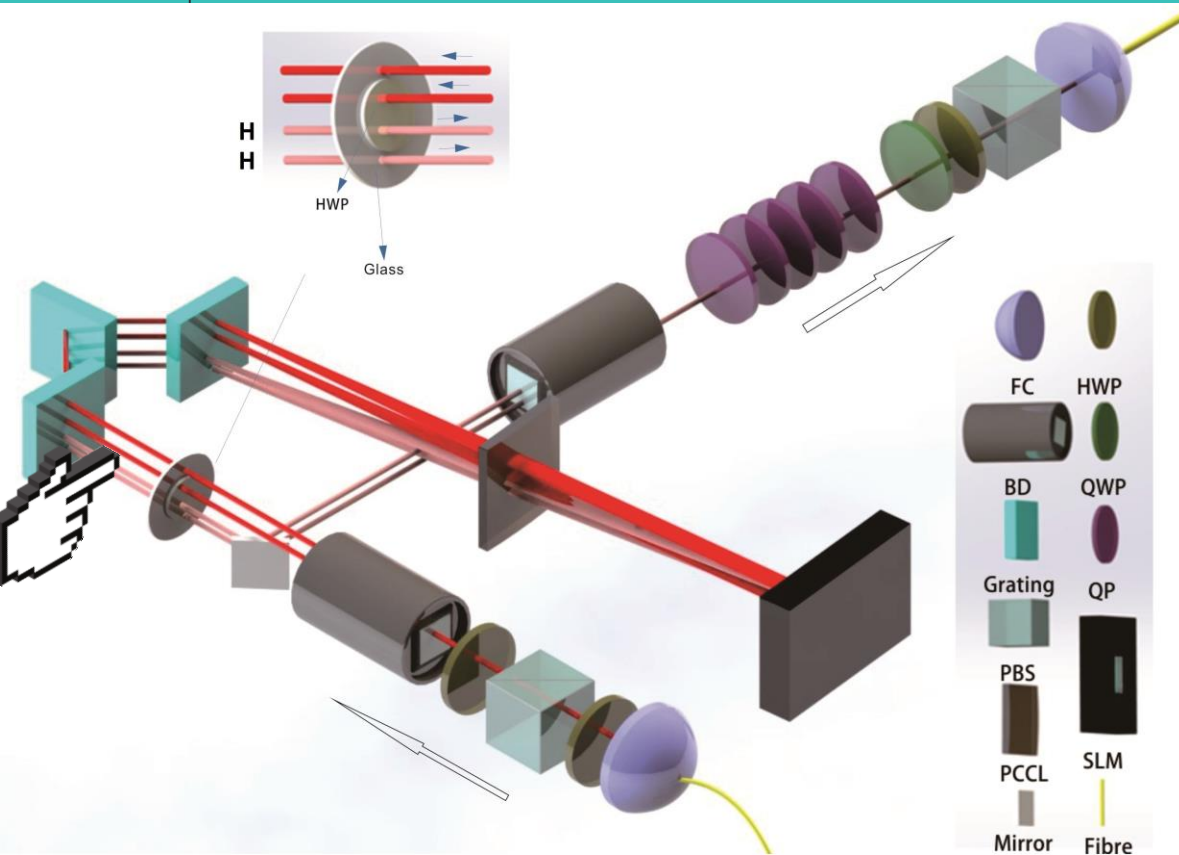
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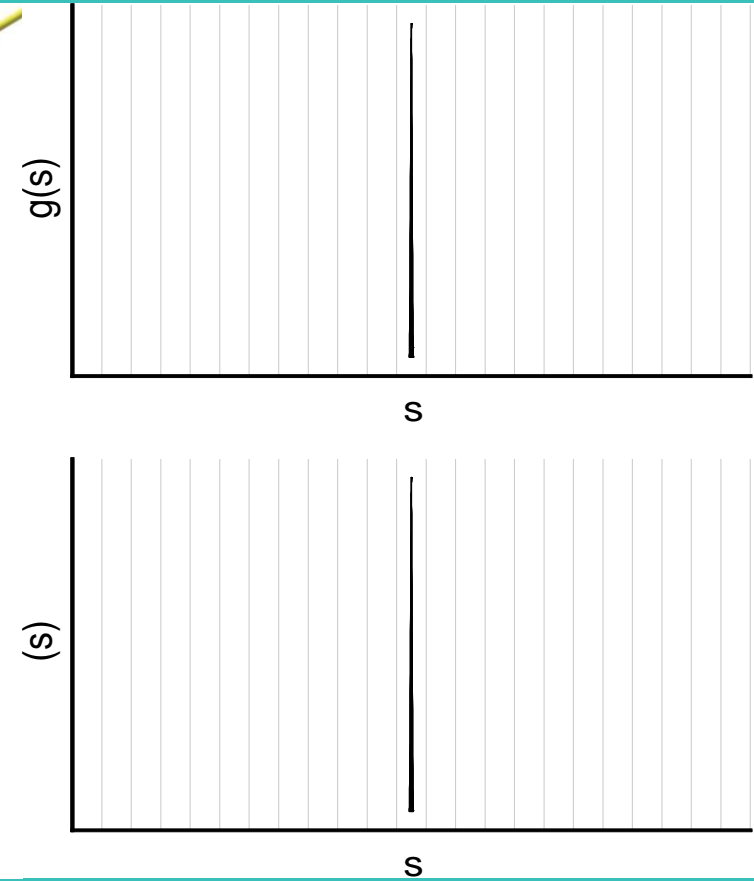
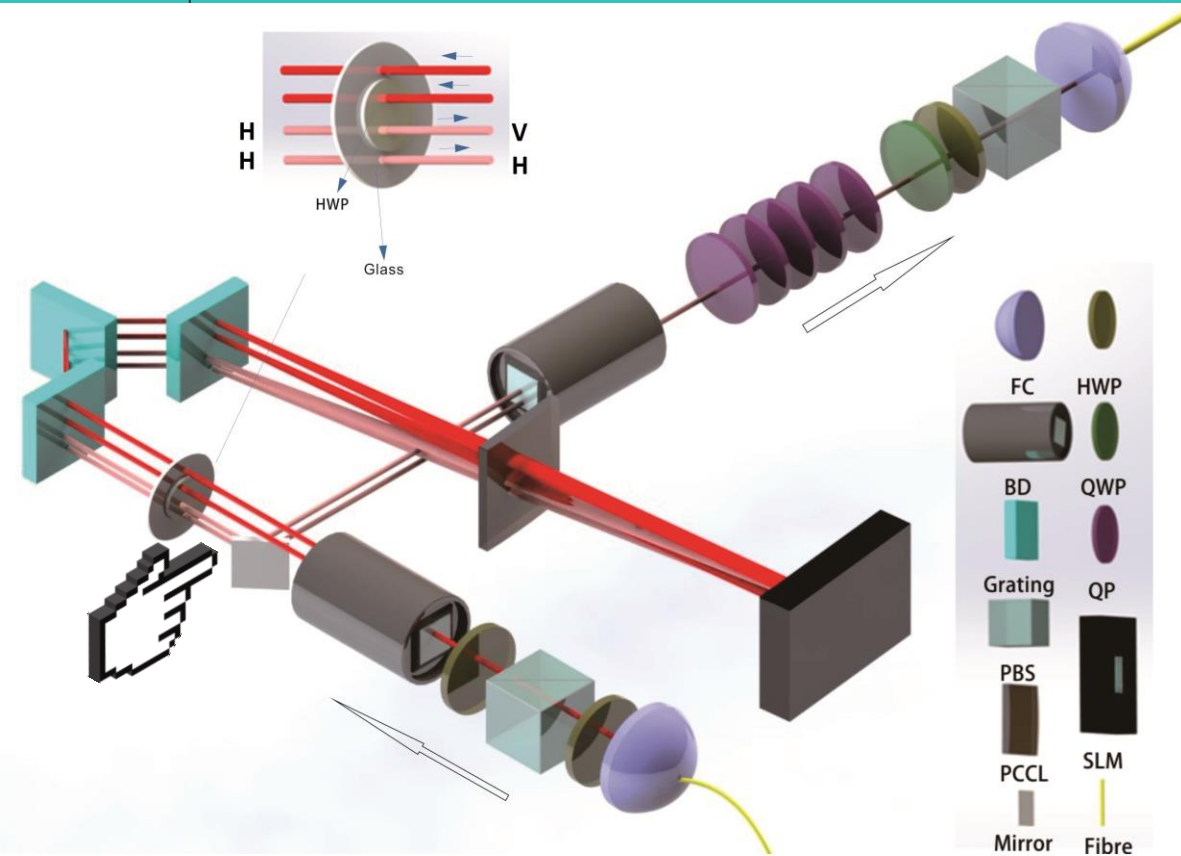
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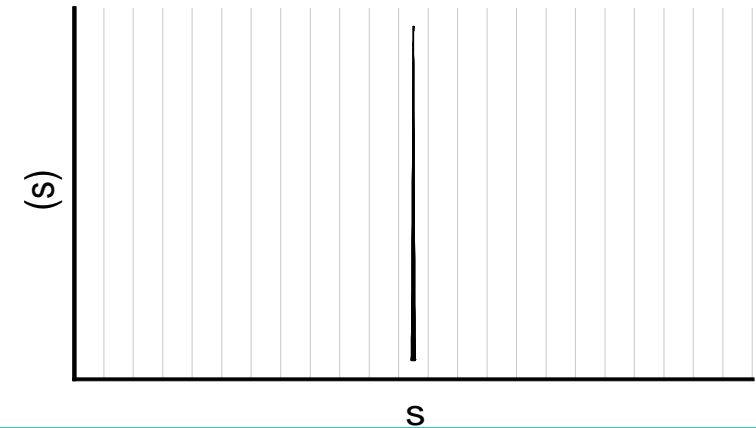
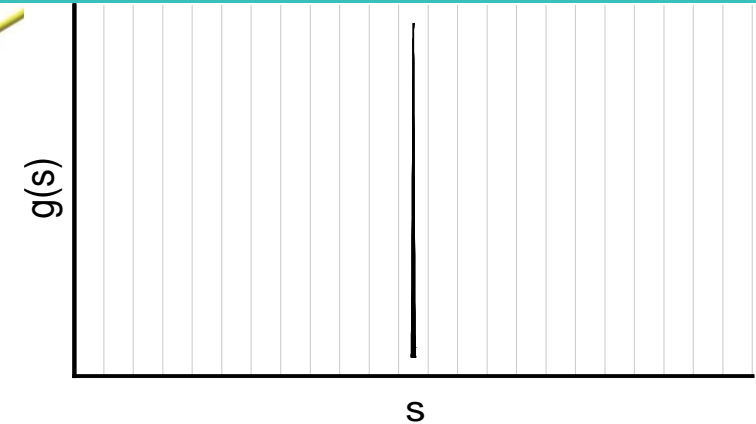
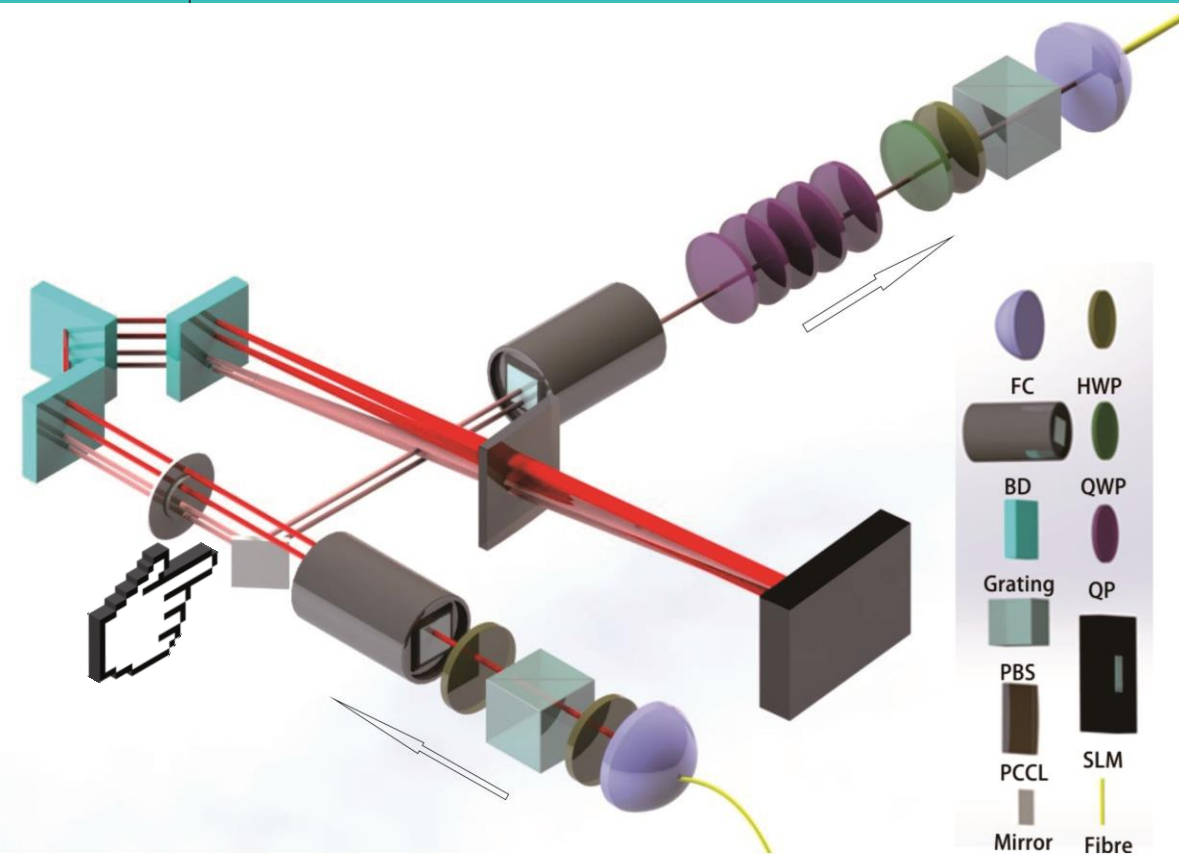
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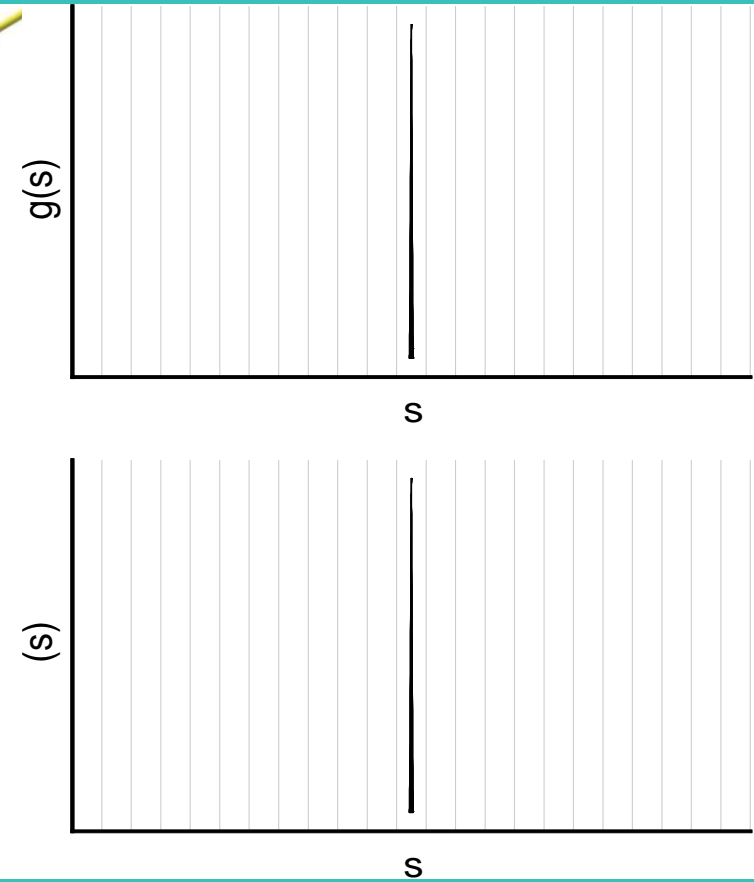
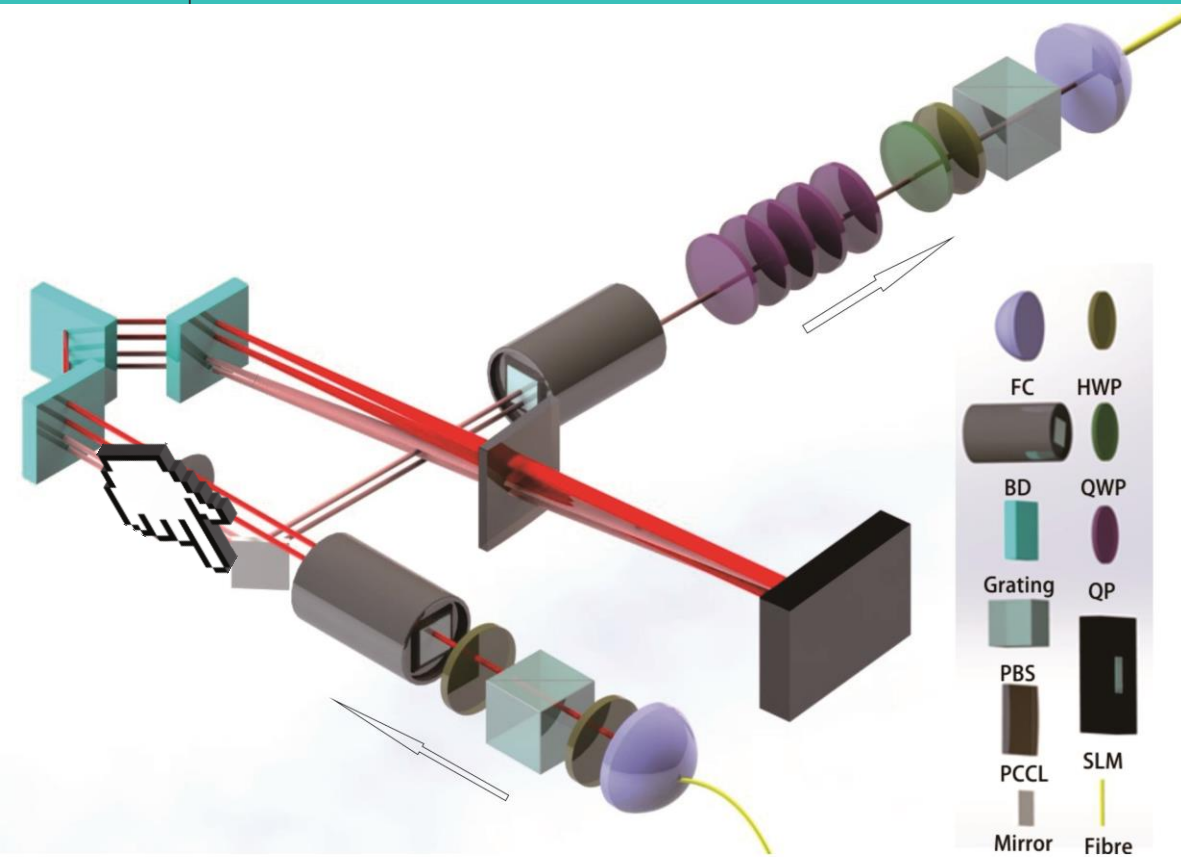
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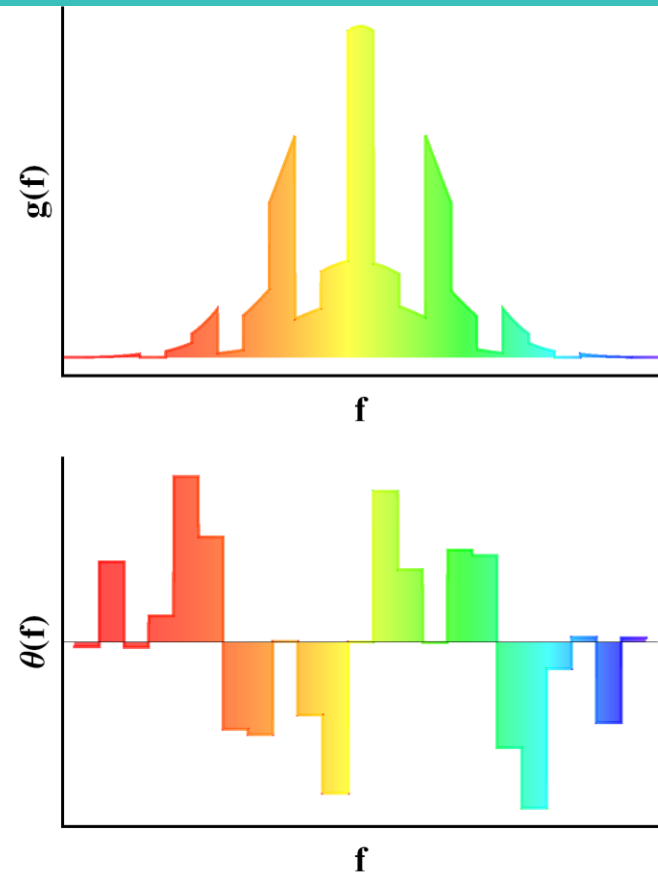
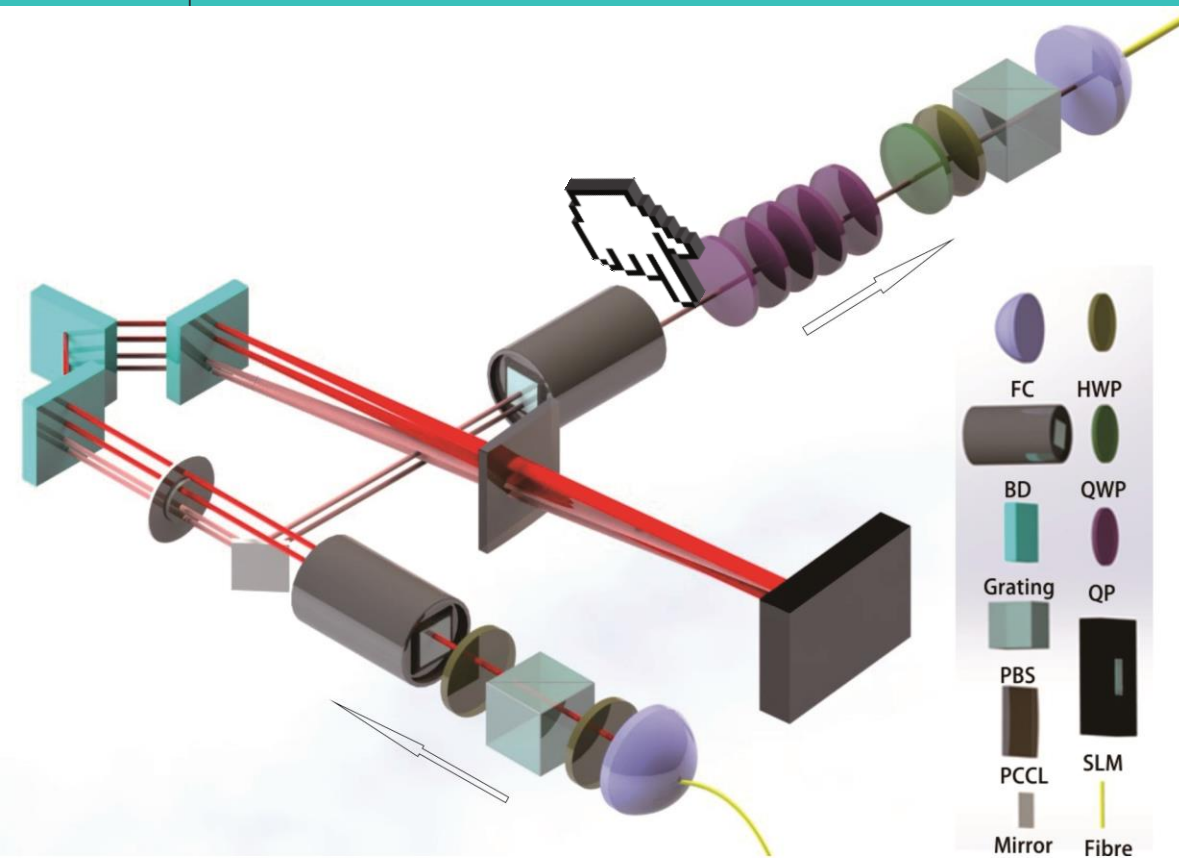
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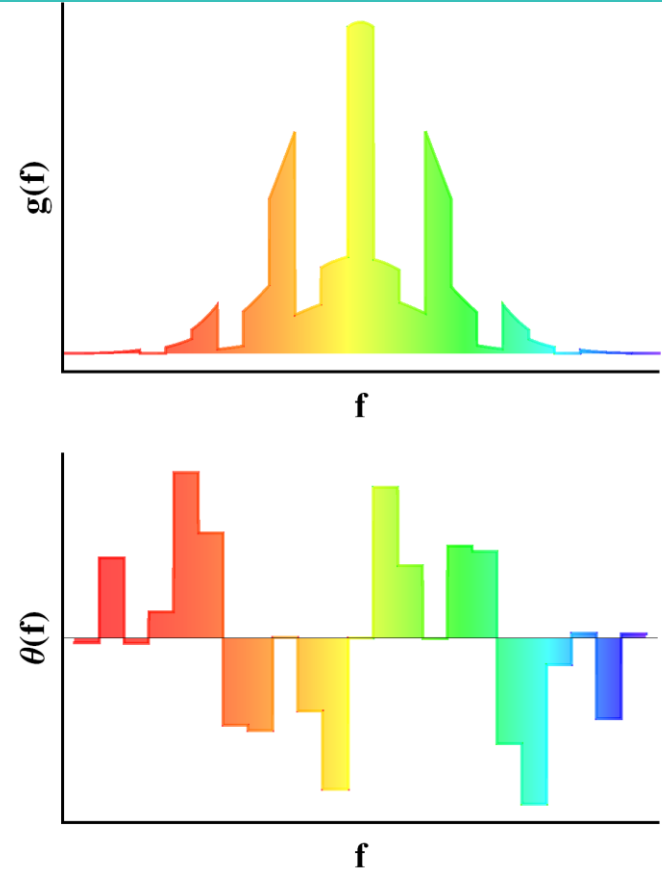
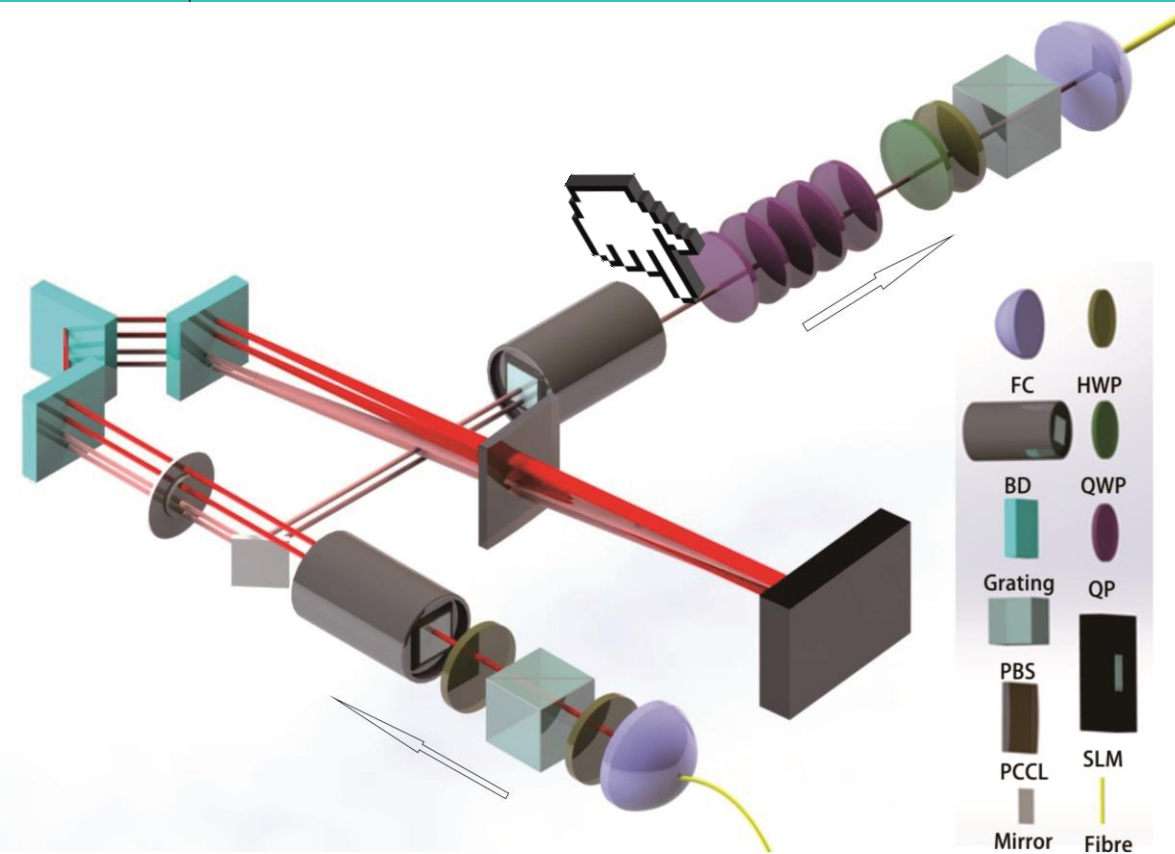
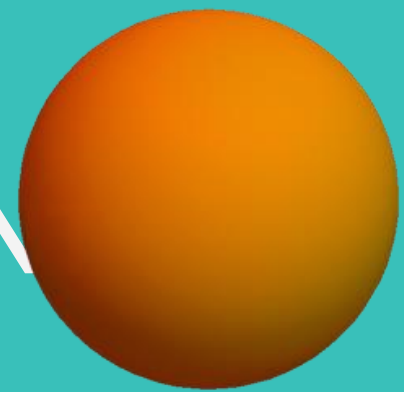
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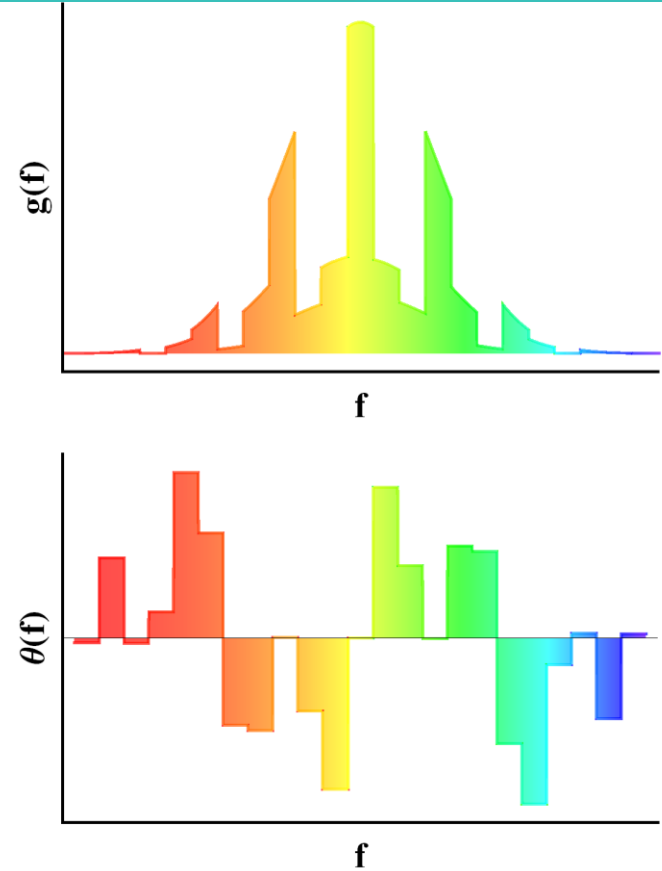
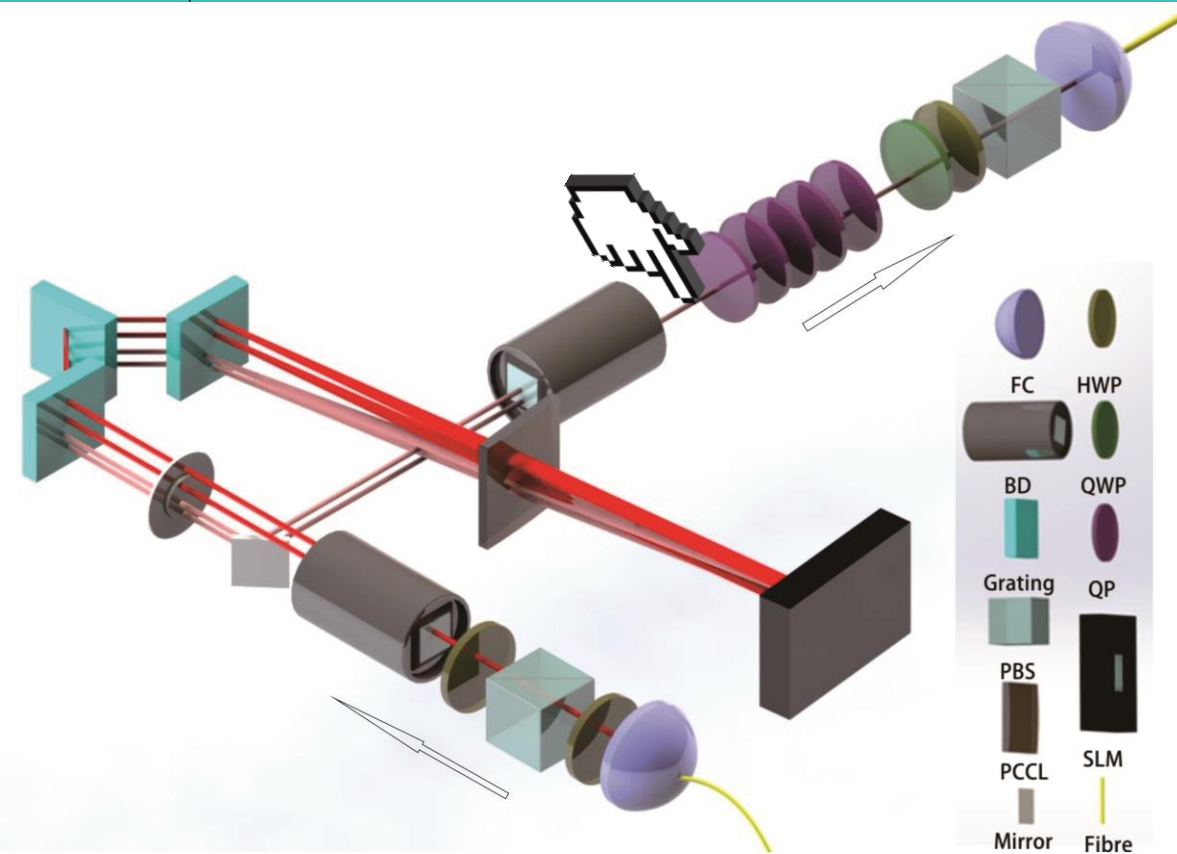
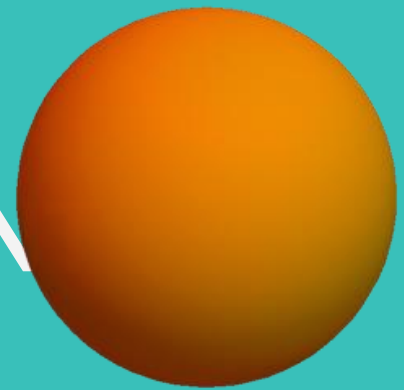
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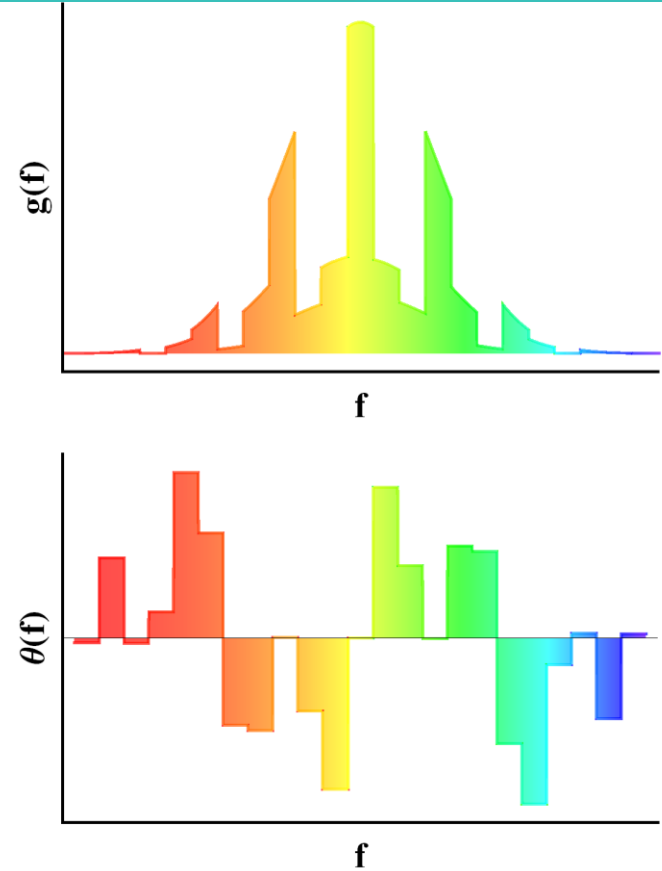
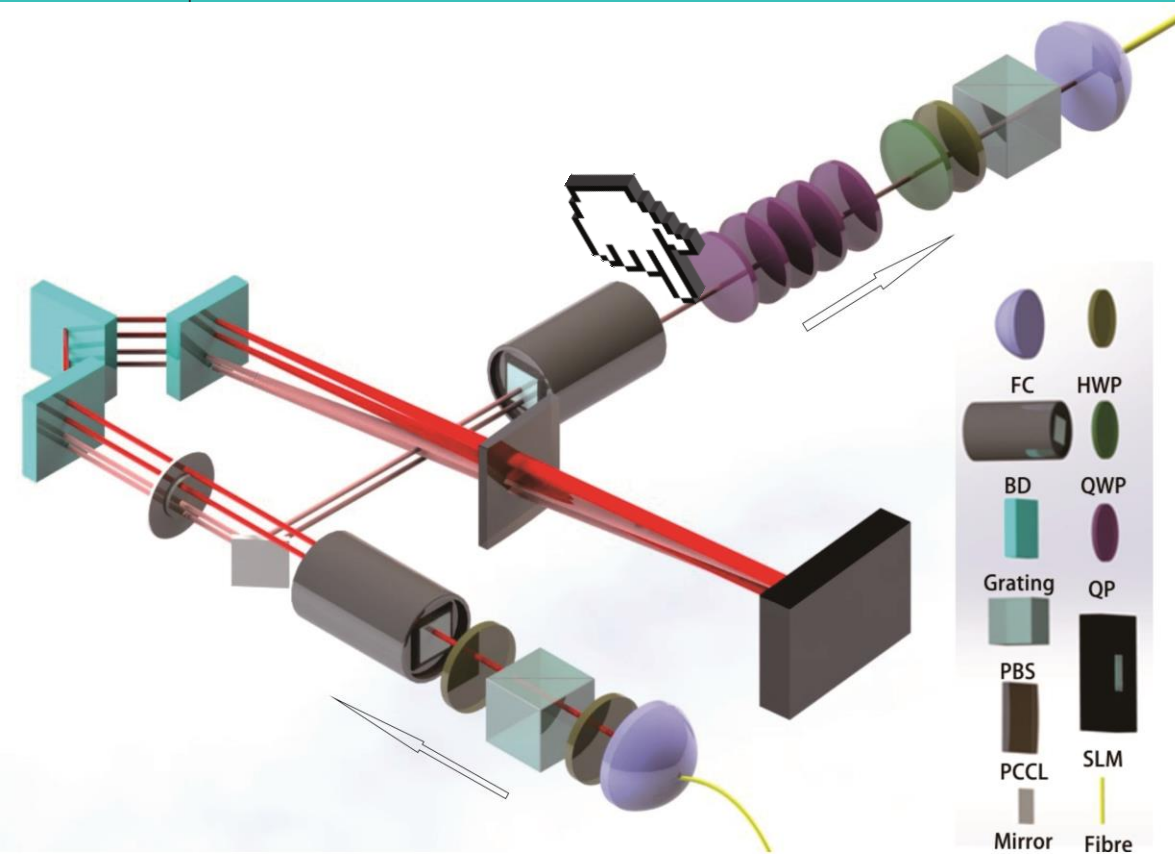
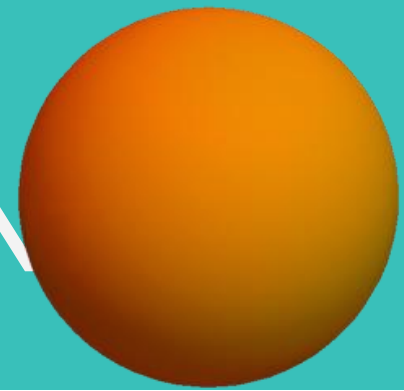
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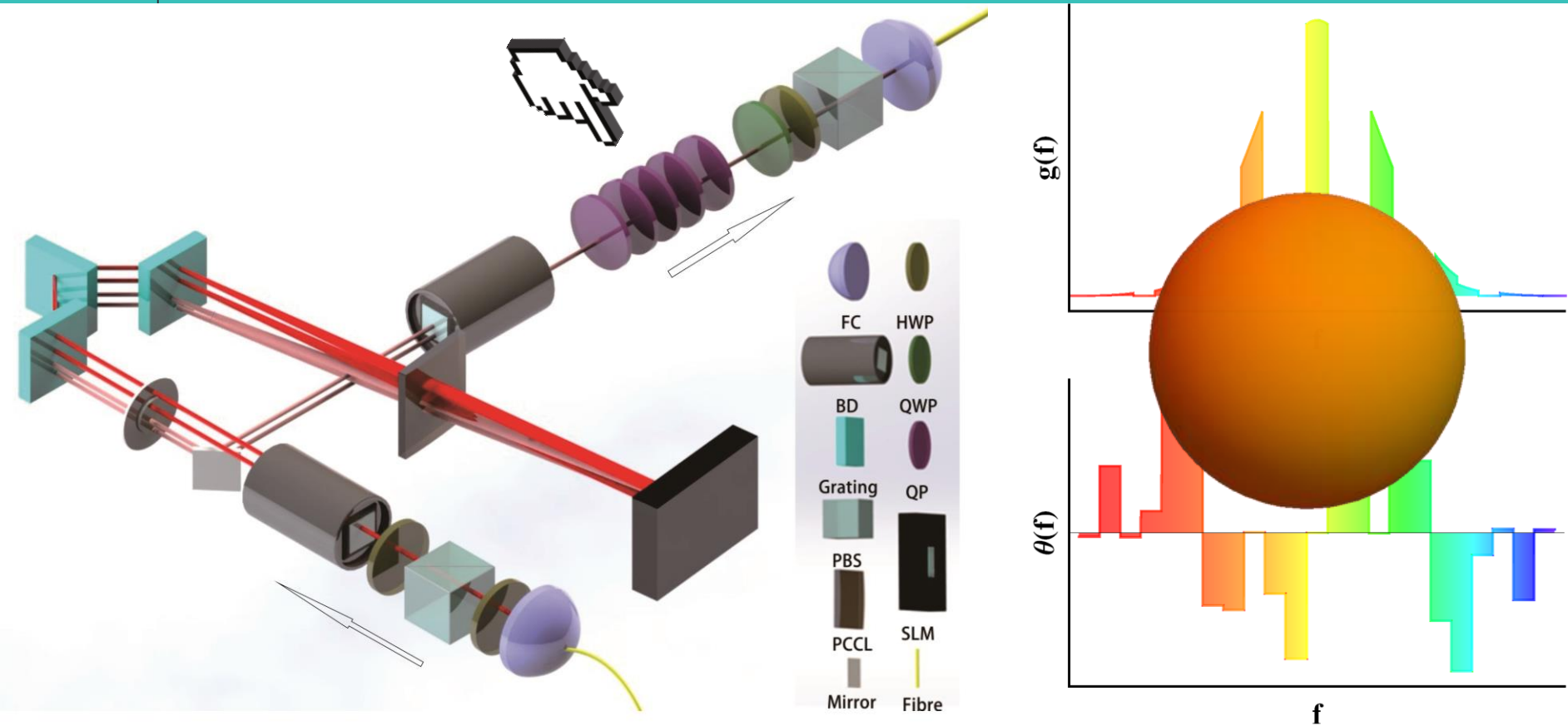
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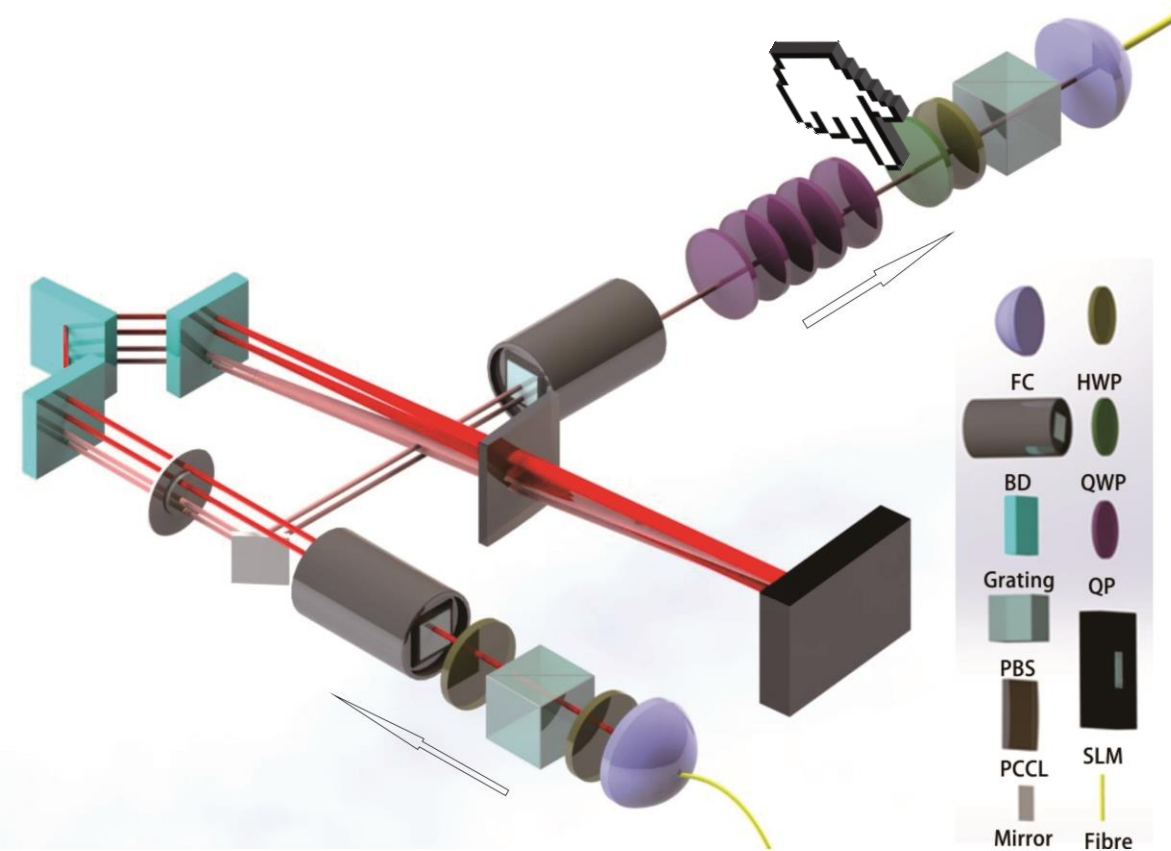
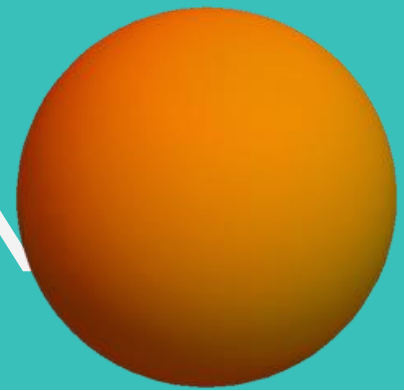
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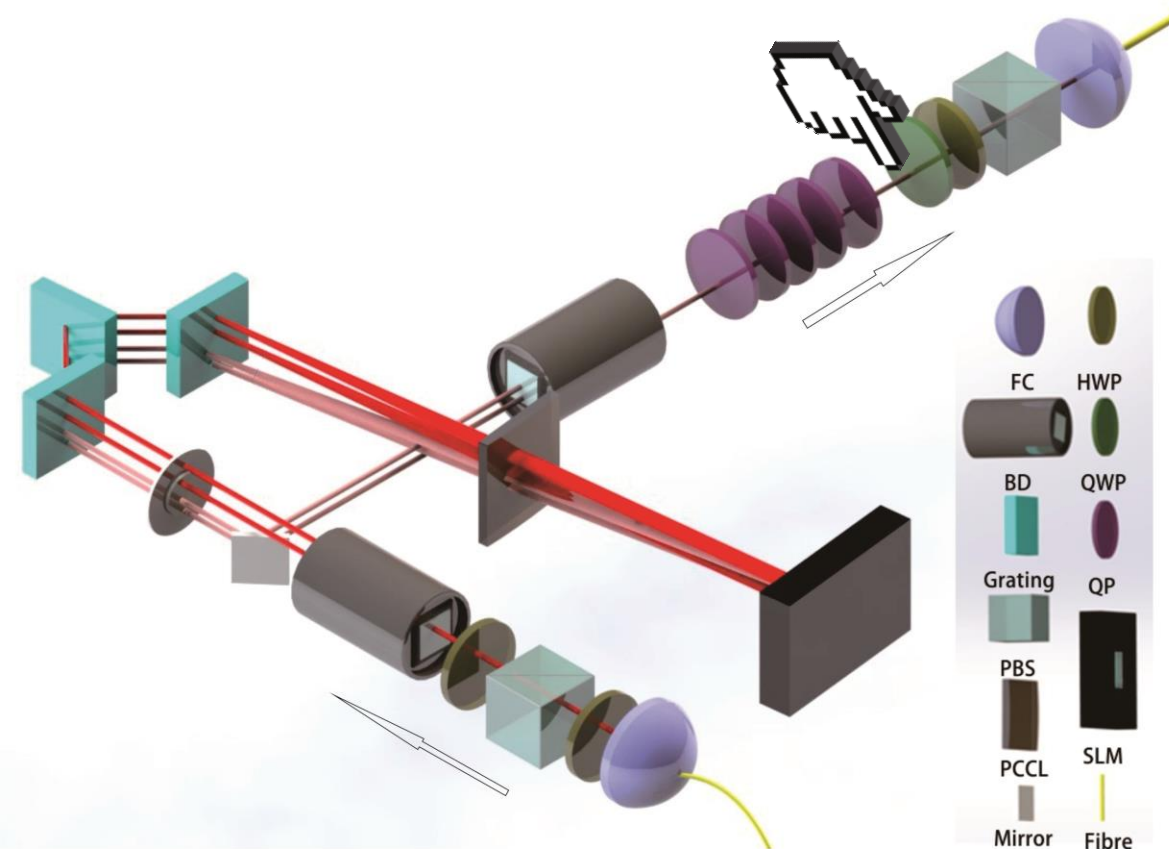
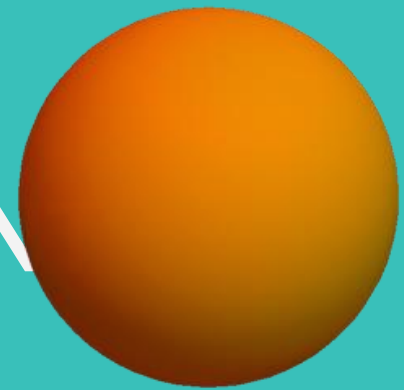
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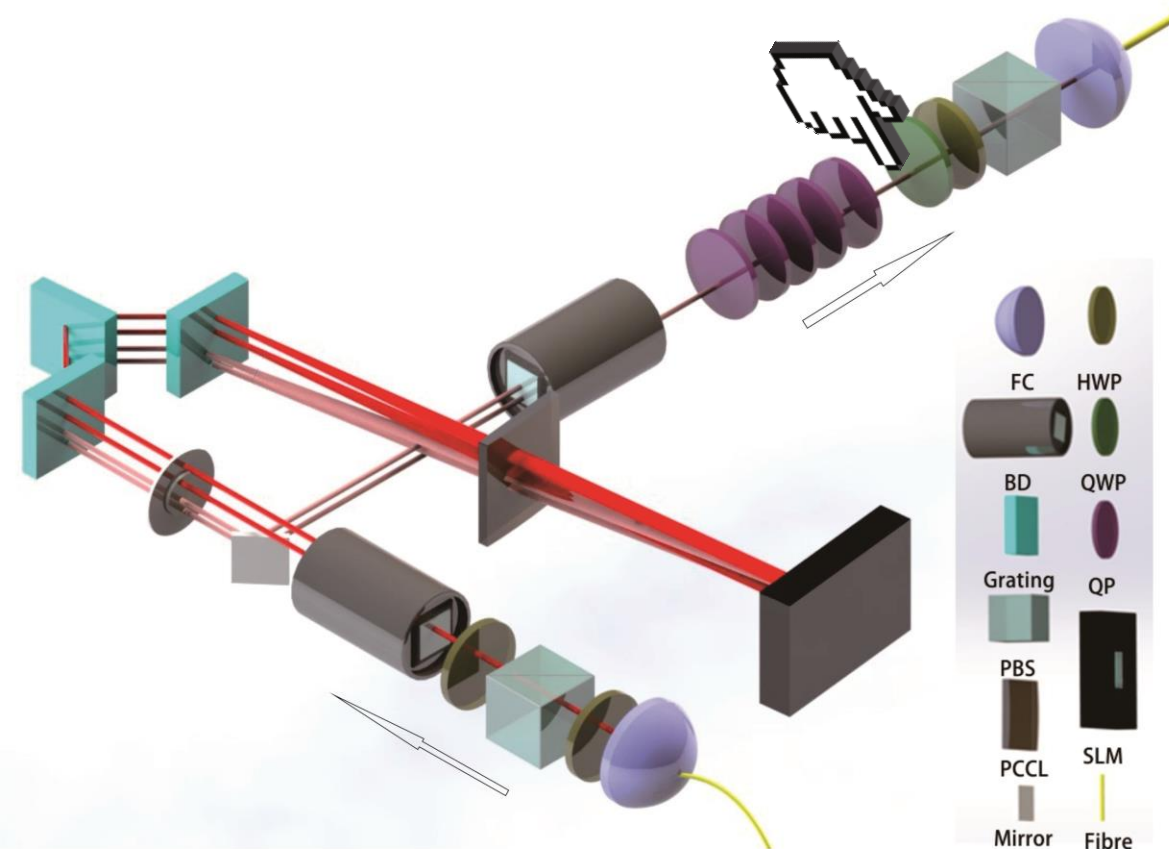
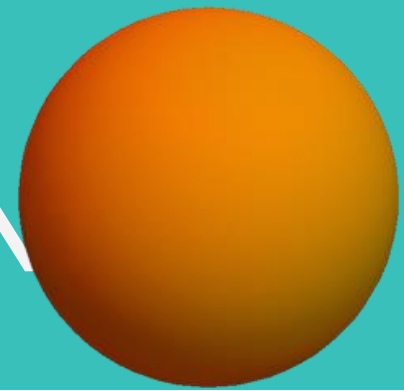


$$\rho^S(0) = \frac{1}{2} \begin{pmatrix} 1 & \kappa^*(0) \\ \kappa(0) & 1 \end{pmatrix}$$

$$\xrightarrow{\Phi_t}$$

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SIMULATOR: EXPERIMENT



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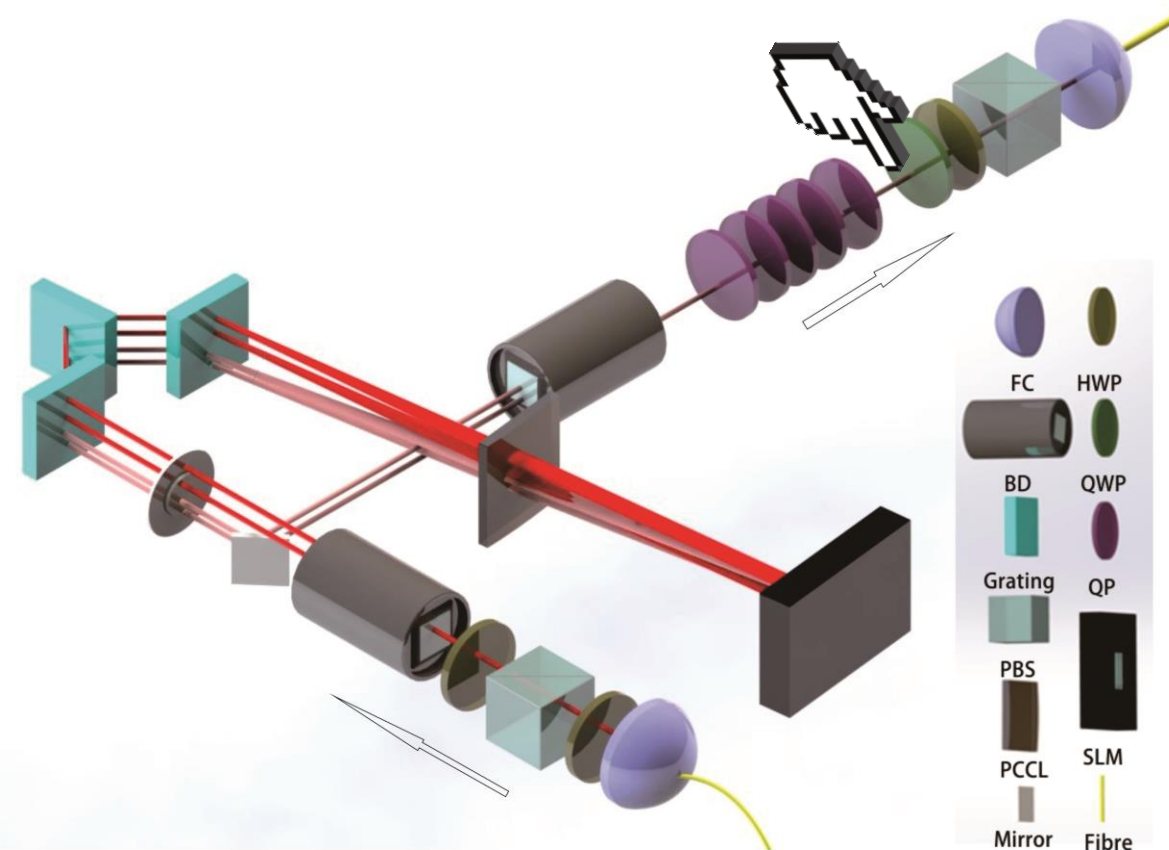
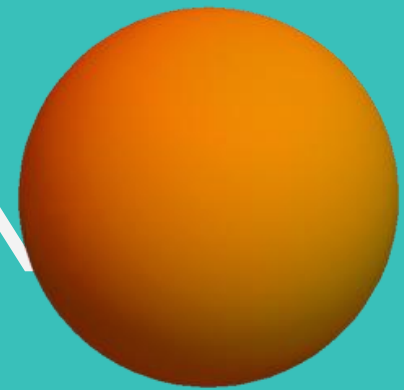
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$$\kappa(t) := \int |g(f)|^2 e^{i\theta(f)} e^{i\Delta n f t / 2\pi} df,$$

$$\Delta n = n_V - n_H$$

SIMULATOR: EXPERIMENT



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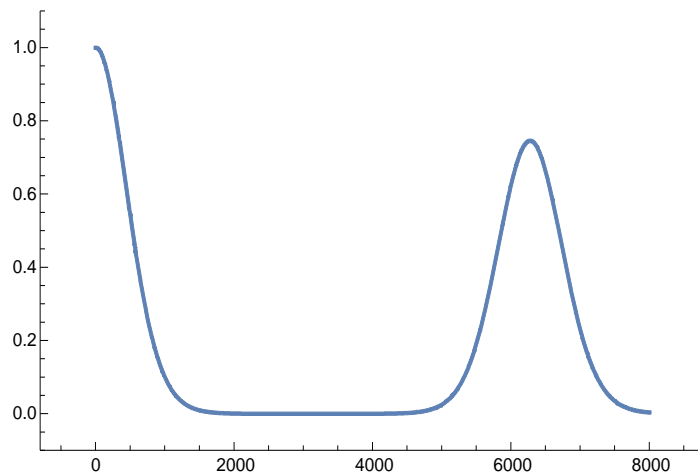
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$$|\kappa(t)|$$

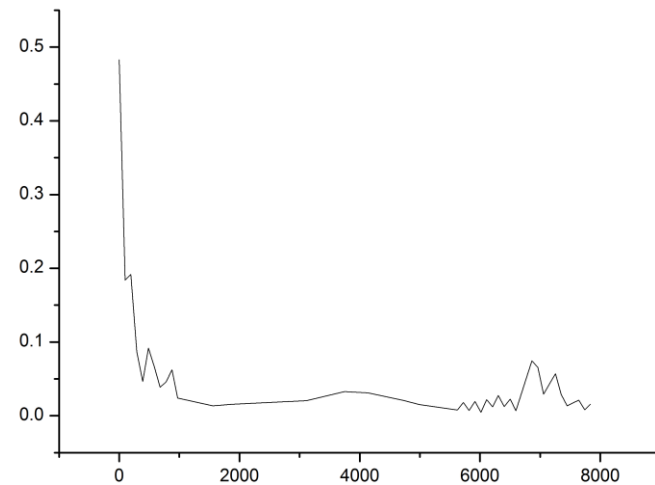
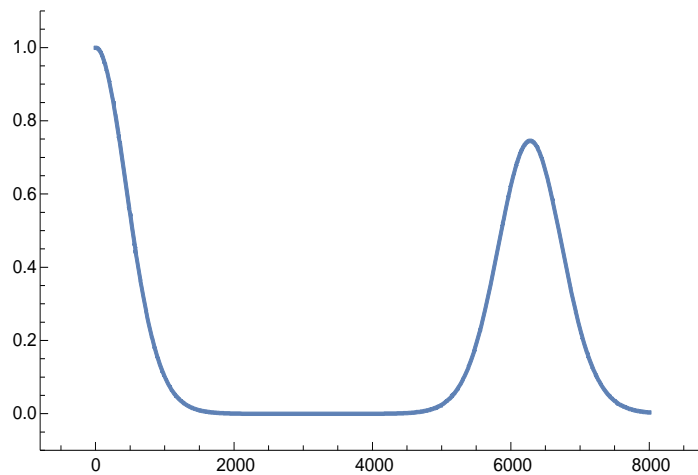
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ONGOING:

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- INCREASE THE REVIVAL IN THE EXPERIMENT
- IMPLEMENT $\lambda = 0.9$ AND $\lambda = 1.8$ DYNAMICS
- RUN EXPERIMENT WITH SINGLE PHOTONS



CONTRIBUTIONS:



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THEORY: UTU GROUPS OF PILO AND MANISCALCO



CONTRIBUTIONS:

THEORY: UTU GROUPS OF PILO AND MANISCALCO

EXPERIMENT: USTC GROUP OF GUO AND LI

MAIN CONTRIBUTION IN EXPERIMENT: ZHAO-DI LIU



THANK YOU!