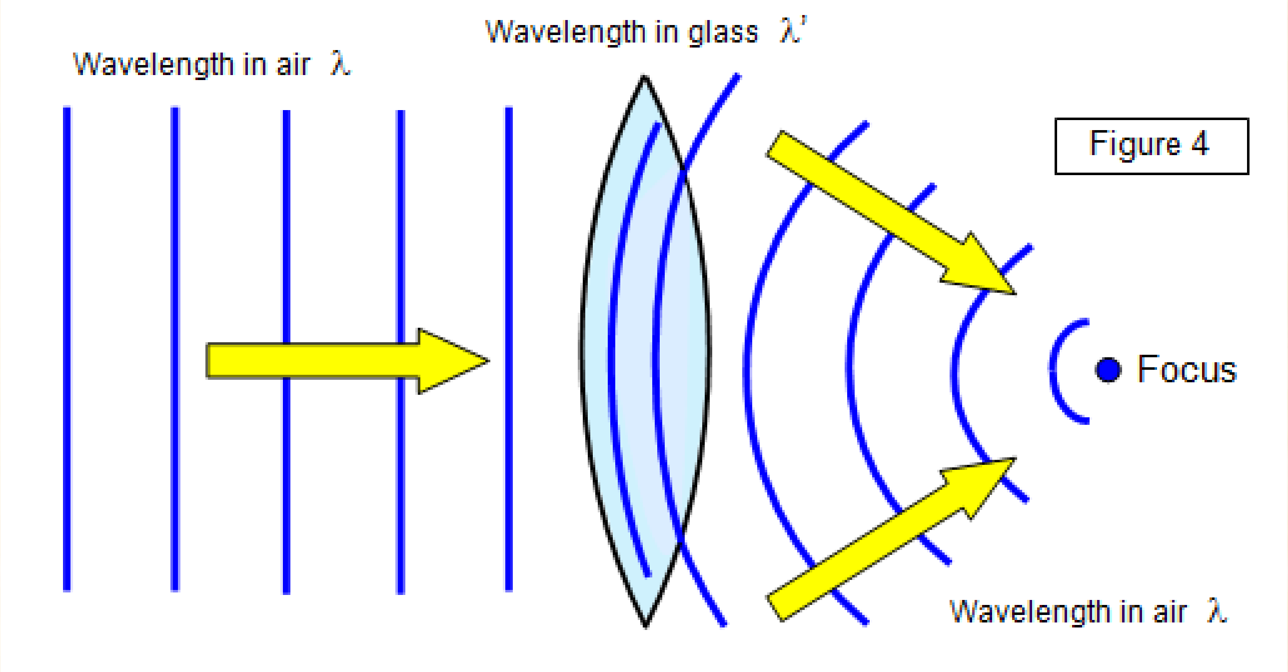
Initial objectives

Employ plasmonic and geometrical resonances to enhance magneto-optical effects ☹

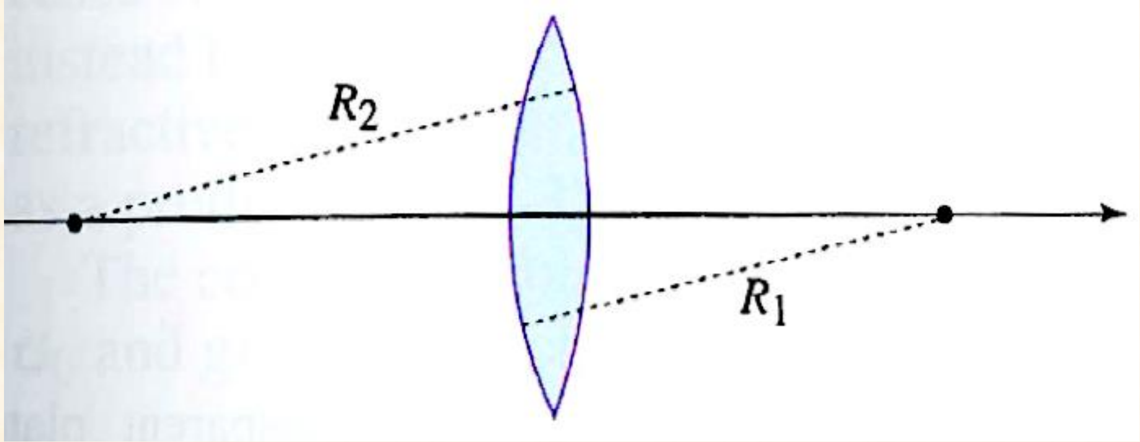
Investigate layouts for efficient rotation of polarization ☹

Magnetically tunable lens based on a gradient metasurface ☺

Double-convex lens

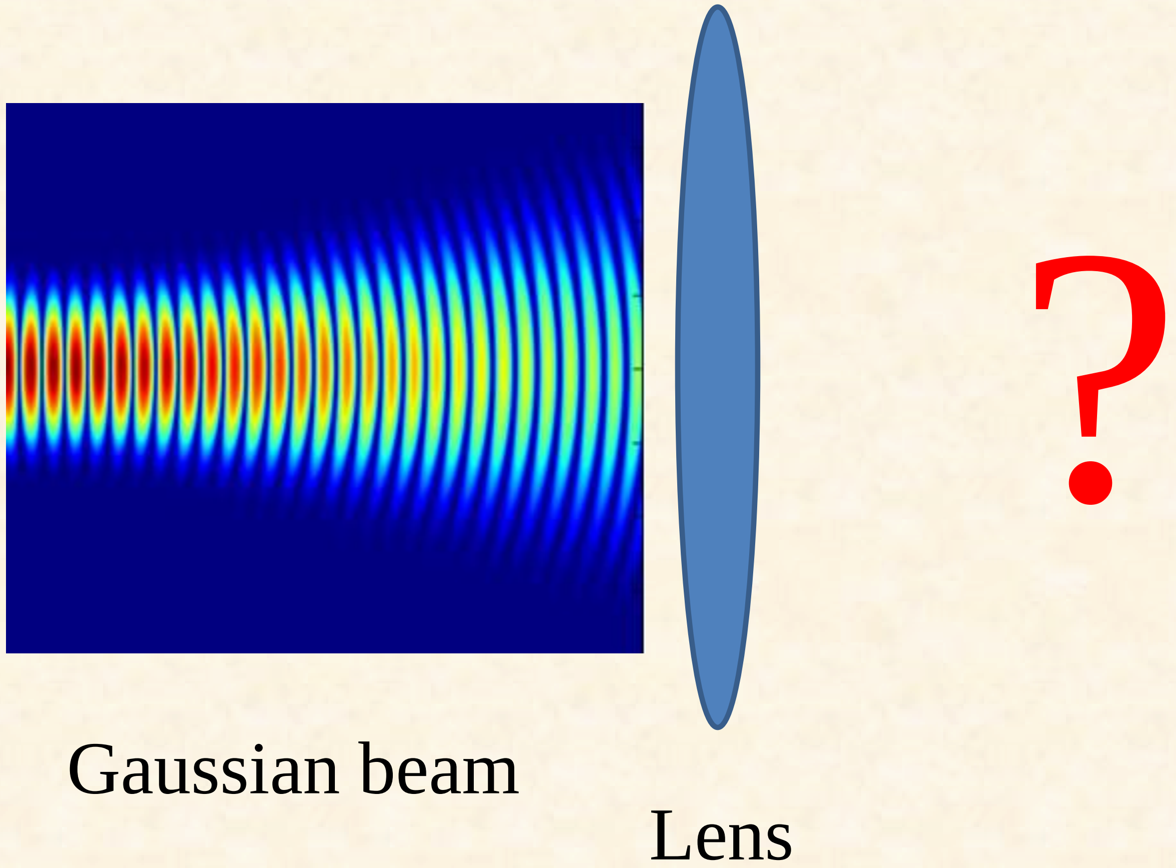


$$\frac{1}{z_1} + \frac{1}{z_2} = \frac{1}{f}$$



$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Transmission of a Gaussian beam through a lens

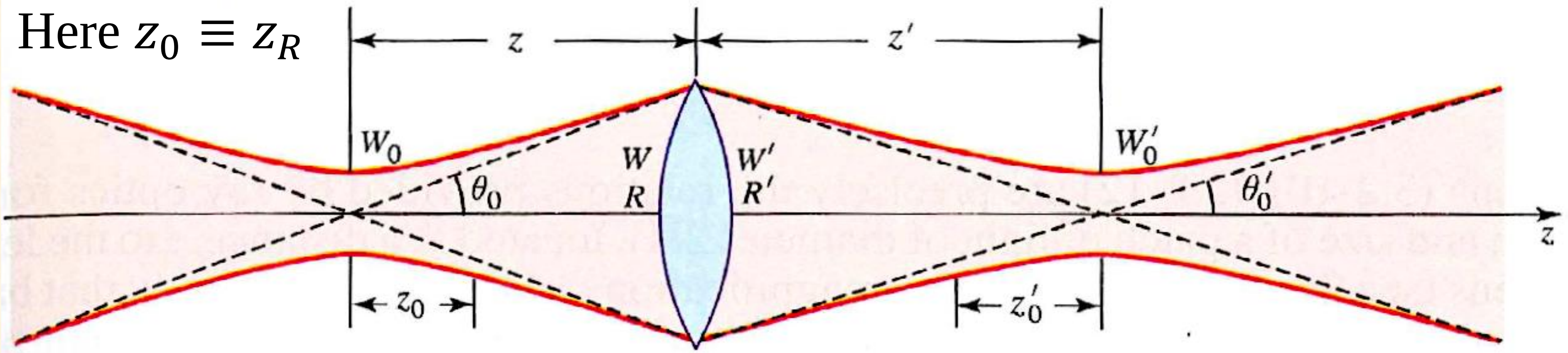


The effect of the lens is an additional phase factor $-\frac{k\rho^2}{2f}$.

The beam width just before and after the lens is the same.

Transmission of a Gaussian beam through a lens: NO PANIC!

Here $z_0 \equiv z_R$



After a lens the total phase reads

$$kz + \frac{k\rho^2}{2R} + \psi - \frac{k\rho^2}{2f} \Rightarrow$$

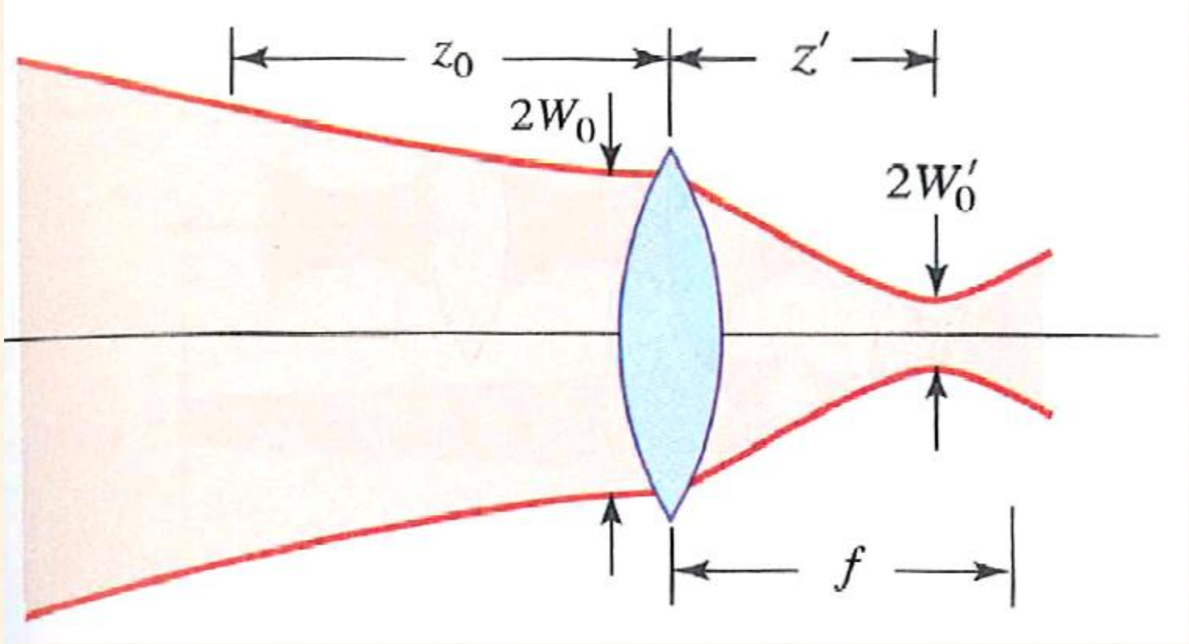
$$kz + \frac{k\rho^2}{2R'} + \psi \qquad \frac{1}{R'} = \frac{1}{R} + \frac{1}{f}$$

$$W' = W$$
$$R \Rightarrow R'$$

new width W_0'
new focus z'
new Rayleigh z_0'

Waist radius	$W_0' = MW_0$
Waist location	$(z' - f) = M^2(z - f)$
Depth of focus	$2z_0' = M^2(2z_0)$
Divergence angle	$2\theta_0' = \frac{2\theta_0}{M}$
Magnification	$M = \frac{M_r}{\sqrt{1 + r^2}}$
$r = \frac{z_0}{z - f}$,	$M_r = \left\lvert \frac{f}{z - f} \right\rvert$.

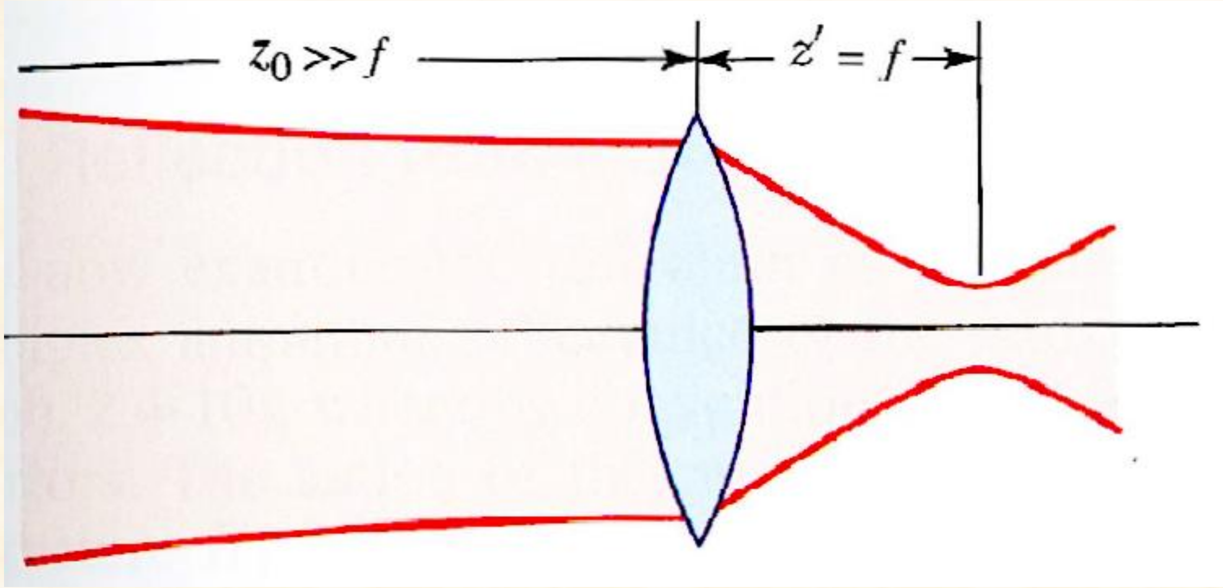
Beam shaping



A lens at the beam waist

$$W_0' = \frac{W_0}{\sqrt{1 + (z_0/f)^2}}$$

$$z' = \frac{f}{1 + (f/z_0)^2}$$



Focusing of a collimated beam

$$W_0' \approx \frac{\lambda}{\pi W_0} f = \theta_0 f$$

$$z' \approx f$$

$$2W_0' \approx \frac{4}{\pi} \lambda F_L; \quad F_L = \frac{f}{D}$$