Optics

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Journal Club

Oct. 18, 2022

Geometrical optics

Useful for $> 90\%$ of calculation.

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Exceptions

- Focus
- Long propagation
- Diffraction optical elements
  e.g. gratings.

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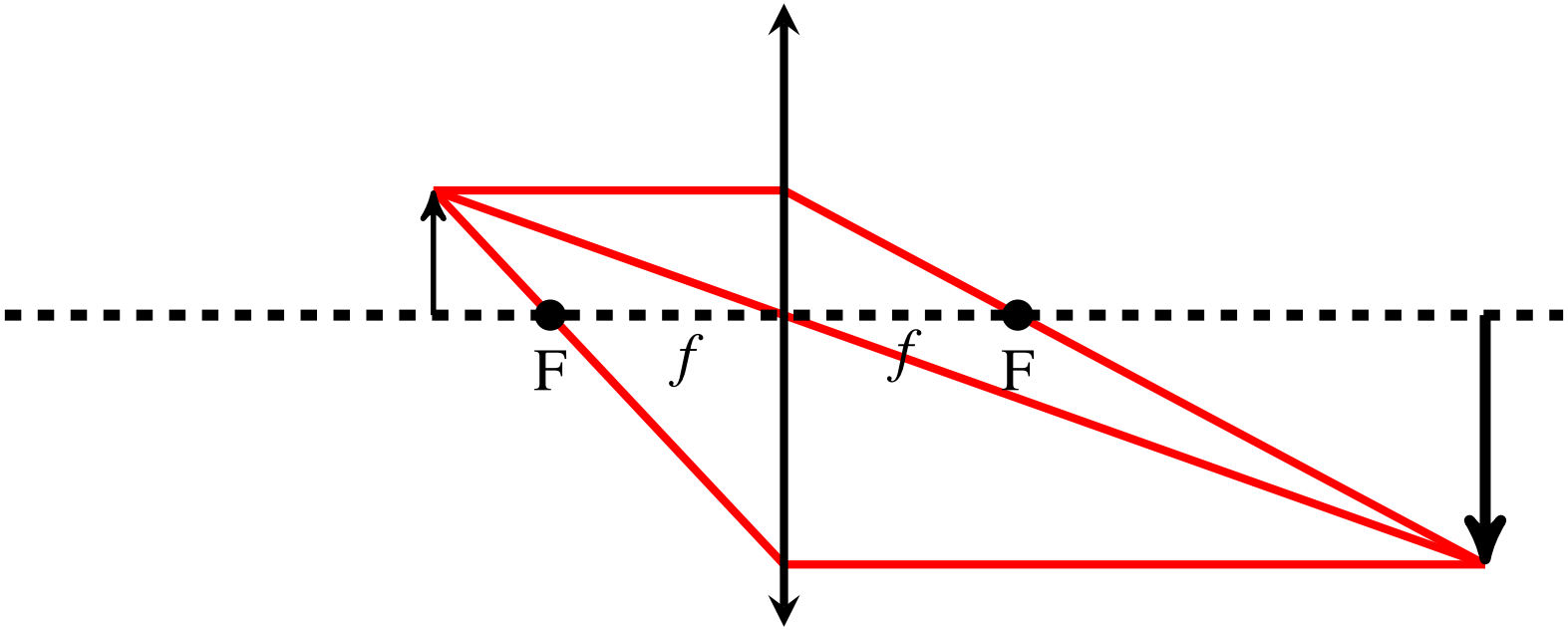
Ideal Lens



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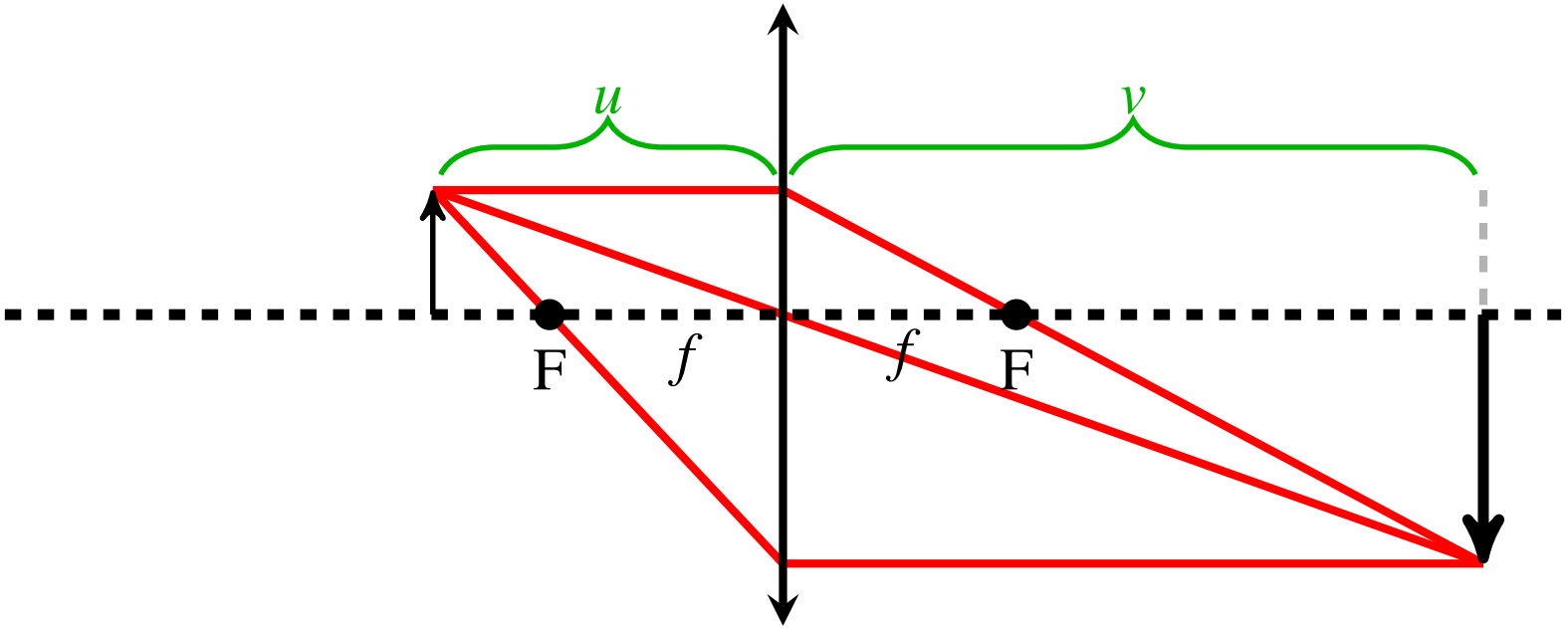

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

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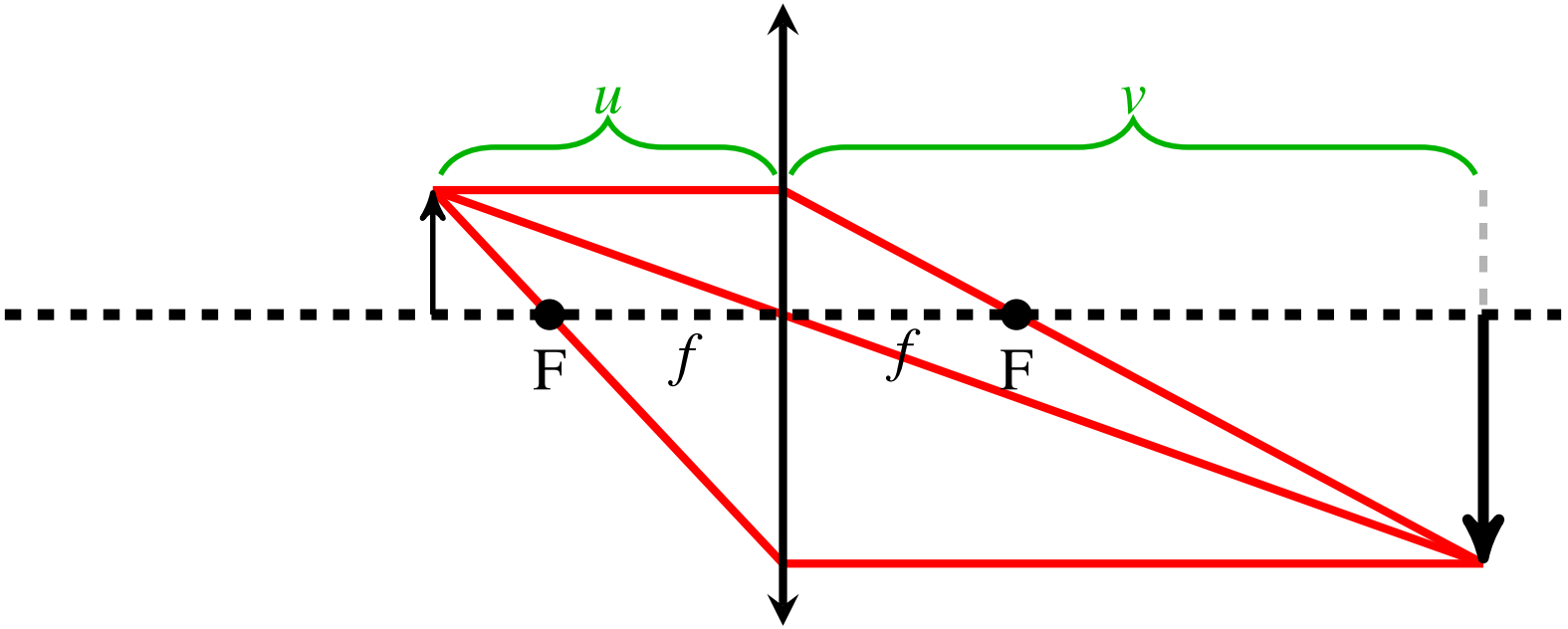
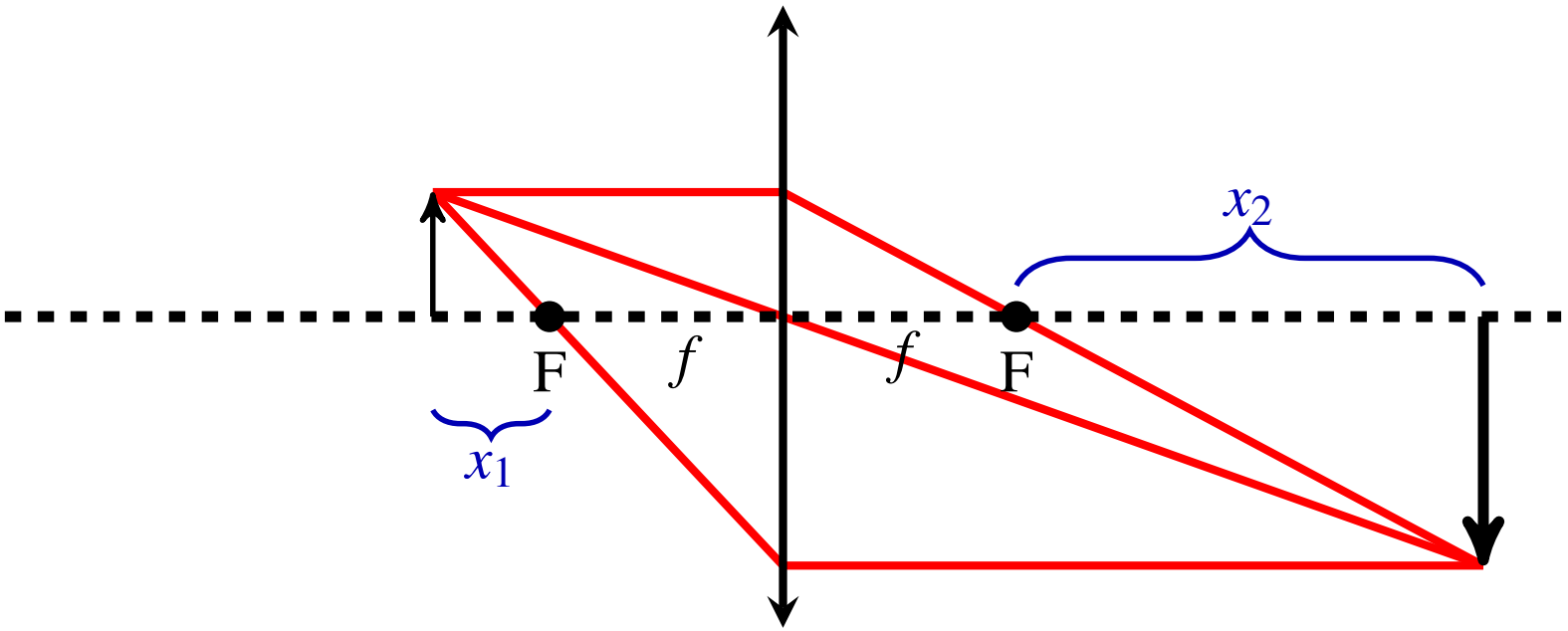


$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

$$M=\frac{v}{u}$$

Ideal Lens



$$x_1 x_2 = f^2$$

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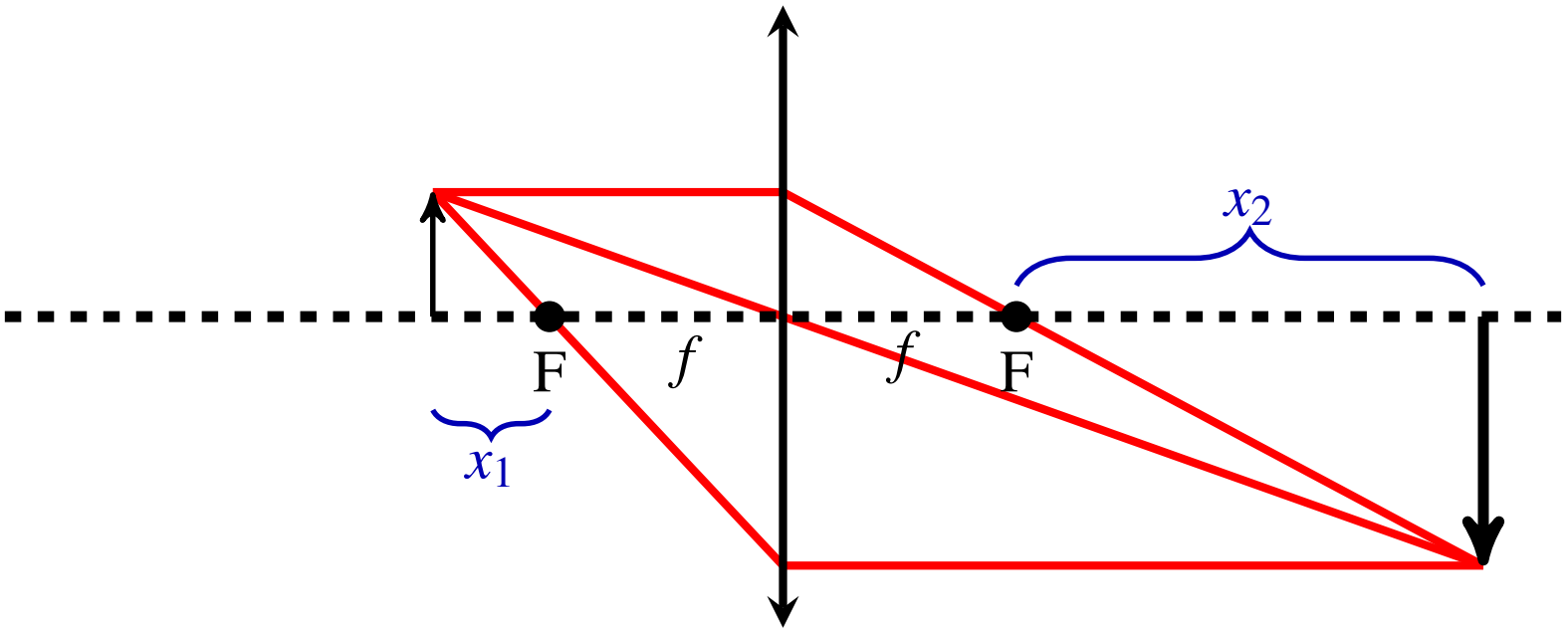
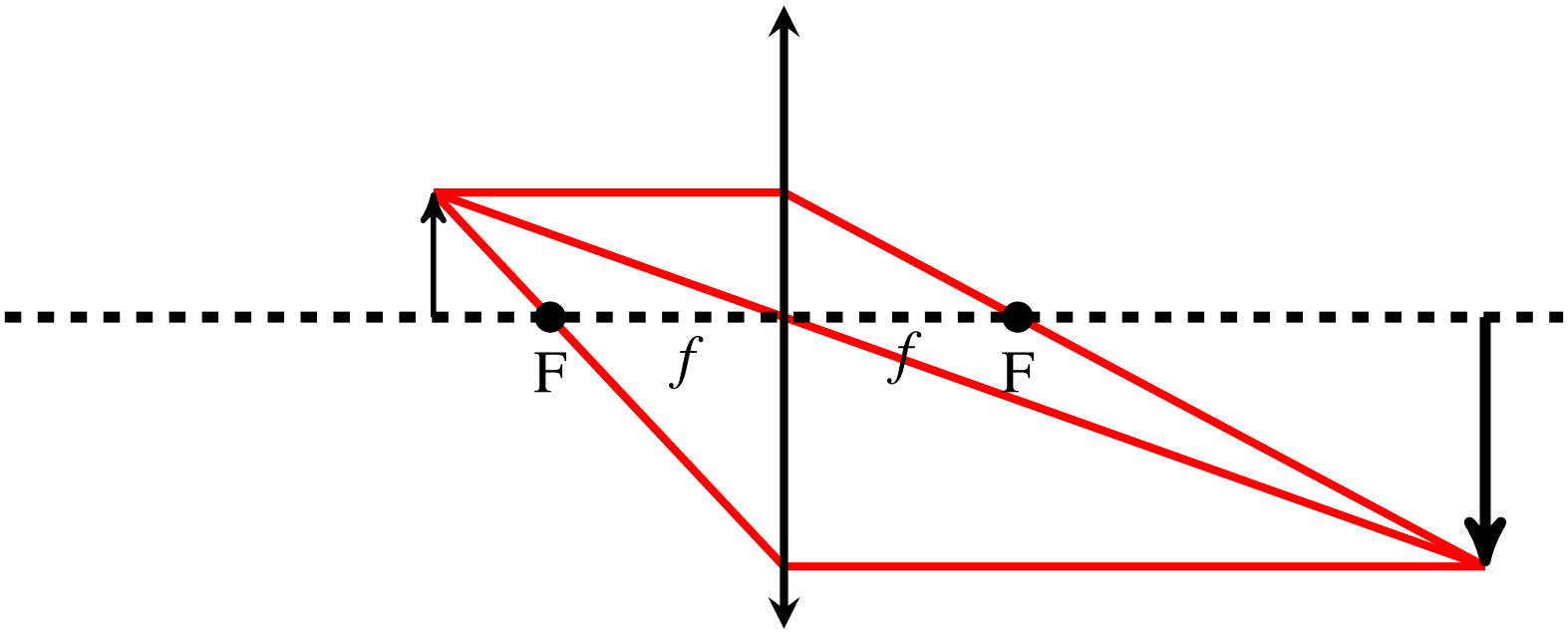


$$x_1 x_2 = f^2$$

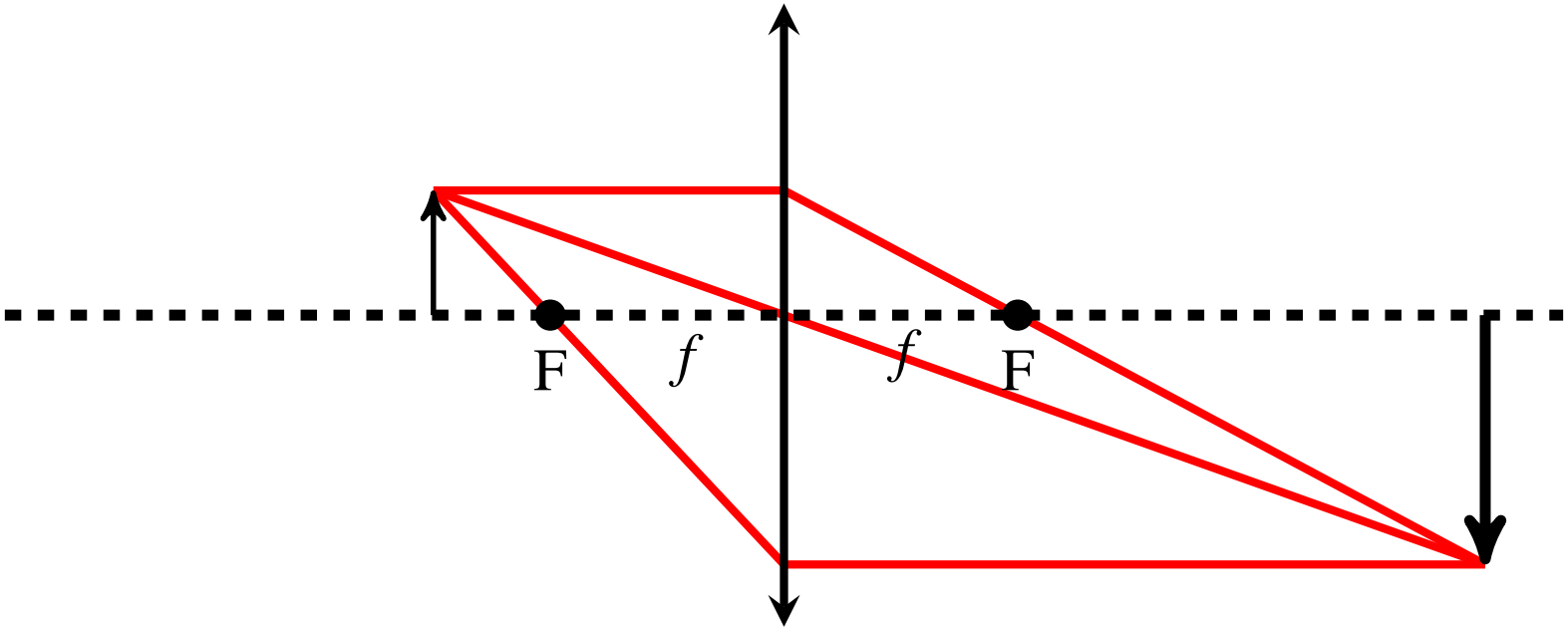
$$M = \frac{f}{x_1} = \frac{x_2}{f} = \sqrt{\frac{x_2}{x_1}}$$

Ideal Lens



Conjugate plane: Perfect image under ray optics

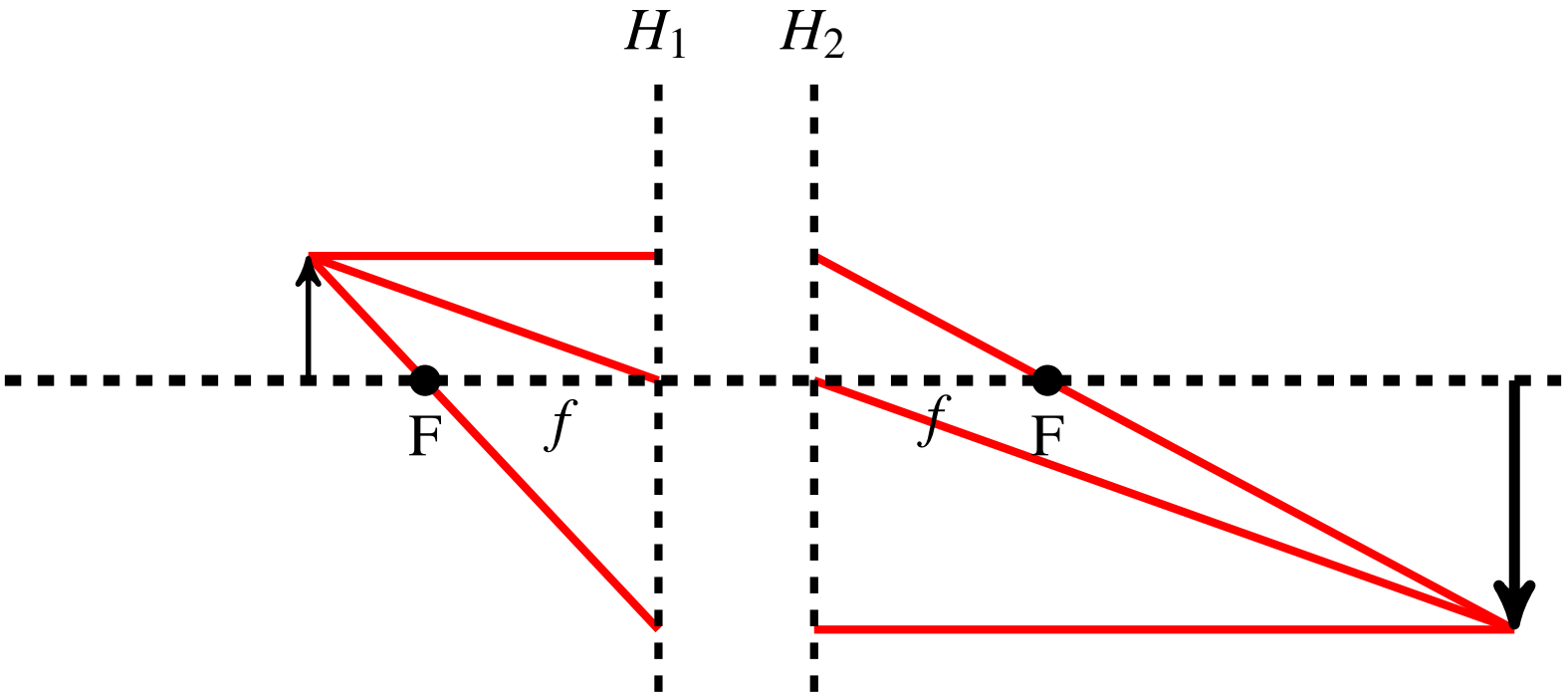
Ideal Lens



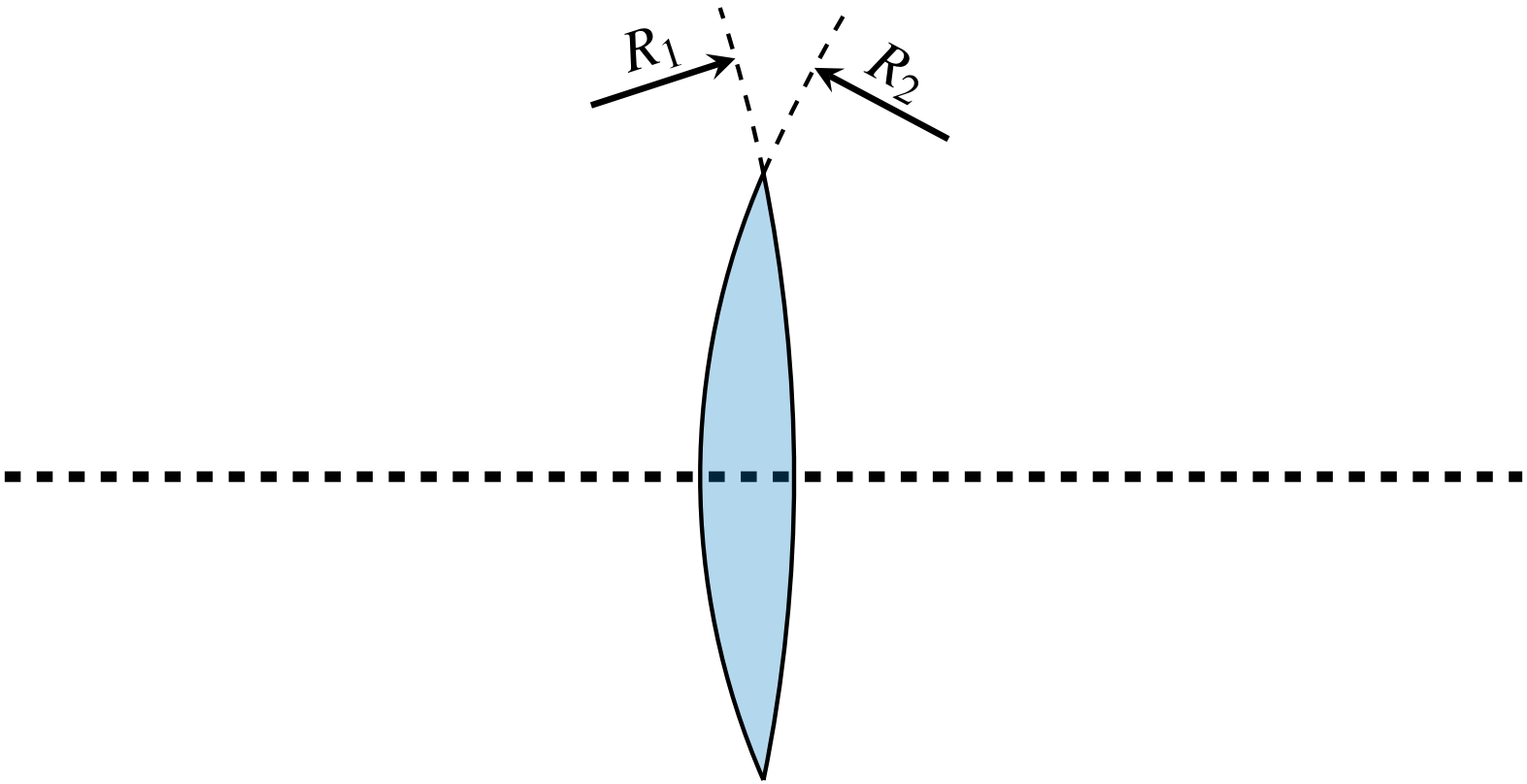
Conjugate plane: Perfect image under ray optics

Principal planes: Conjugate plane where $M = 1$

Ideal Lens



Spherical lens



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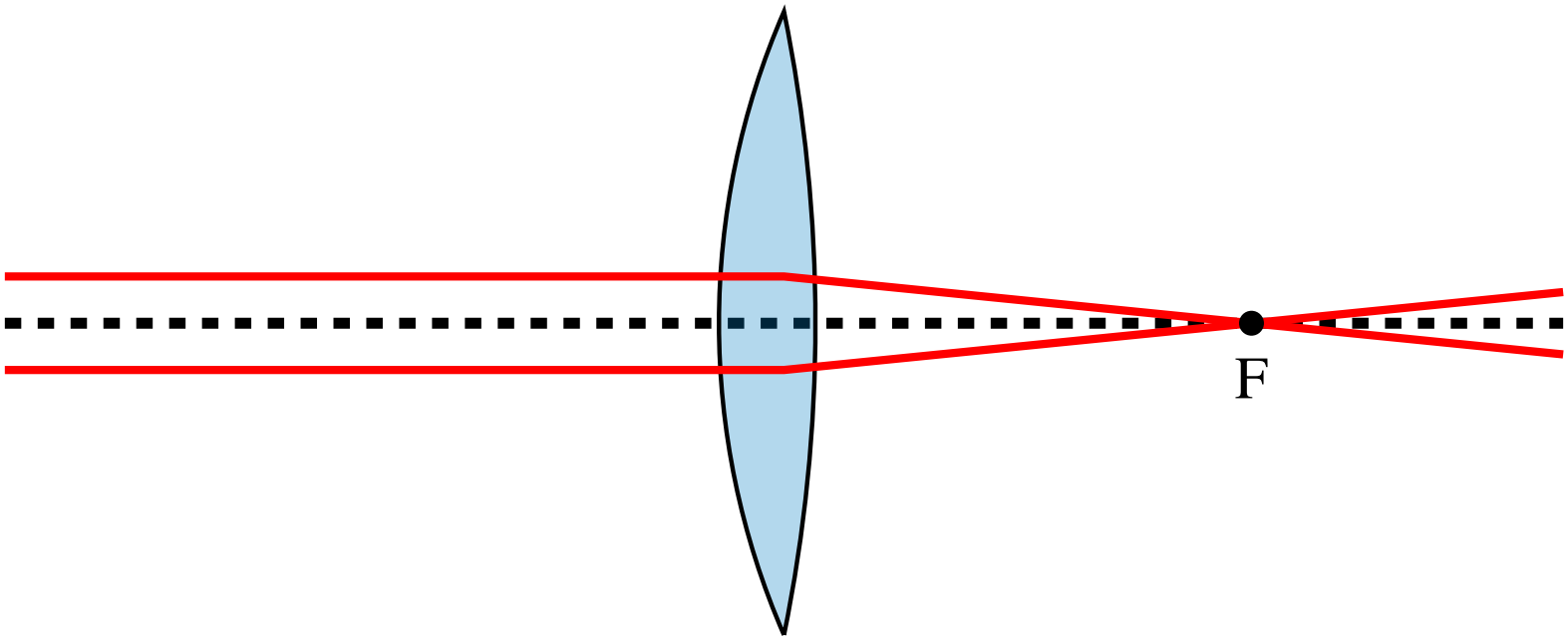

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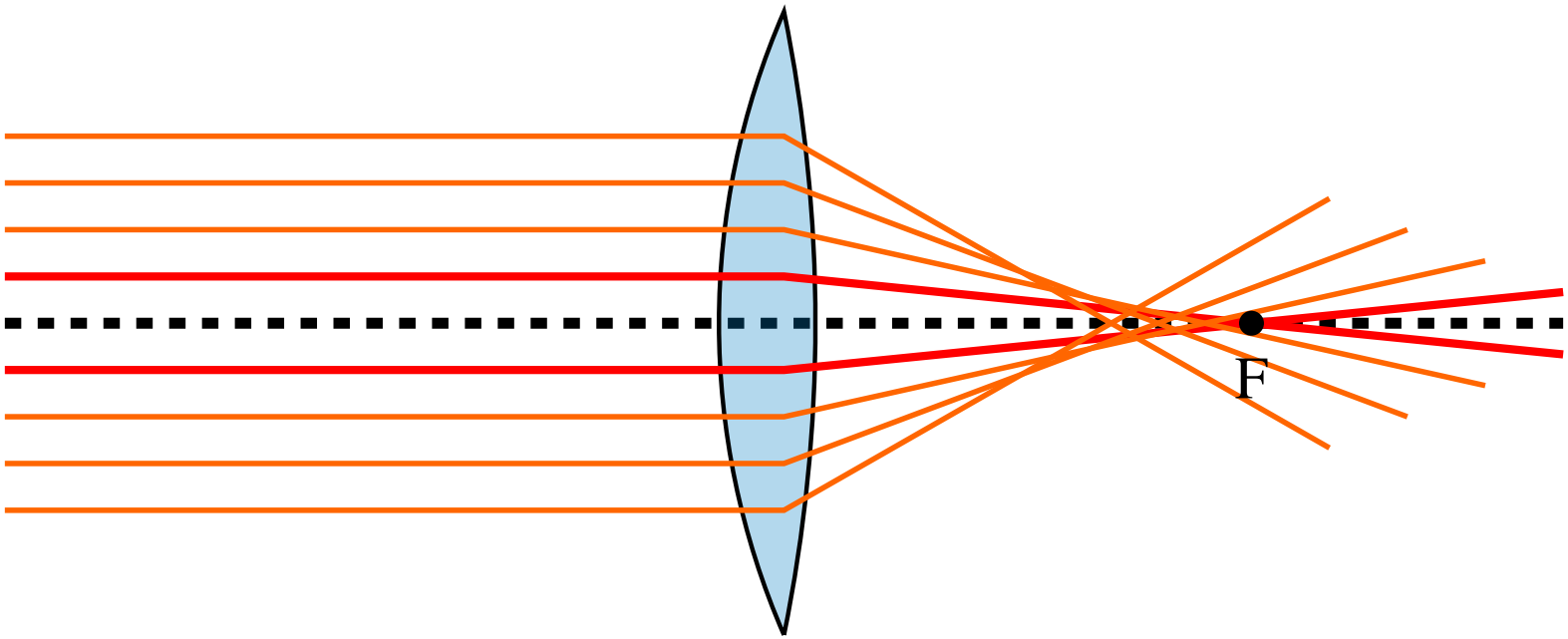

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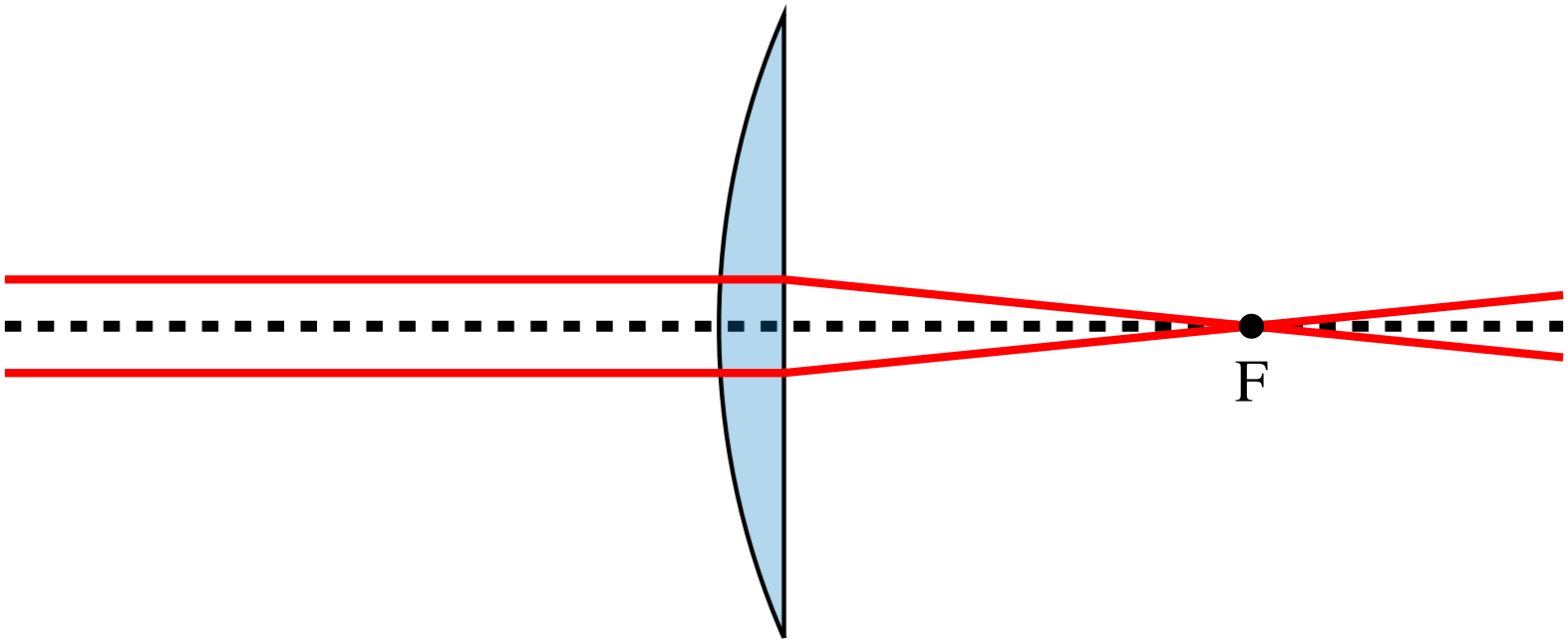
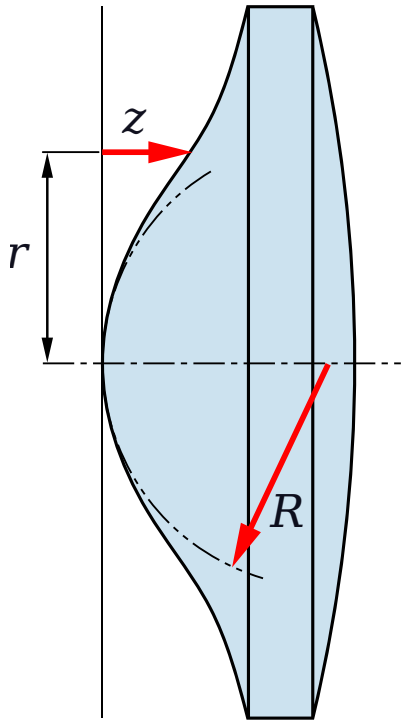


Aspherical lens



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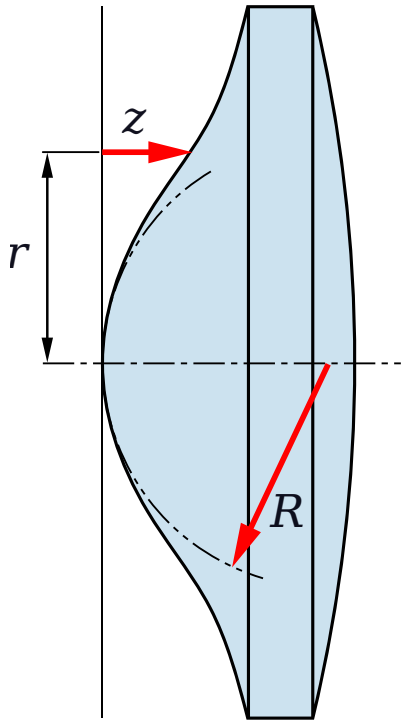

Use cases

- Collimation
- Fiber coupling

Other lens types

Reflective

- No chromatic shift
- Can be aspherical
- More difficult beam path layout

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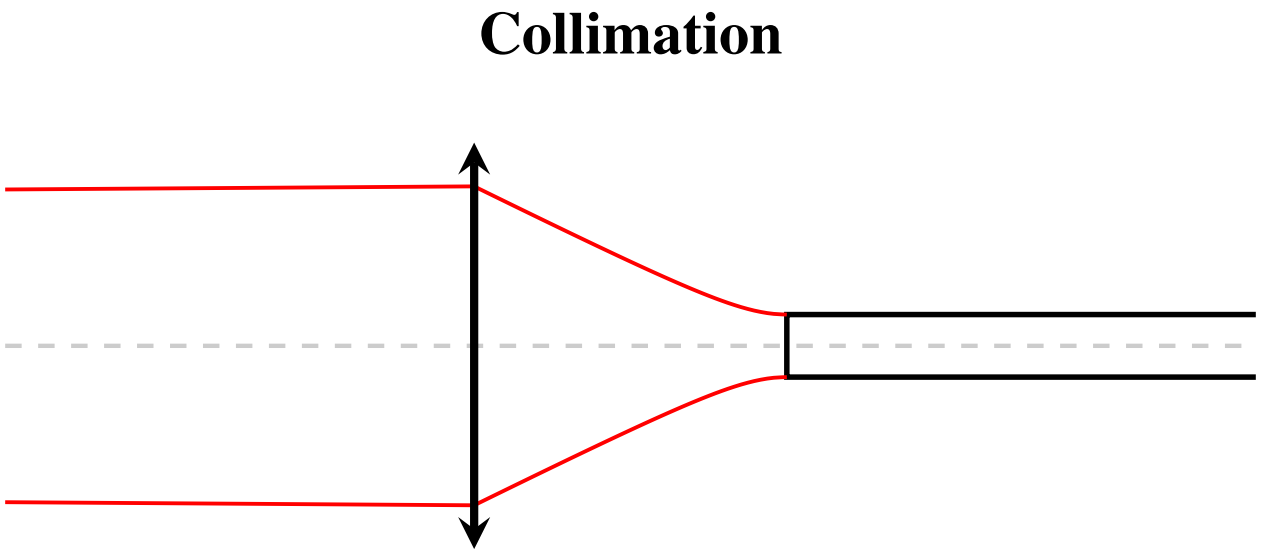
- No chromatic shift
- Can be aspherical
- More difficult beam path layout

Lens set

- Could fix chromatic shift
- Could fix monochromatic aberration
- Better surface quality
- May not be UV compatible

Fiber coupling



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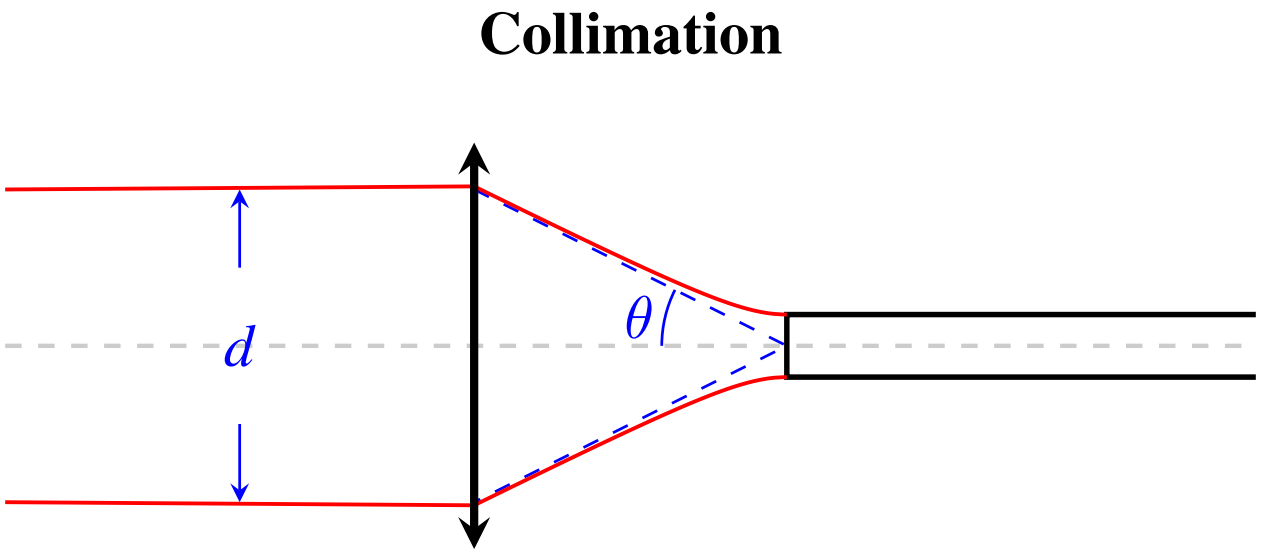
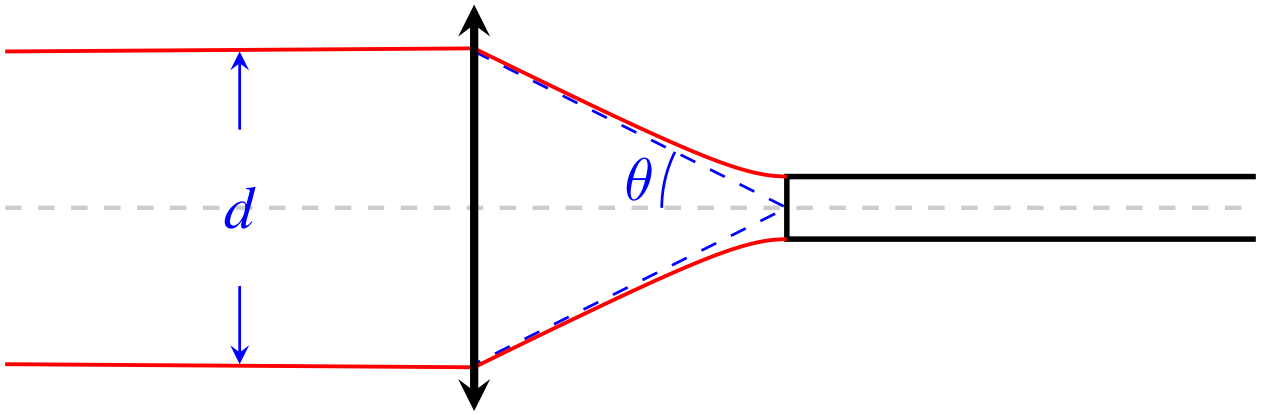


Fiber coupling

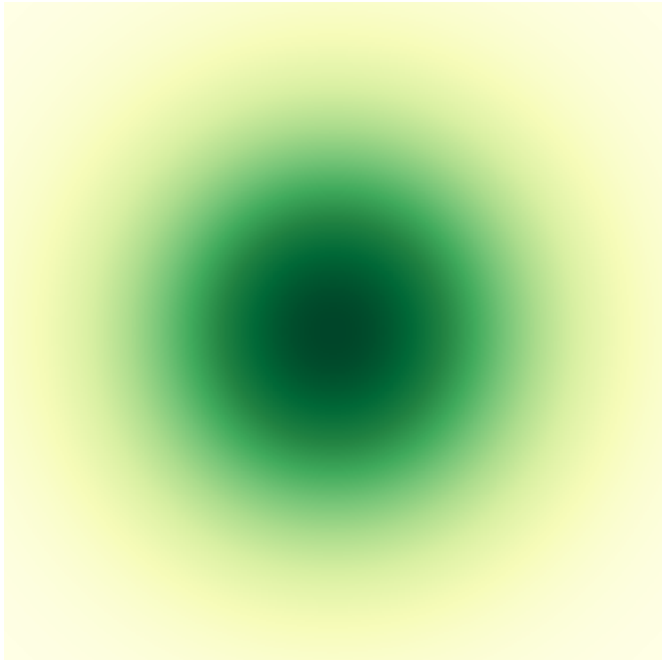
Collimation



$$d \approx 2f \tan\theta$$

Alignment

Alignment



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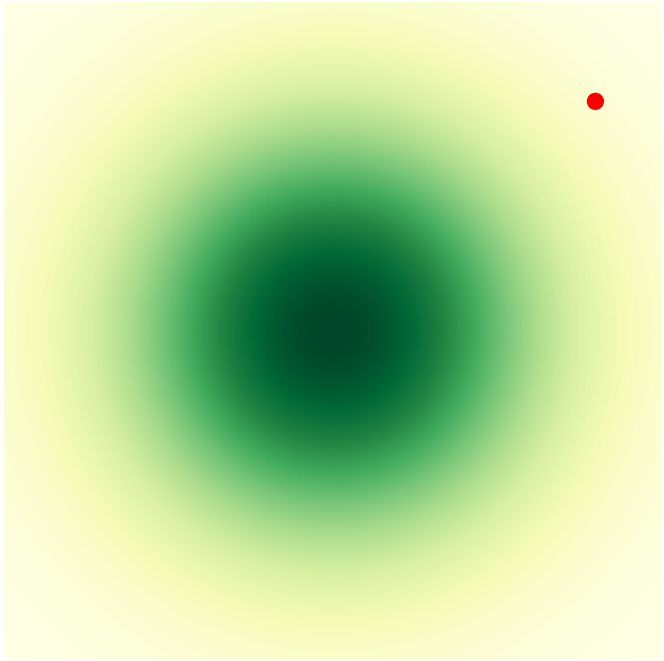

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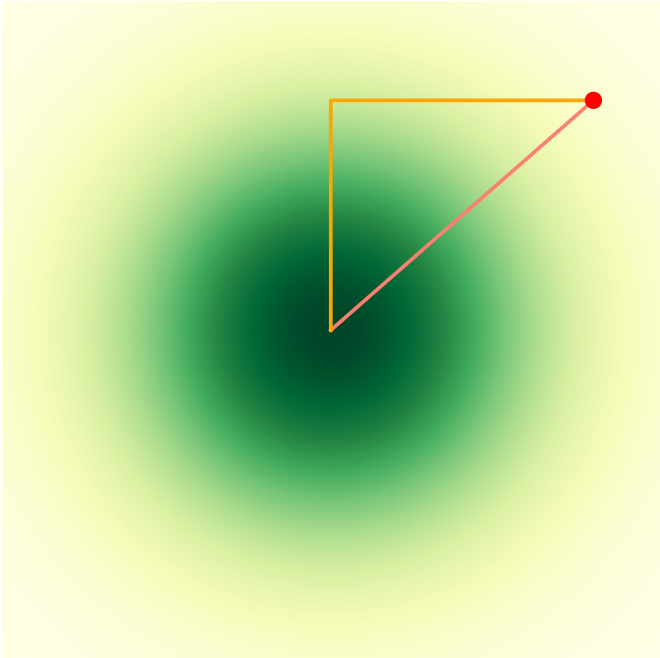

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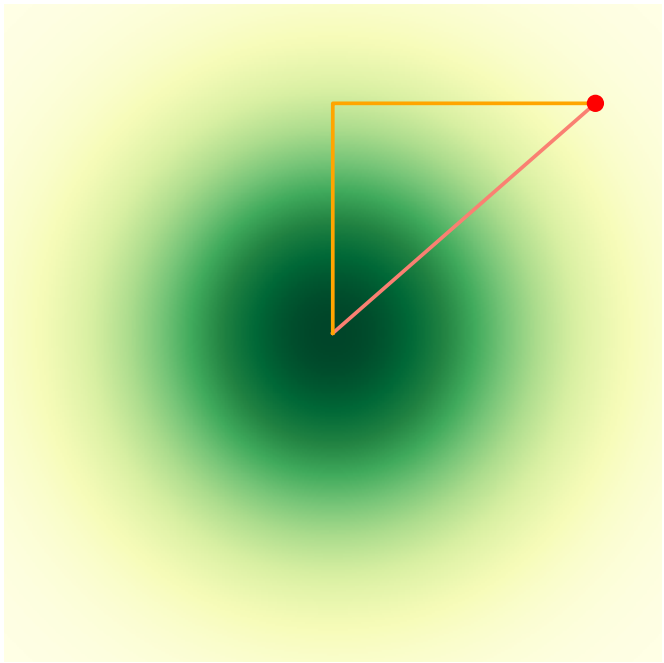

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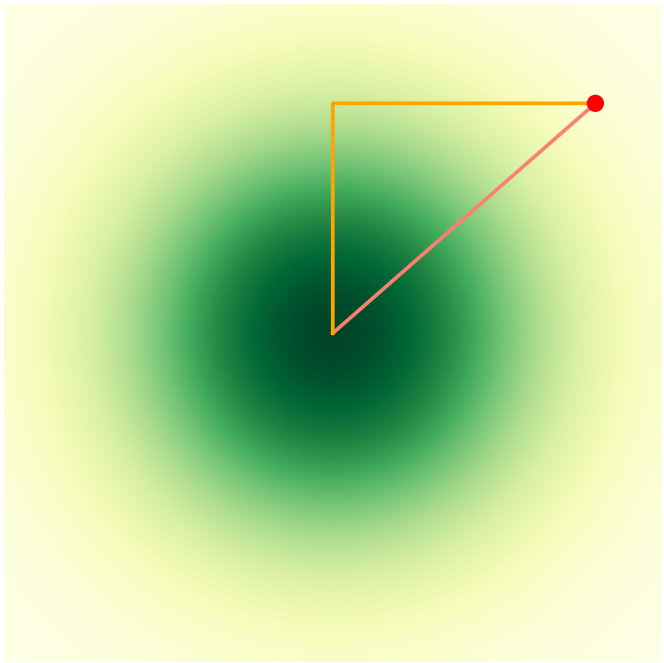

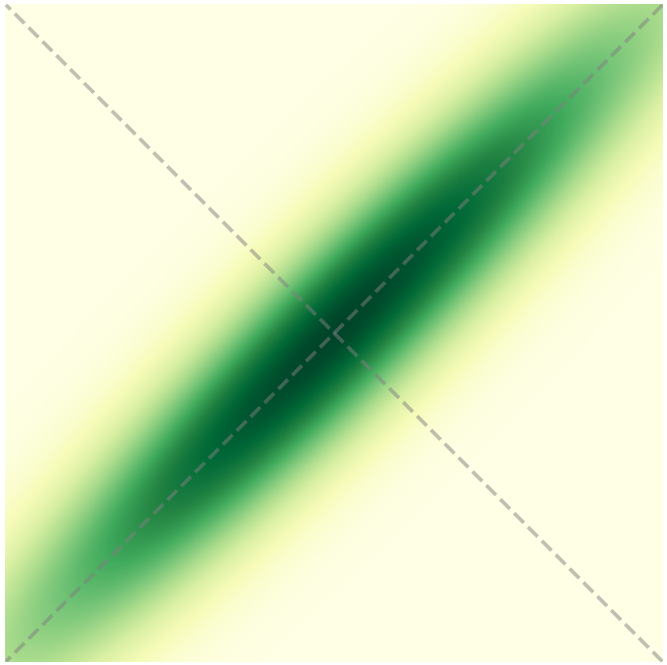

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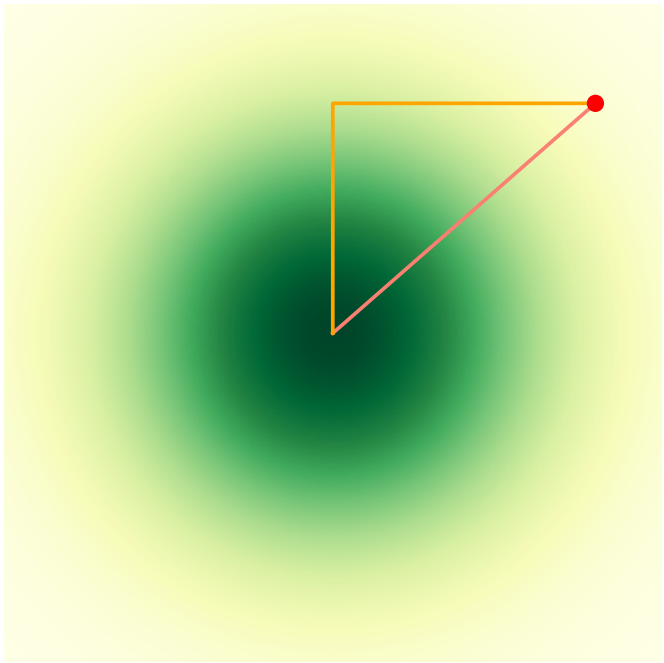

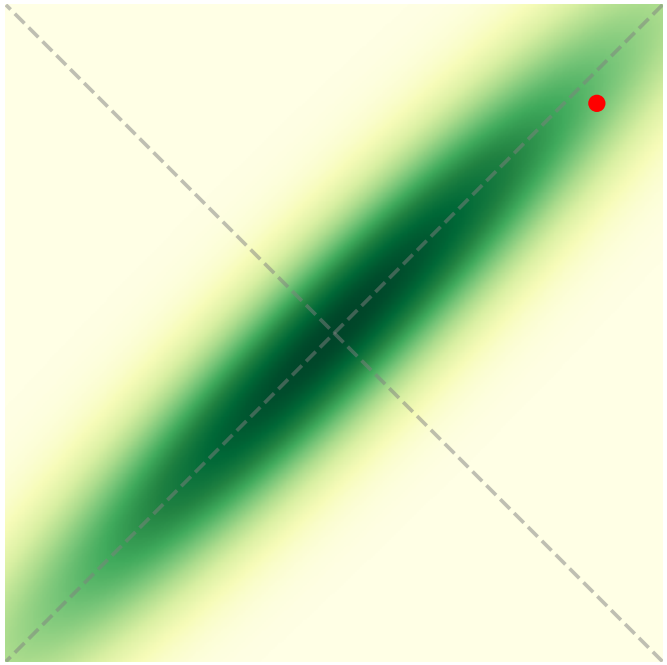

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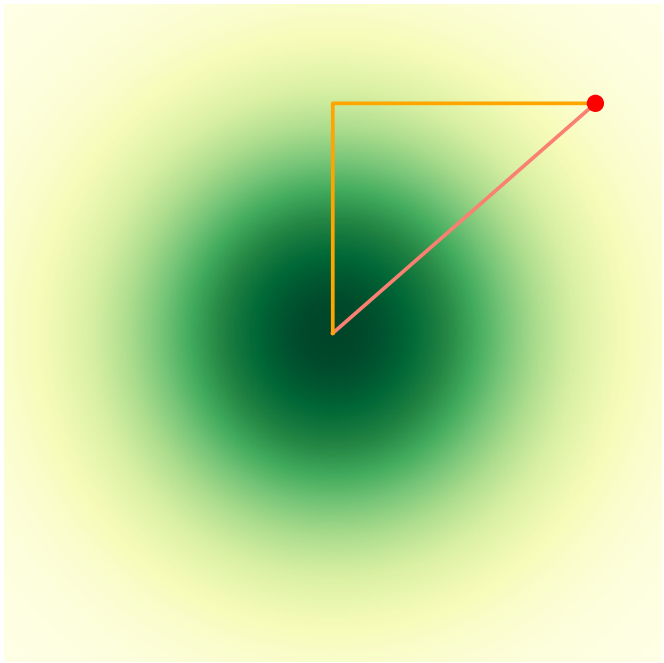

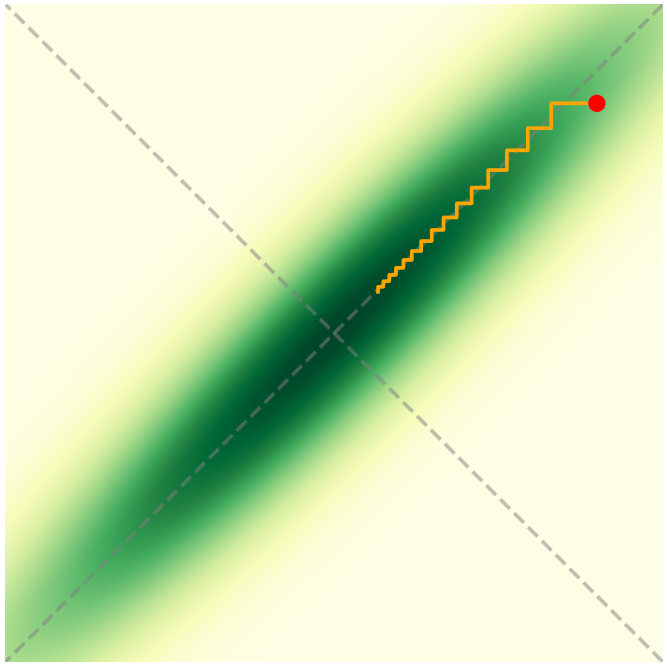

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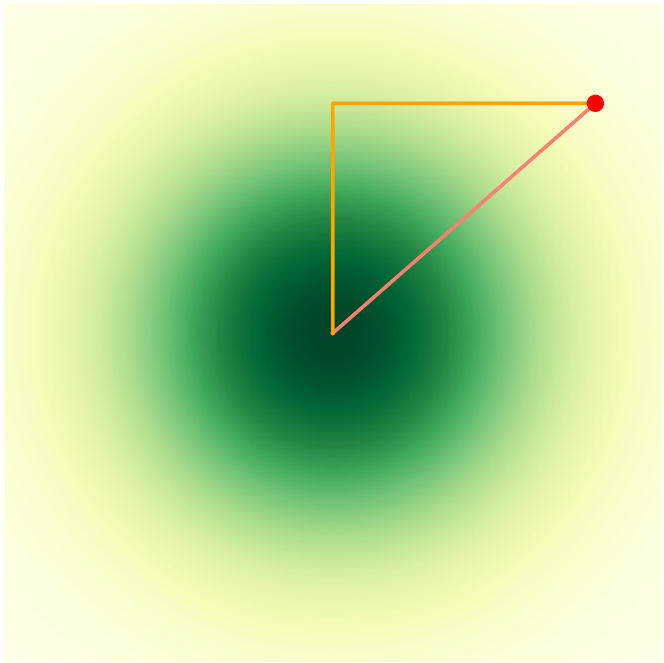

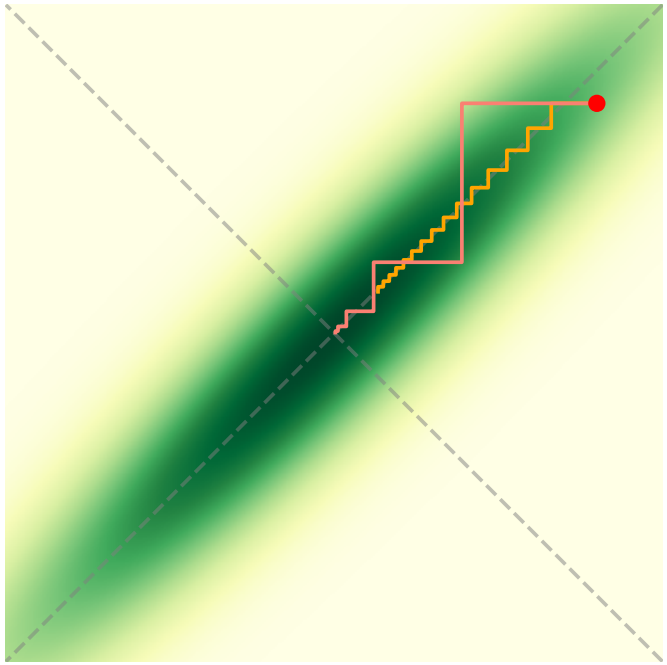

Polarization

Polarization: Polarizers

PBS Cubes

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- Based on coating
- Easy to use for both polarizations
- OK loss (few %)
- low-mid extinction
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- Broadband

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- Broadband

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Polarization: Waveplates

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Other WP type: Achromatic, "Magic"

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Normal incident

- π phase shift
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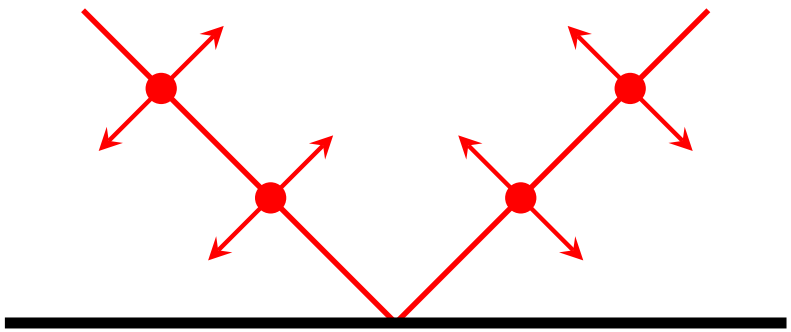

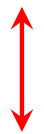

p-polarization

s-polarization

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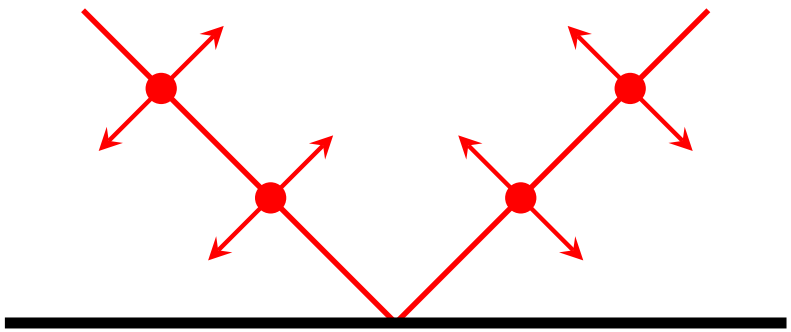
Simple surface

- (metal or dielectric)
- π phase shift
- Change relative amplitude



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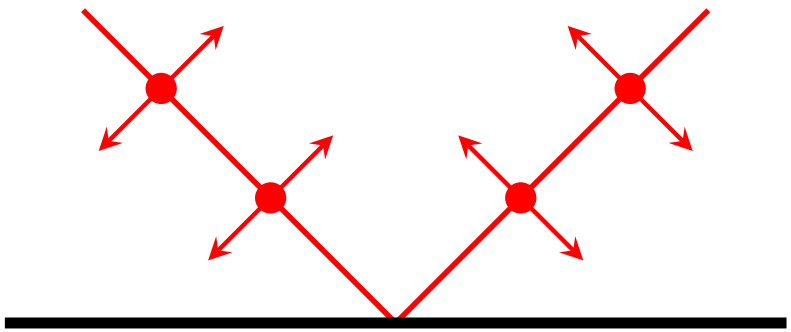

p-polarization

● *s*-polarization

Coating

- "Arbitrary" phase shift
- Change relative amplitude
- (dielectric mirror, dichroics)