Interference allows us to measure properties of light fields: amplitude, phase, frequency, coherence.

Instruments that use interference effects are called interferometers. There are several different types including Fabry-Perot, Michelson, Mach-Zehnder, Fizeau, Sagnac.

**Fabry-Perot**

```
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           \\ \|
            \ \|
```

**Michelson**

```
/ \                  /
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```

**Mach-Zehnder**

```
/ \                  /
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```

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Ph 325
2016.02.01
Fizeau

Surfaces are compared

\[
\begin{array}{c}
\text{known reference plate} \\
\text{to be tested}
\end{array}
\]

Sagnac

Out \rightarrow Out

Measures rotation

These devices range from very small to very large.

F-P resonators can be a few \( \mu \)m long.

Michelson interferometers can have arms that are several km long. (LIGO for detecting gravitational waves)
Interference

Two waves $\vec{E}_1, \vec{E}_2$

If $|\vec{E}_1| = |\vec{E}_2|$ and $\vec{E}_1 - \vec{E}_2 = 0$

then $\vec{E} = \vec{E}_1 + \vec{E}_2$ has minimum 0 maximum $2|\vec{E}_1|$

If $|\vec{E}_2| = \alpha |\vec{E}_1|, \alpha < 1$

then maximum field is $(1+\alpha)\vec{E}_1$
minimum field is $(1-\alpha)\vec{E}_1$

Intensity visibility is

$$V = \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}} = \frac{(1+\alpha)^2 - (1-\alpha)^2}{(1+\alpha)^2 + (1-\alpha)^2}$$

$$= \frac{4\alpha}{2 + 2\alpha^2} \approx 2 \frac{\alpha}{1 + \alpha^2} \quad (\alpha \ll 1)$$

So if $I_2 = \alpha^2 I_1$ Say $\alpha^2 = 0.01$, 1% of light in $I_2$
then $V \approx 2\alpha$ still get visibility of 20%.

Good for detection, bad for unwanted fringes.