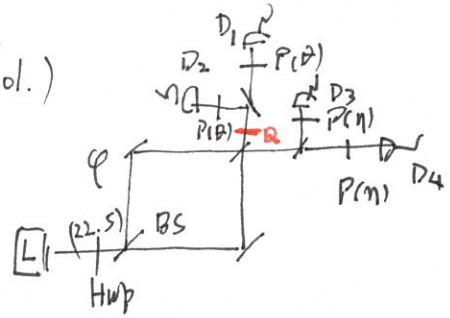
EC4301
Quiz#2
2023.11.15
Name:

In sensing and metrology, the resolution is governed by diffraction limit in the range of the wavelength of the probe field in an interferometer. Unlike sensitivity, this diffraction limit can be overcome by either interference of multi-waves or intensity products of the output fields manipulating the input probe field. For the super-resolution using ordered product of output fields, discuss a four-times enhanced resolution in a delayed-choice scheme compared to the double slit fringe. Hint: a modified interferometric scheme for a phase control, individual fringe shifts, and intensity-product fringe.

Sol.)



Q : Quarter-wave plate

$$\begin{pmatrix} \hat{V} \to i\hat{V} \\ \hat{H} \to \hat{H} \end{pmatrix}$$

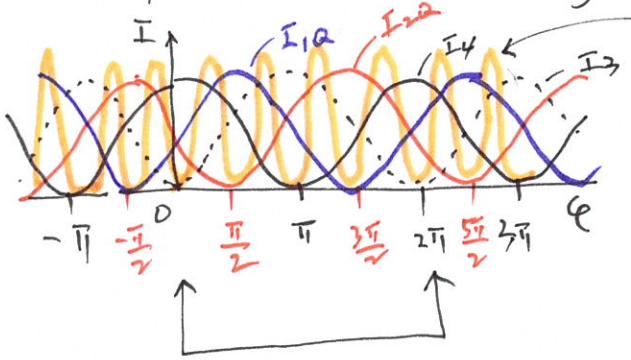
1. In a usual quantum eraser (See the lecture note on 10/30),

$$I_4 = 1 + \cos\varphi,$$
$$I_3 = 1 - \cos\varphi, \quad \text{where } \theta \mp \eta = 45^\circ.$$

2. In the same quantum eraser with a QWP (0° slow-axis horizontal)

$$I_{1Q} = 1 + \sin\varphi,$$
$$I_{2Q} = 1 - \sin\varphi.$$

3. Thus, the individual interference fringes are as follows.



$$C^{(4)}_{1Q2Q34} = I_{1Q} \cdot I_{2Q} \cdot I_3 \cdot I_4$$

∴ In the 2π range, $C^{(4)}_{1Q2Q34}$ fringes are four times in numbers compared to the I_j.

→ 4-times enhanced phase resolution.