Pre-selected state

$$|\psi\rangle = a_1 |1\rangle + e^{i\chi} a_2 |2\rangle$$

Post-selected state

$$|+\rangle = \frac{|1\rangle + |2\rangle}{\sqrt{2}}$$

$$|-\rangle = \frac{|1\rangle - |2\rangle}{\sqrt{2}}$$

Path operator

$$\hat{\Pi}_i = |i\rangle\langle i| \,, \;\; i = 1,2$$

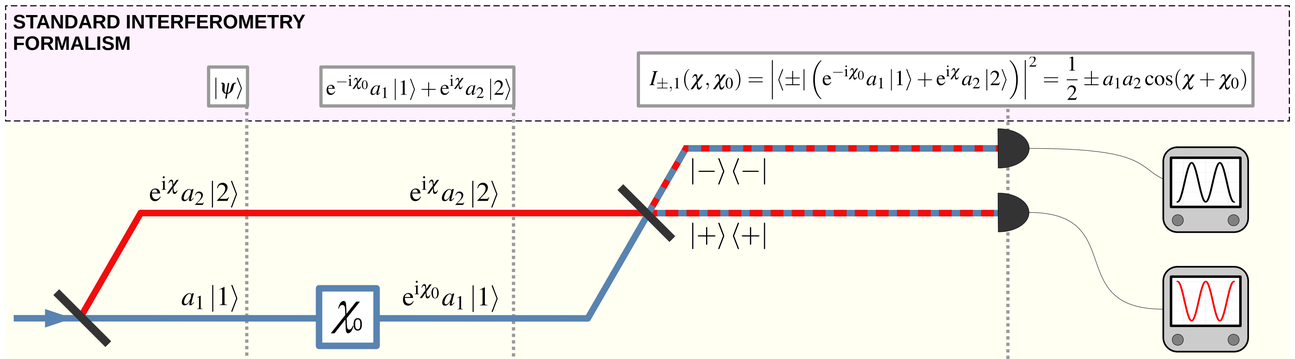
Path weak value

$$w_{\pm,i} = \frac{\langle \pm|\hat{\Pi}_i|\psi\rangle}{\langle \pm|\psi\rangle} = w^{\Re}_{\pm,i} + i\, w^{\Im}_{\pm,i}$$

Real part — Imaginary part

STANDARD INTERFEROMETRY FORMALISM

$$I_{\pm,1}(\chi,\chi_0) = \left|\langle \pm| \left(e^{-i\chi_0} a_1 |1\rangle + e^{i\chi} a_2 |2\rangle \right)\right|^2 = \frac{1}{2} \pm a_1 a_2 \cos(\chi + \chi_0)$$



WEAK VALUE PICTURE

$|\psi\rangle$

Pre-selection:
The path amplitudes a_1 and a_2 and the phase χ define the pre-selected state.

$e^{-i\chi_0 \hat{\Pi}_1} |\psi\rangle$

Interaction:
The phase χ_0 is coupled to the path observable.

$$I_{\pm}(\chi,\chi_0) = \left|\langle \pm| e^{-i\chi_0 \hat{\Pi}_1} |\psi\rangle\right|^2 = \left|\langle \pm| \left[1 + \left(e^{-i\chi_0} - 1\right)\hat{\Pi}_1\right] |\psi\rangle\right|^2$$
$$= |\langle \pm|\psi\rangle|^2 \left[1 + 2\left(|w_{\pm,1}|^2 - w^{\Re}_{\pm,1}\right)(1 - \cos\chi_0) + 2 w^{\Im}_{\pm,1} \sin\chi_0\right]$$

Post-selection and recorded intensity modulations for different values of χ:
The state is post-selected and the interferograms are recorded.
The recorded intensity contains the path weak value information!