ARISTOTELIAN EQUATIONS OF HOLOGRAPHY

the hologram output includes terms with the following phases:

$$\varphi_{out}(x,y) = \varphi_{obj}(x,y) - \varphi_{ref}(x,y) + \varphi_{ill}(x,y) \quad \text{, and (direct image)}$$
$$-\varphi_{obj}(x,y) + \varphi_{ref}(x,y) + \varphi_{ill}(x,y) \quad \text{, and (conjugate image)}$$
$$\varphi_{ill}(x,y) \quad \text{(zero-order image)}$$

or, in general form:

$$\phi_{out}(x,y) = m\,(\phi_{obj}(x,y) - \phi_{ref}(x,y)) + \phi_{ill}(x,y), \quad m = 0, \pm 1, \pm 2, \ldots$$

it follows that, for the diffraction angle:

$$\sin\theta_{out} = m\frac{\lambda 2}{\lambda 1}(\sin\theta_{obj} - \sin\theta_{ref}) + \sin\theta_{ill}$$

and, for the y-focus distance (horizontal focus):

$$\frac{1}{R_{out,h}} = m\frac{\lambda 2}{\lambda 1}\left(\frac{1}{R_{obj}} - \frac{1}{R_{ref}}\right) + \frac{1}{R_{ill}}$$

and for the x-focus distance (off-axis, when astigmatism arises):

$$\frac{\cos^2\theta_{out}}{R_{out,v}} = m\frac{\lambda 2}{\lambda 1}\left(\frac{\cos^2\theta_{obj}}{R_{obj}} + \frac{\cos^2\theta_{ref}}{R_{ref}}\right) + \frac{\cos^2\theta_{ill}}{R_{ill}}$$