29 JANUARY 2008

(1)

POLARIZED LIGHT

JONES VECTORS $\longrightarrow$ COHERENCY MATRIX

$$J = \begin{bmatrix} \langle E_x E_x^* \rangle & \langle E_x E_y^* \rangle \\ \langle E_x^* E_y \rangle & \langle E_y E_y^* \rangle \end{bmatrix} = \begin{bmatrix} \langle |E_x|^2 \rangle & \langle E_x E_y^* \rangle \\ \langle E_x^* E_y \rangle & \langle |E_y|^2 \rangle \end{bmatrix}$$

IF COMPLETELY POLARIZED ALONG x

$$J[\text{LP ALONG } x] = \begin{bmatrix} I_0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\det J[\text{LP } x] = 0$$

y

$$J[\text{LP ALONG } y] = \begin{bmatrix} 0 & 0 \\ 0 & I_0 \end{bmatrix}$$

$$\left\langle \begin{bmatrix} E_0 \cos\theta \\ E \sin\theta \end{bmatrix} \begin{bmatrix} E_0^* \cos\theta & E_0^* \sin\theta \end{bmatrix} \right\rangle = \cancel{\langle |E_0|^2 \cos^2\theta \rangle \quad \langle E_0}$$

2/29/10 – ②

$$J(\text{LP along } \theta) = \begin{bmatrix} \langle |E_0|^2 \rangle \cos^2\theta & \langle |E_0|^2 \rangle \sin\theta \cos\theta \\ \langle |E_0|^2 \rangle \sin\theta \cos\theta & \langle |E_0|^2 \rangle \sin^2\theta \end{bmatrix}$$

$$= I_0 \begin{bmatrix} \cos^2\theta & \cos\theta \sin\theta \\ \cos\theta \sin\theta & \sin^2\theta \end{bmatrix}$$

$$\det J(\text{LP} @ \theta) = \cos^2\theta \sin^2\theta - (\cos\theta \sin\theta)^2 = 0$$

$$\underset{\sim}{J} = \begin{bmatrix} \langle E_x E_x^* \rangle & \langle E_x E_y^* \rangle \\ \langle E_x^* E_y \rangle & \langle E_y E_y^* \rangle \end{bmatrix} = \begin{bmatrix} \langle |E_x|^2 \rangle & \langle E_x E_y^* \rangle \\ \langle E_x^* E_y \rangle & \langle |E_y|^2 \rangle \end{bmatrix}$$

$$\boxed{\underset{\sim}{J}\, \underset{\sim}{x} = \lambda\, \underset{\sim}{x}\, \underset{\sim}{I}}$$

$$\det \left[\underset{\sim}{J} - \lambda \underset{\sim}{I} \right] = 0$$

$$\det \begin{bmatrix} J_{xx} - \lambda & J_{xy} \\ J_{yx} & J_{yy} - \lambda \end{bmatrix} = 0$$

$$(J_{xx} - \lambda)(J_{yy} - \lambda) - J_{xy} J_{yx} = 0$$

$$J_{xx} J_{yy} - \lambda (J_{xx} + J_{yy}) + \lambda^2 - J_{xy} J_{yx} = 0$$

$$\lambda^2 - \lambda \underbrace{(J_{xx} + J_{yy})}_{\text{TRACE } \underset{\sim}{J}} + \underbrace{(J_{xx} J_{yy} - J_{xy} J_{yx})}_{\det \underset{\sim}{J}} = 0$$

$$a = 1 \qquad b = -\mathrm{Tr}\, \underset{\sim}{J} \qquad c = \det \underset{\sim}{J}$$

$$\lambda = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{\mathrm{Tr}\, J}{2} \pm \frac{\sqrt{(\mathrm{Tr}(J))^2 - 4 \det J}}{2}$$

$$= \left(\frac{\mathrm{Tr}\, J}{2}\right)\left(1 \pm \sqrt{1 - \frac{4 \det J}{\mathrm{Tr}(J)}}\right)$$

$$\underset{\sim}{J} \longrightarrow \underset{\sim}{\Omega} = \begin{bmatrix} \lambda_+ & 0 \\ 0 & \lambda_- \end{bmatrix}$$

$$\lambda_+ = \frac{Tr\, J}{2}\left[1 + \sqrt{\frac{1 - 4 \det \underset{\sim}{J}}{Tr\, \underset{\sim}{J}}}\right]$$

$$\lambda_- = \frac{Tr\, J}{2}\left[1 - \sqrt{\frac{1 - 4 \det \underset{\sim}{J}}{Tr\, \underset{\sim}{J}}}\right]$$

$$\det \underset{\sim}{\Omega} = \lambda_+ \cdot \lambda_- - 0 \cdot 0 = \lambda_+ \lambda_-$$

$$= \det \underset{\sim}{J}$$

1/29/10 – ⓪

$$\underset{\sim}{A}\,\underset{\sim}{x} = \underset{\sim}{b}$$

MATRIX

$$\underset{\sim}{\mathcal{L}}\,\underset{\sim}{\mathcal{E}} = \underset{\sim}{\mathcal{E}}'$$

JONES VECTORS

$$\underset{\sim}{\mathcal{E}} + \underset{\sim}{\mathcal{E}}^* \rightarrow \underset{\sim}{J}$$

$$\underset{\sim}{A}$$

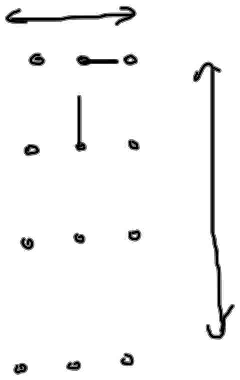
$$\begin{bmatrix} \langle |E_x|^2\rangle & \langle E_x E_y^*\rangle \\ \langle E_x^* E_y\rangle & \langle |E_y|^2\rangle \end{bmatrix} \underset{\sim}{J} \longrightarrow \underset{\sim}{\Omega} \begin{bmatrix} \lambda_+ & 0 \\ 0 & \lambda_- \end{bmatrix}$$

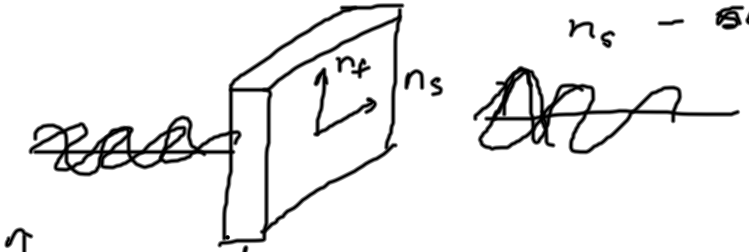
UNPOLARIZED

$$\begin{bmatrix} (\lambda_+ - \lambda_-) & 0 \\ 0 & 0 \end{bmatrix} + \begin{bmatrix} \lambda_- & 0 \\ 0 & \lambda_- \end{bmatrix}$$

POLARIZED UNPOL

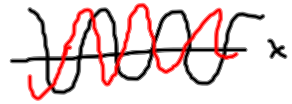
DOUBLE REFRACTION

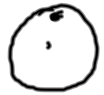




n

n_s – SLOW $\Rightarrow$ $n_s > n_f$





ω_0

OPTICAL THICKNESS

$$\frac{2\pi d_0}{\lambda_0/n} = \frac{2\pi\,\underbrace{(n\,d_0)}}{\lambda_0}$$

$$\Delta\phi_s = \frac{2\pi d_0 n_s}{\lambda_0}$$

$$\Delta\phi_f = \frac{2\pi d_0 n_f}{\lambda_0}$$

$$\Delta\phi = \frac{2\pi d_0}{\lambda_0}(n_s - n_f)$$

$$\Delta\phi = \frac{\pi}{2} \Rightarrow \frac{2\pi d_0}{\lambda_0}\, n_s - n_f \Rightarrow d_0 = \frac{\lambda_0}{4(n_s - n_f)}$$

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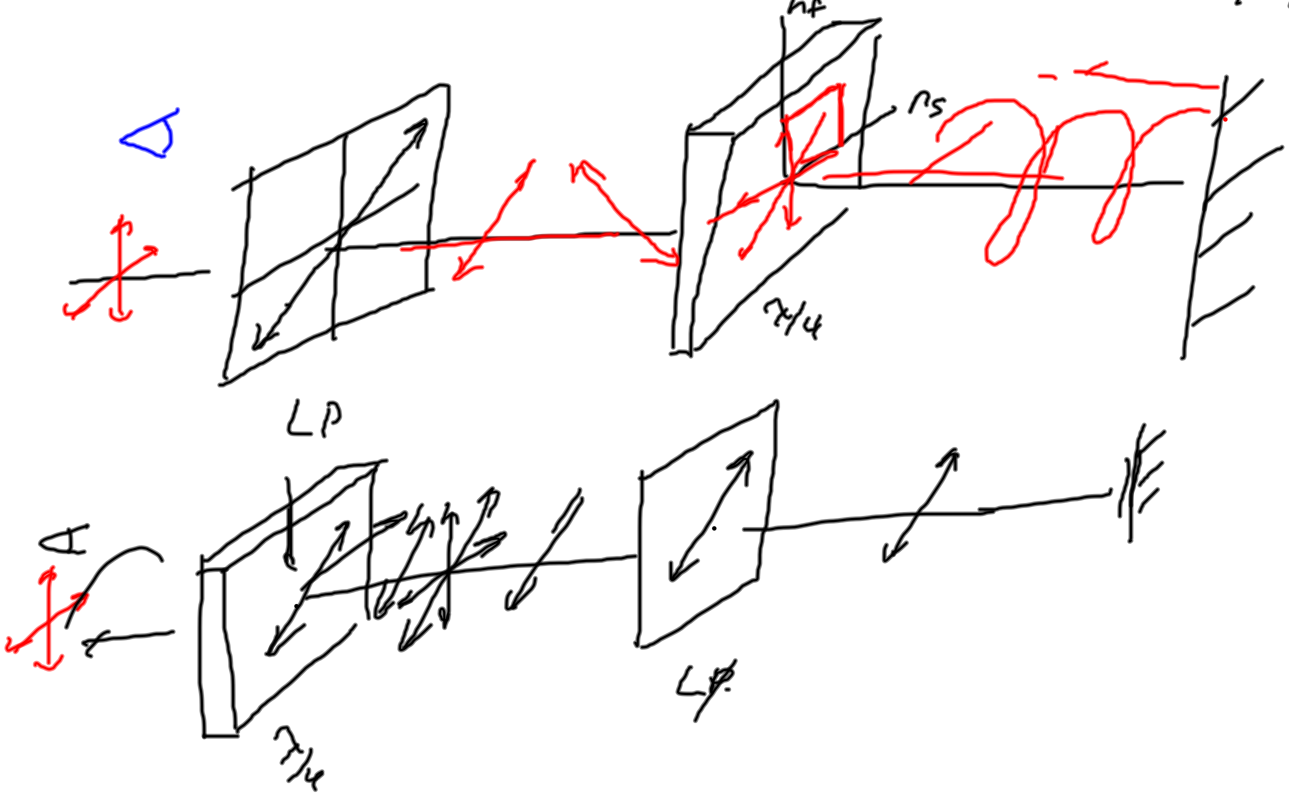


OPTICAL INTERFERENCE & COHERENCE

DIFFRACTION ≡ INTERFERENCE (FEW SOURCES)

MANY IRRADIATING POINT SOURCES

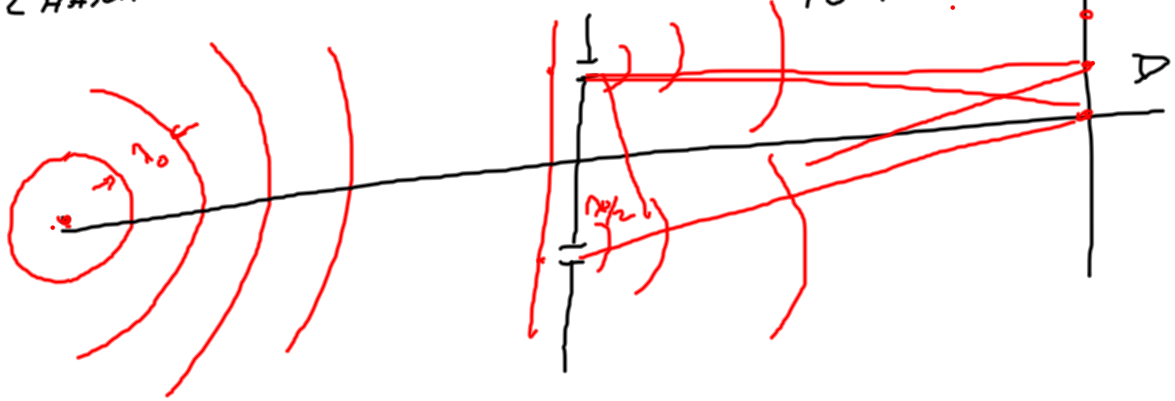
FRESNEL — PARABOLOIDS — LSI

FRAUNHOFER — PLANE — LSV — FOURIER TRANSFORM

ANALYSIS OF SOURCE, RATHER THAN (IMAGING) OPTICAL SYSTEM

CHARACTERISTICS — COHERENCE — SPATIAL — TRANSVERSE

TEMPORAL — LONGITUDINAL

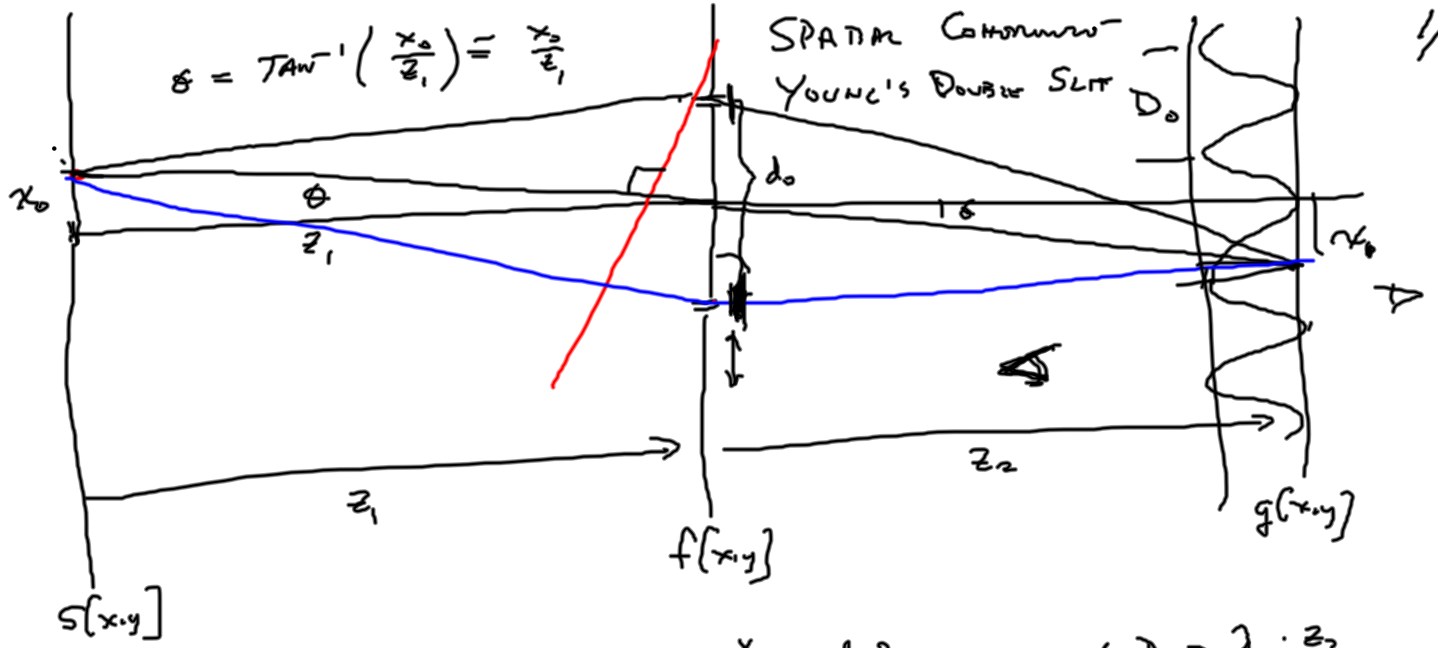


1/29-10

SPATIAL COHERENCE

YOUNG'S DOUBLE SLIT

$\theta = \tan^{-1}\left(\frac{x_0}{z_1}\right) \approx \frac{x_0}{z_1}$

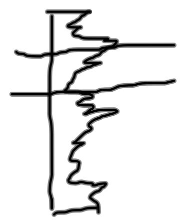


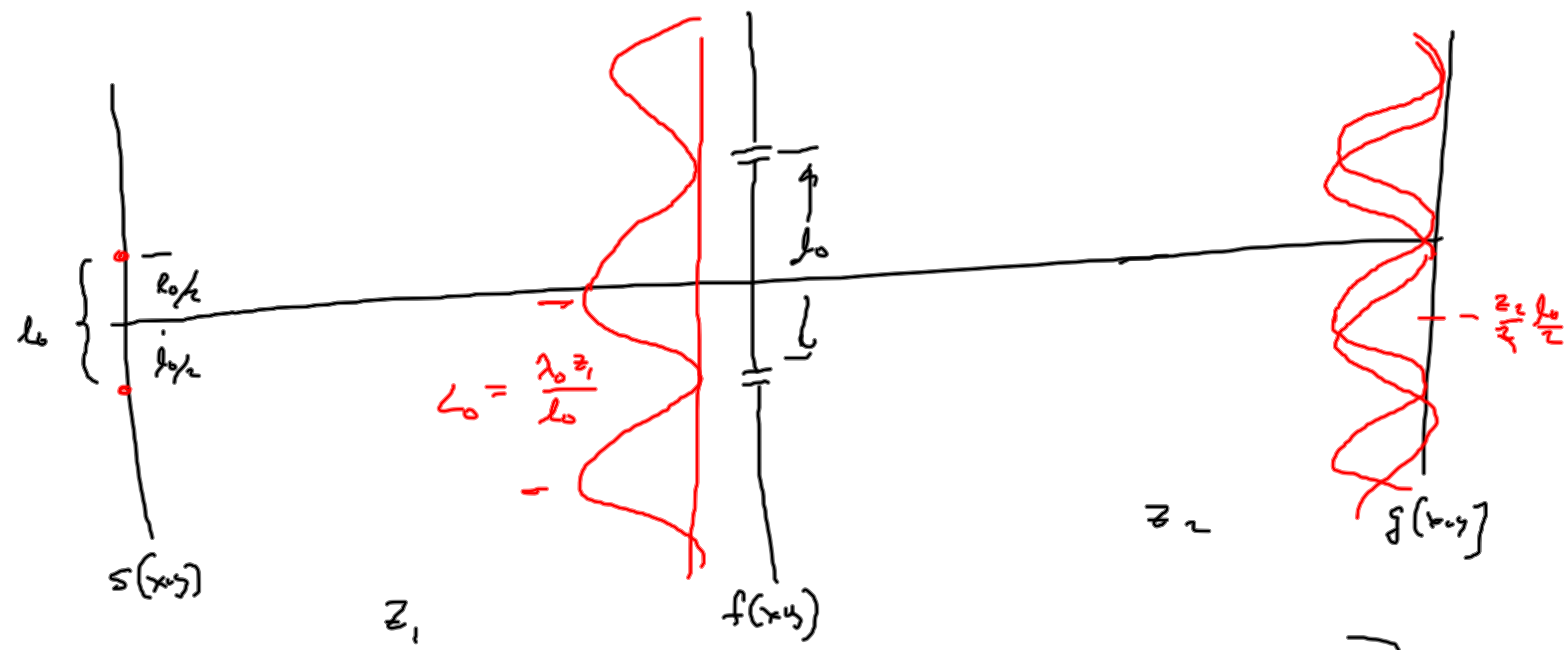
$d_0 D_0 = \lambda_0 \cdot z_2$

$\delta[x-x_0]\,\delta[x] \xrightarrow{\mathcal{F}_2} e^{-2\pi i \frac{x}{\left(\frac{\lambda_0 z_1}{x_0}\right)}}\, 1[y]$

CENTER OF COSINE FRINGES IS $x_1 = -\frac{z_2}{z_1} x_0$

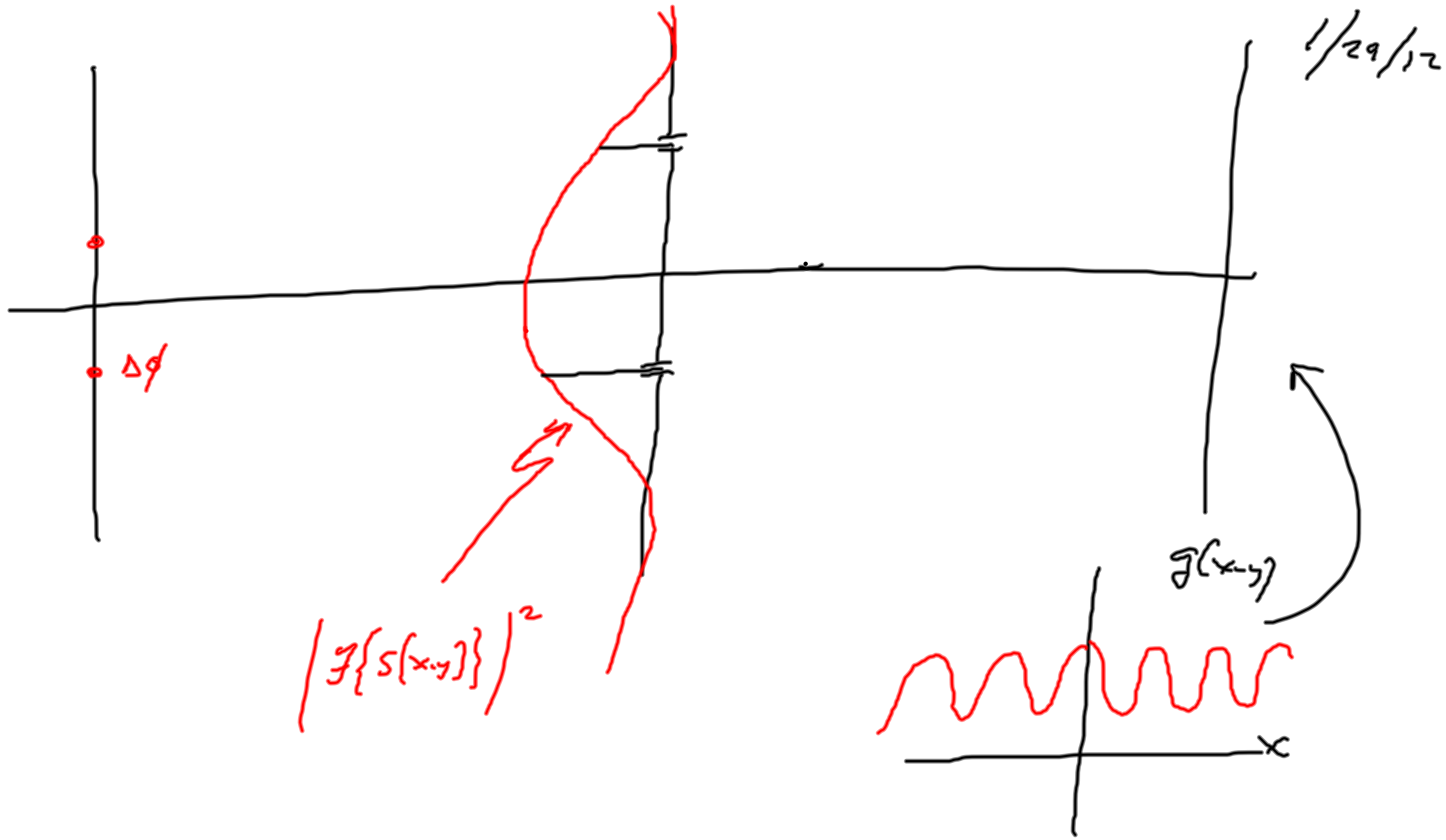
$f[x,y] = \left(\delta\left(x+\frac{d_0}{2}\right) + \delta\left(x-\frac{d_0}{2}\right)\right)\delta(y)$





(1) VARY PHASE OF TWO SOURCES (OR TWO APERTURES)
THE COSINE FRINGES MOVE TRANSVERSELY

(2) VARY AMPLITUDE OF SOURCES, MODULATION OF ~~THE~~ IRRADIANCE
PATTERN CHANGE


1/29/12
$\Delta\phi$
$|\mathcal{F}\{S(x,y)\}|^2$
$g(x,y)$
x