



IMEDEA



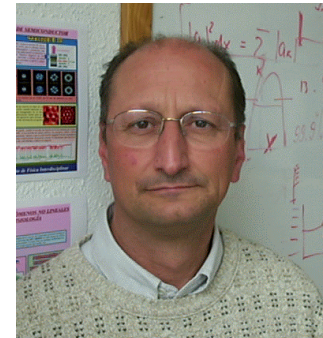
# All Optical Processing of images in intracavity type II SHG



Pierre Scotto



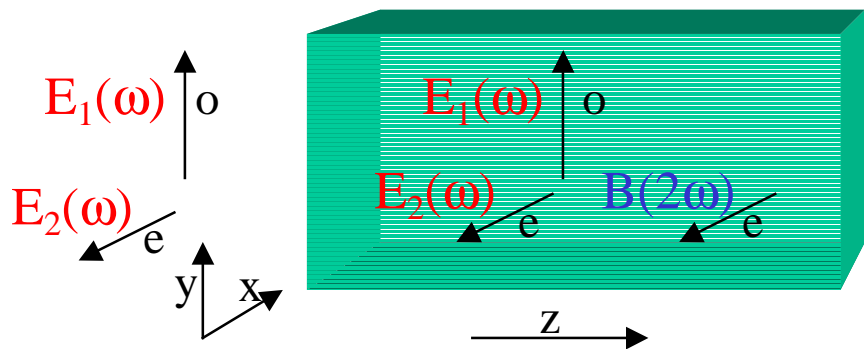
Pere Colet



Maxi San Miguel

*Acknowledgment: Marco Santagiustina, Univ. Padova*

# Optical Switching based on polarization control in type II SHG



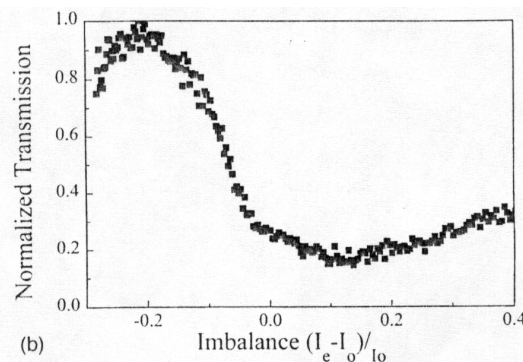
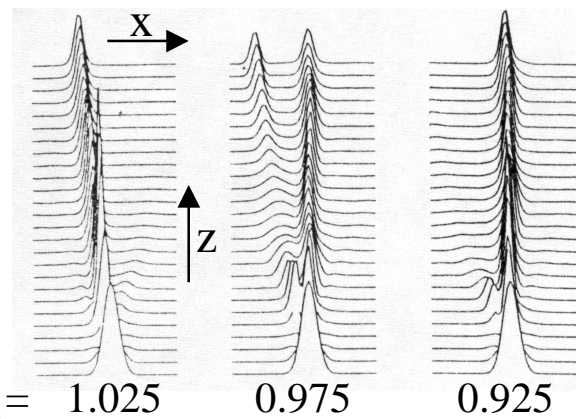
$$\partial_z E_1 + \frac{1}{2ik_1} \nabla_{\perp}^2 E_1 = i\Gamma E_2^* B e^{i\Delta kz}$$

$$\partial_z E_2 - \rho_2 \partial_x E_2 + \frac{1}{2ik_2} \nabla_{\perp}^2 E_2 = i\Gamma E_1^* B e^{i\Delta kz}$$

$$\partial_z B - \rho_B \partial_x B + \frac{1}{2ik_B} \nabla_{\perp}^2 B = iE_1 E_2 e^{i\Delta kz}$$

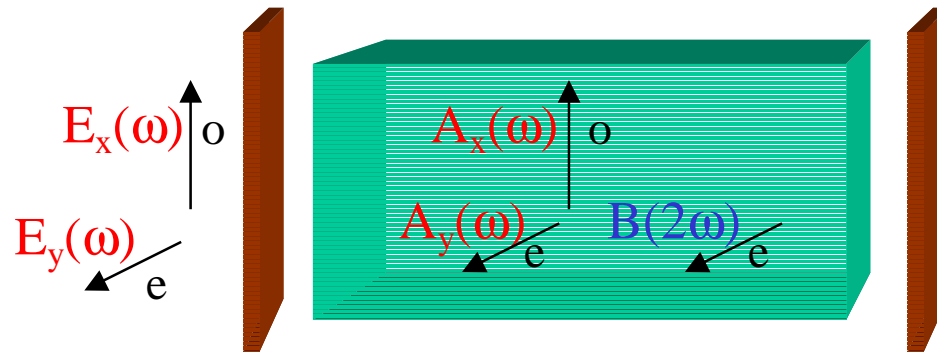
$I_1, I_2$ , above threshold for solitary wave formation.

Changing the ratio  $I_2/I_1$  it is possible to control the propagation direction of the solitary wave.



Torruellas, Assanto, Lawrence, Fuerst, Stegeman,  
App. Phys. Lett. 68, 1449 (96)

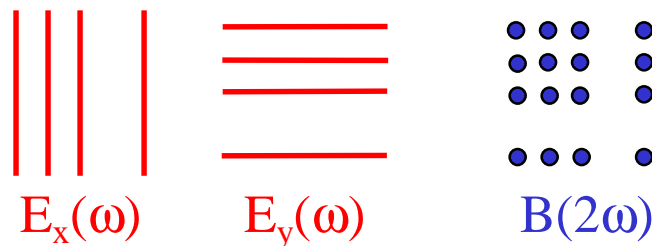
# Image processing in intracavity SHG



$$\begin{aligned} \partial_t B &= (-\gamma_0 + i\Delta_0)B + ia_0 \nabla_{\perp}^2 B + iA_x A_y \\ \partial_t A_x &= (-\gamma_x + i\Delta_x)A_x + ia_x \nabla_{\perp}^2 A_x + iA_y^* B + E_x \\ \partial_t A_y &= (-\gamma_y + i\Delta_y)A_y + ia_y \nabla_{\perp}^2 A_y + iA_x^* B + E_y \end{aligned}$$

**Change of polarization and frequency:**  $E_x$ : Image  $E_y$ : Plane wave }  $\Rightarrow$  image in  $B(2\omega)$

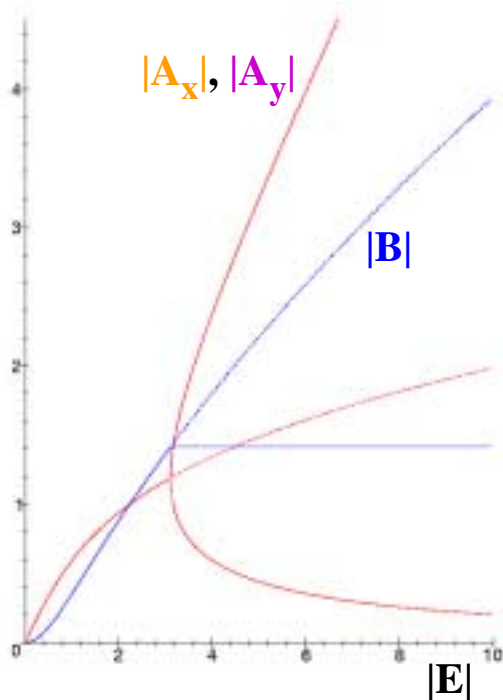
**“AND” logic:**  $E_x, E_y$ : different images  $\Rightarrow$  “AND” image in  $B(2\omega)$



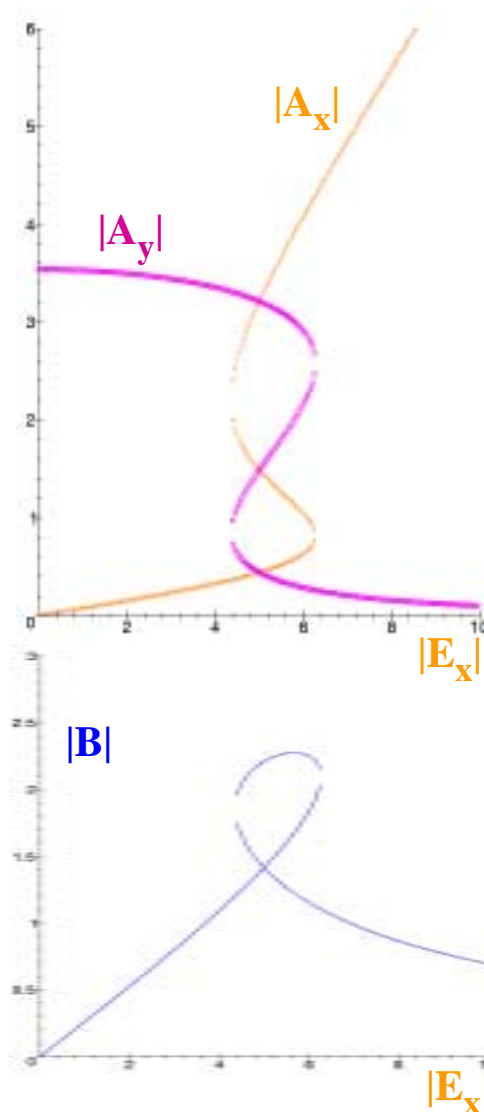
# Homogeneous solutions for plane wave pump

## Symmetric pump

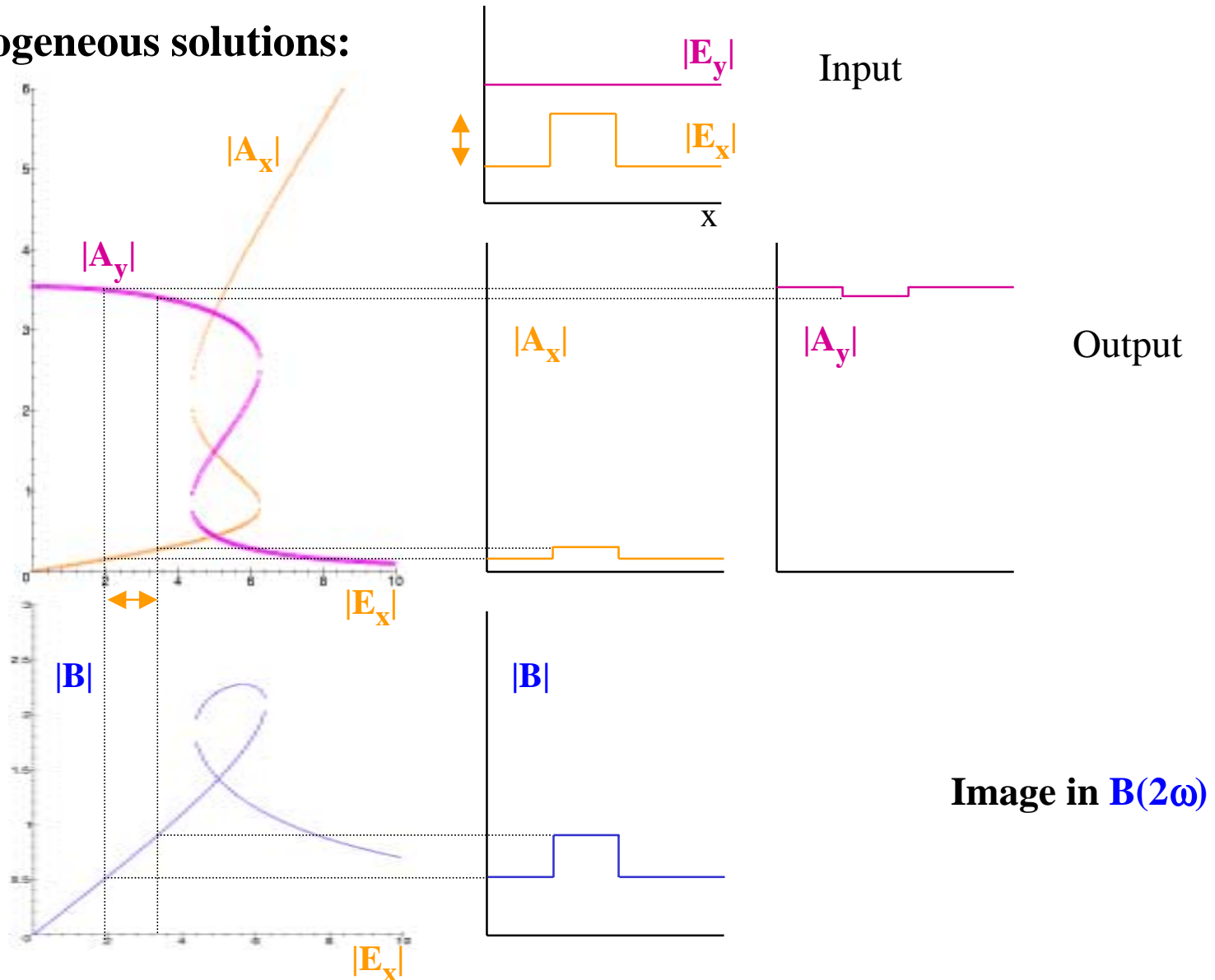
$$|E_x| = |E_y| = |E|$$

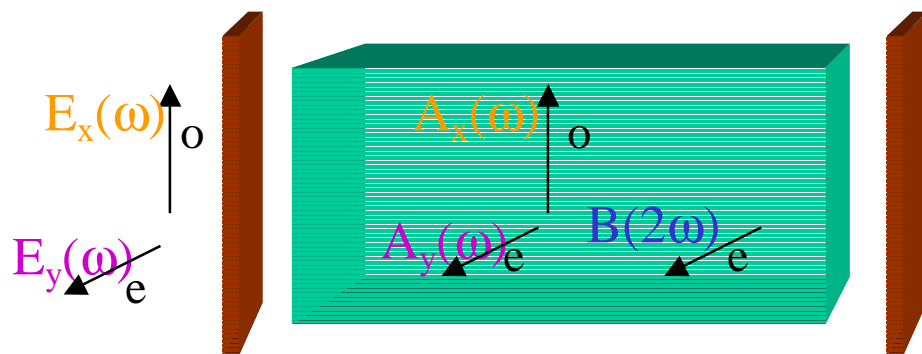


## Asymmetric pump $|E_y|=5$

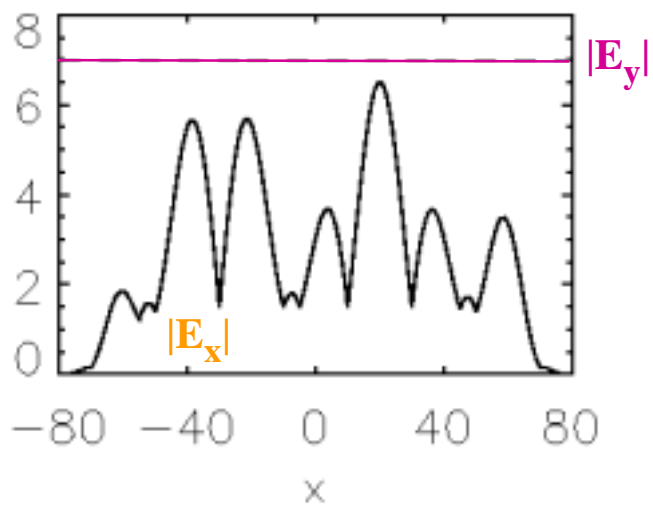


## Homogeneous solutions:

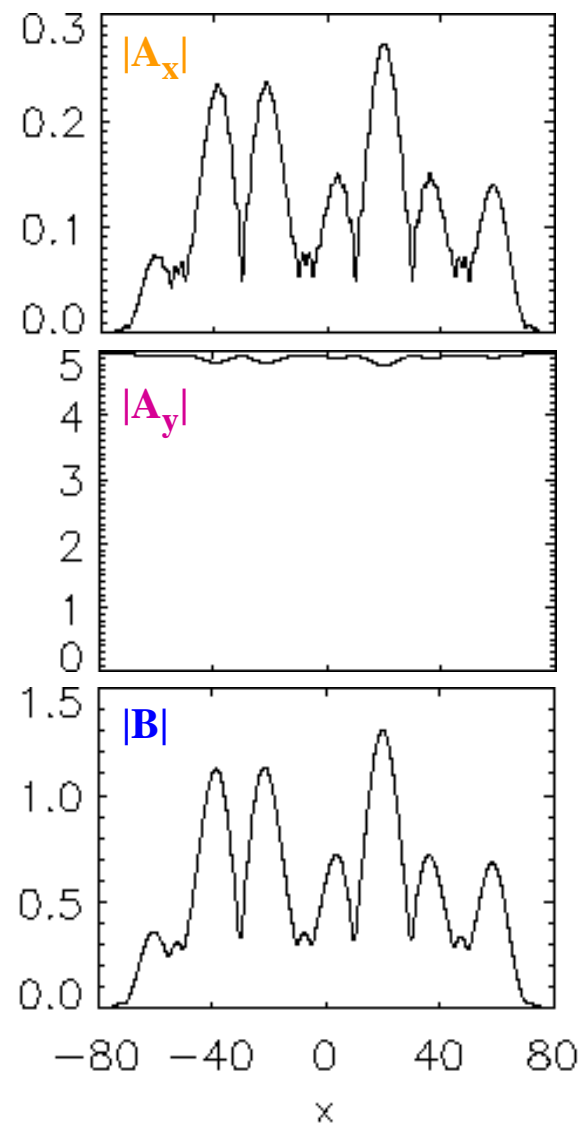


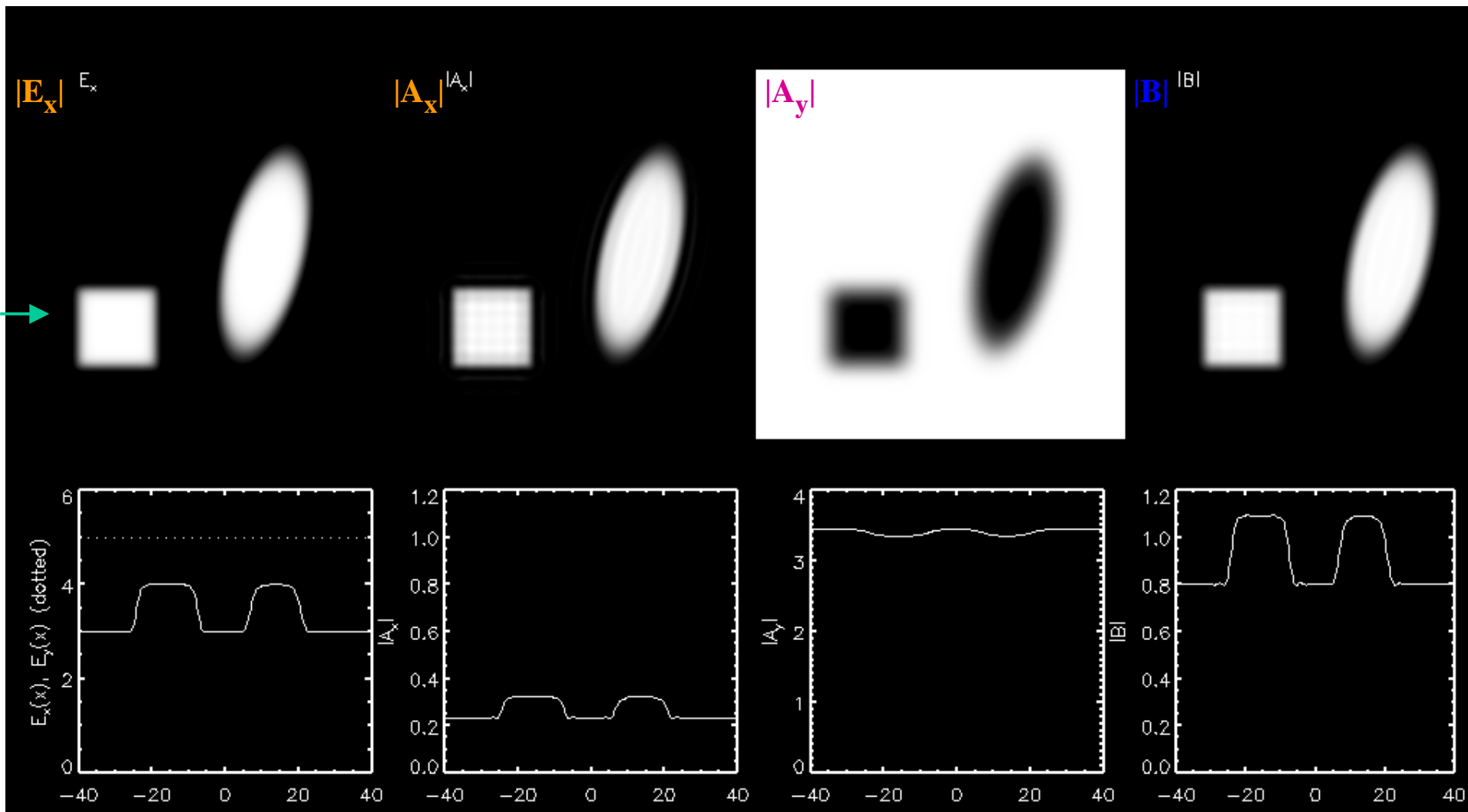


Input: 1d image  $E_x(x)$

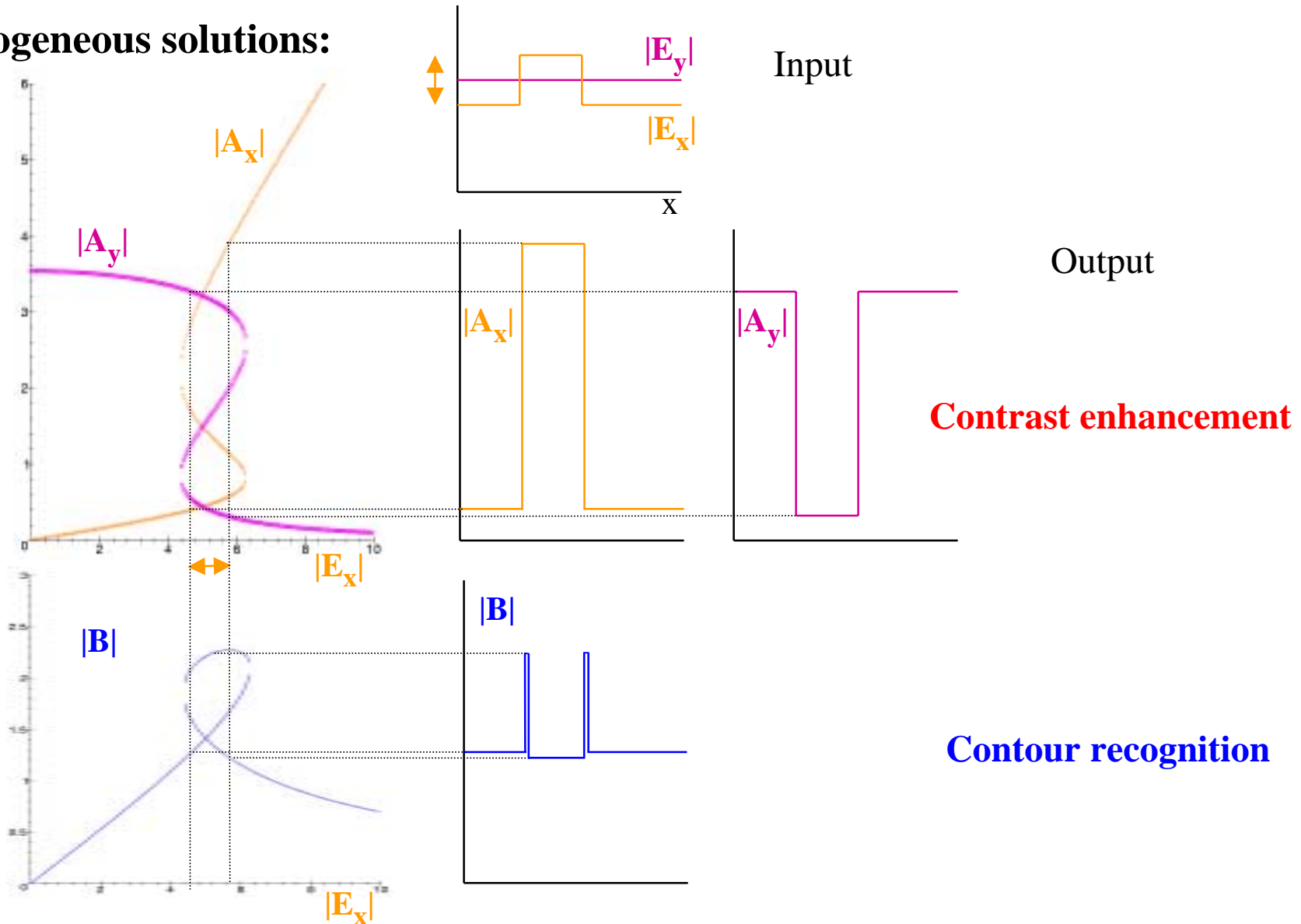


Output



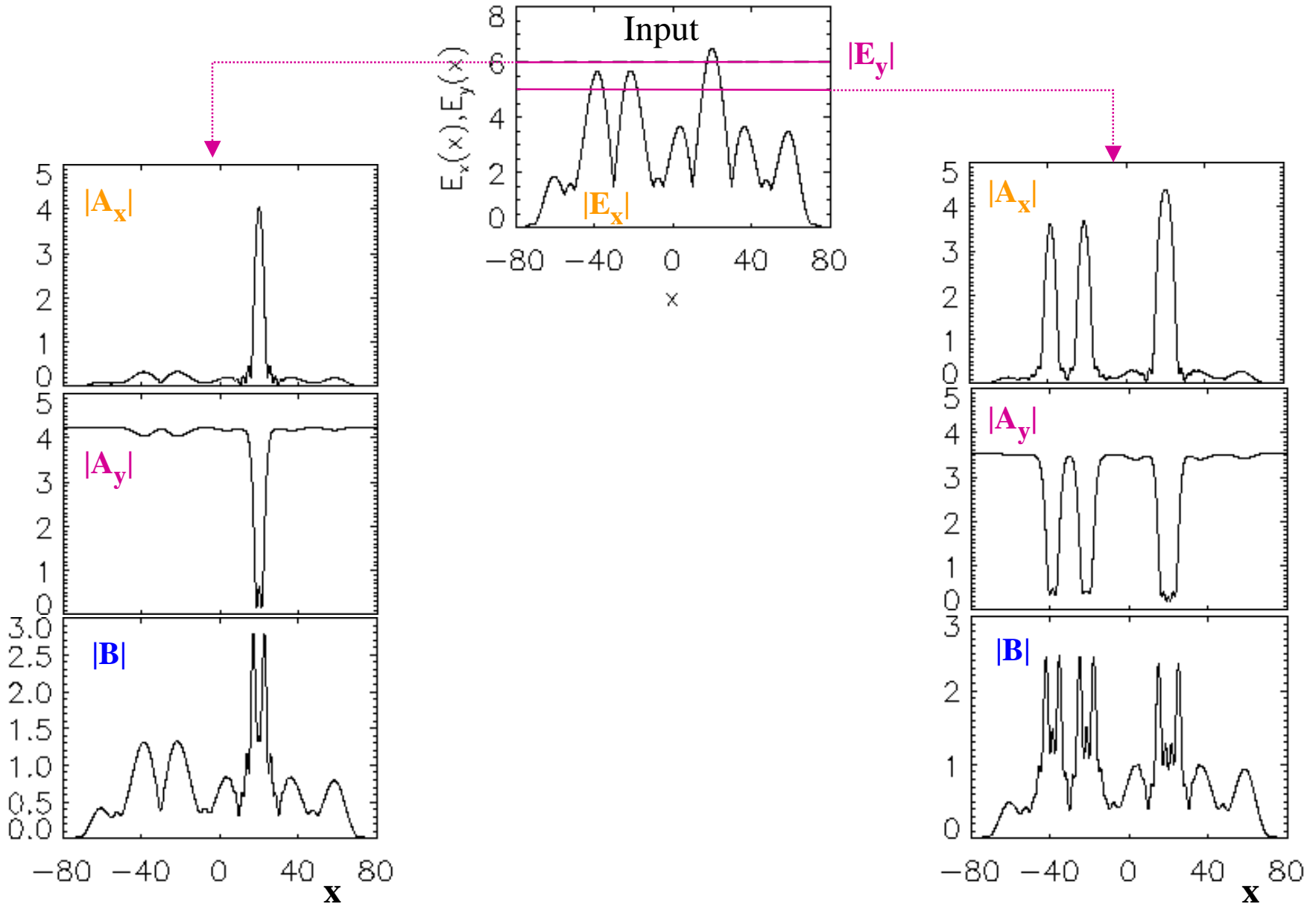


## Homogeneous solutions:

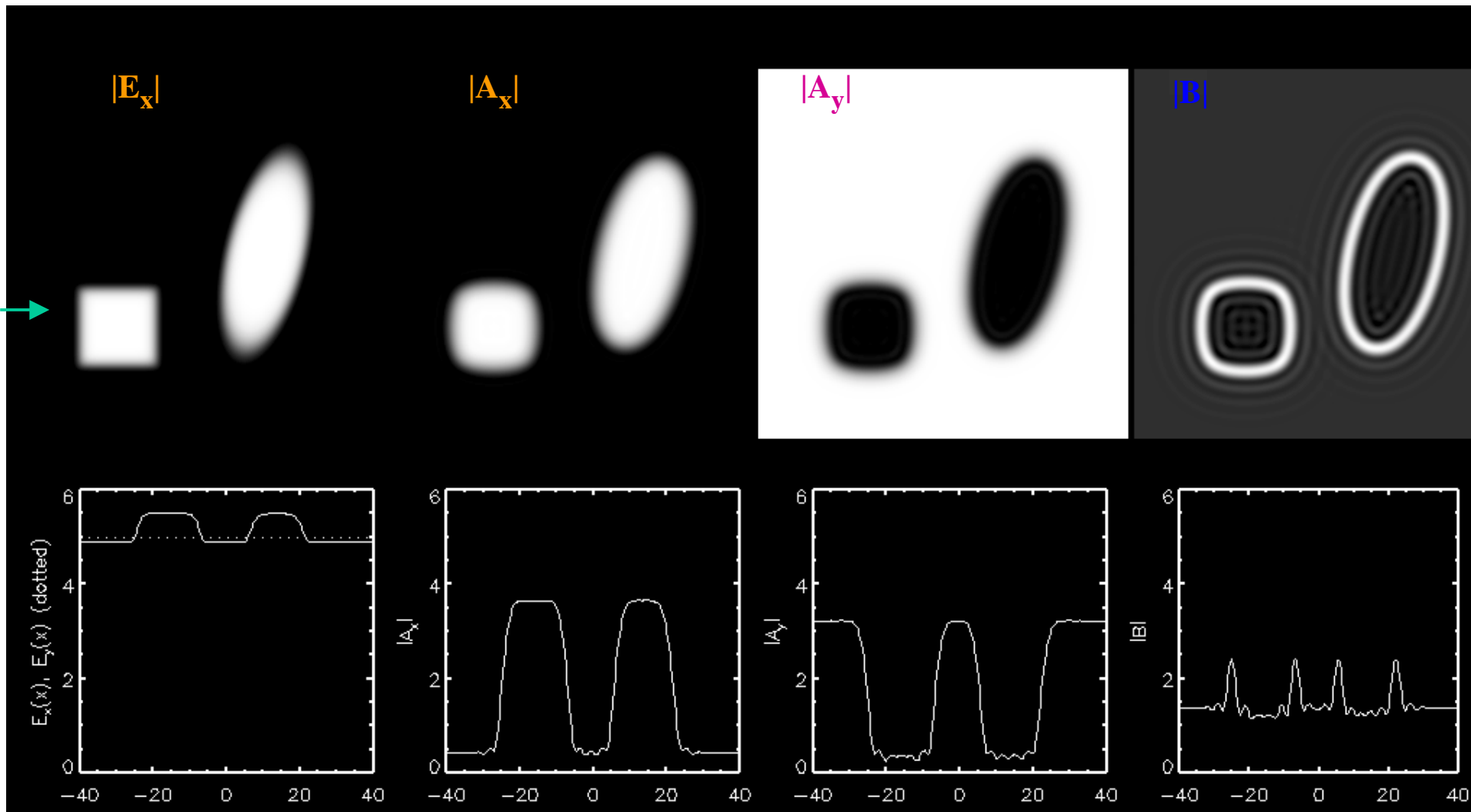




# Contrast enhancement

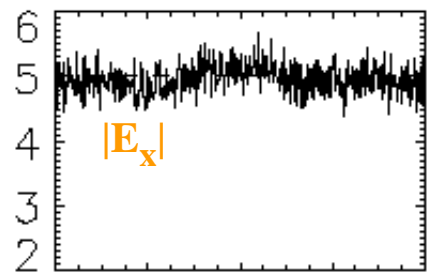
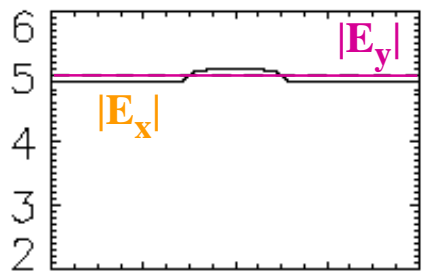
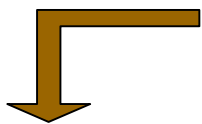


# Contrast enhancement/contour recognition

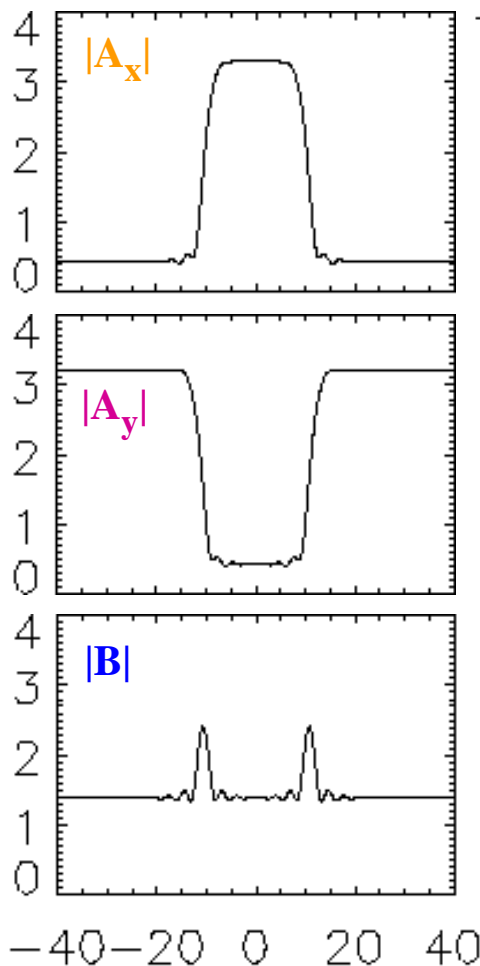
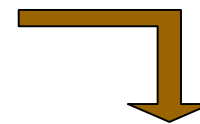


# Contrast enhancement: Noise filtering

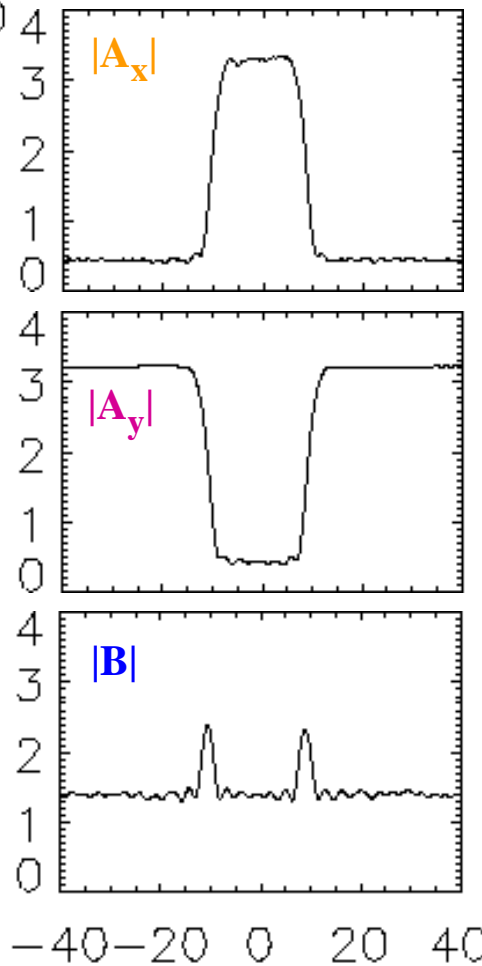
Small input signal



Noisy image

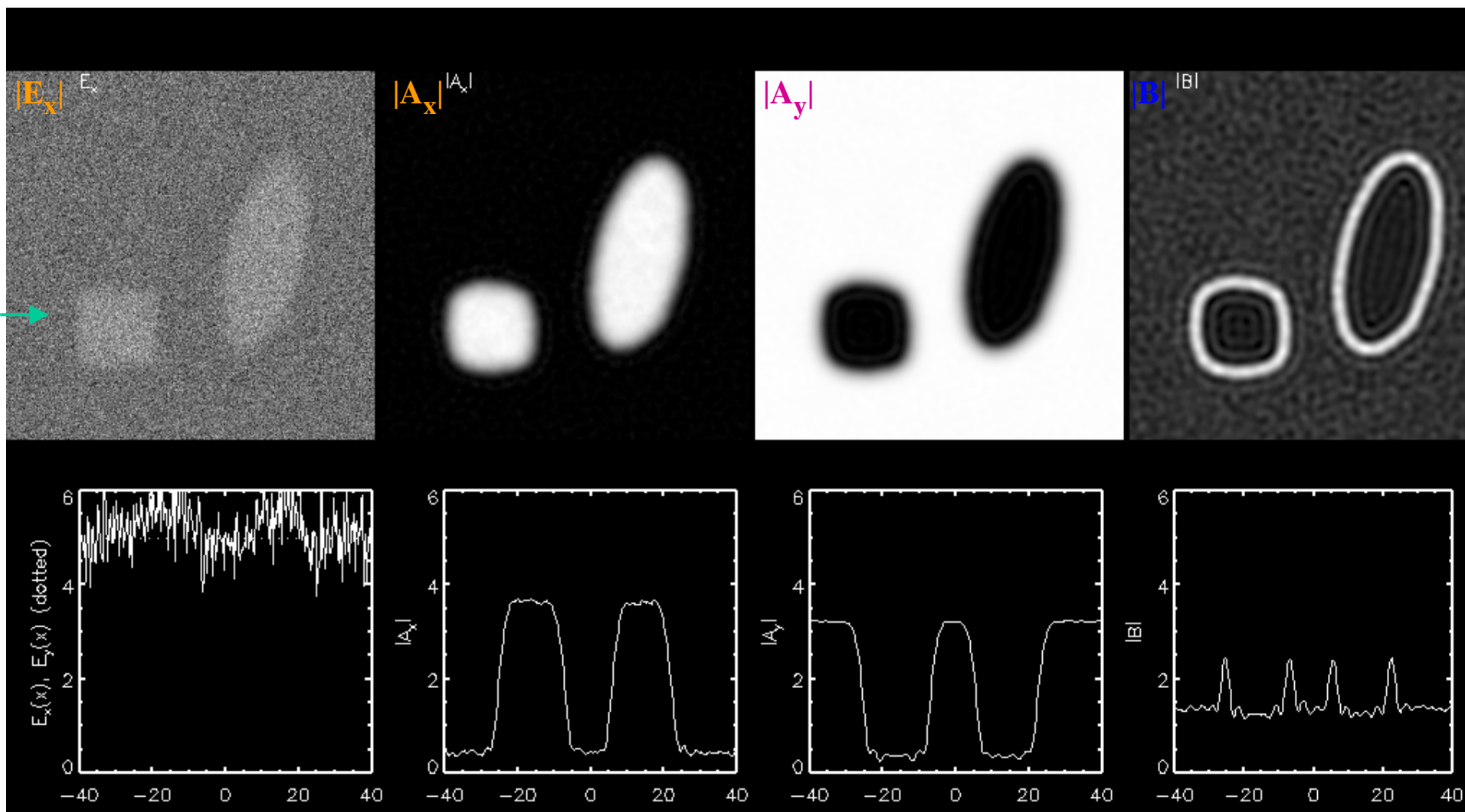


-40 -20 0 20 40



-40 -20 0 20 40

# Contrast enhancement: filtering of a noisy image



Type II SHG may be useful for processing images

Transfer an image to another polarization & frequency

Enhance the contrast

Contour recognition

Filtering the noise