

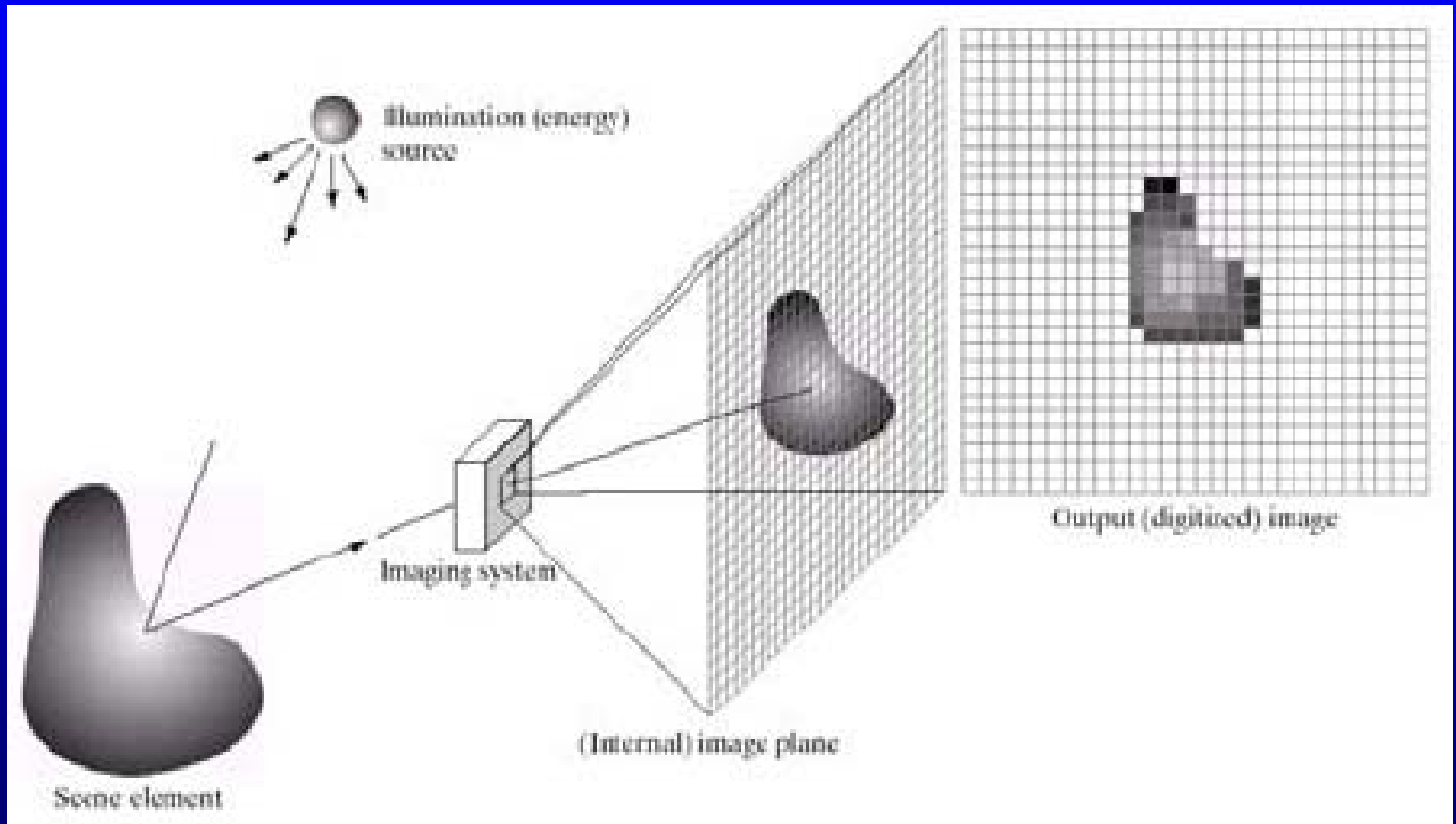
Conceptos Básicos

Procesamiento Digital de Imágenes:

¿Que es visión ?

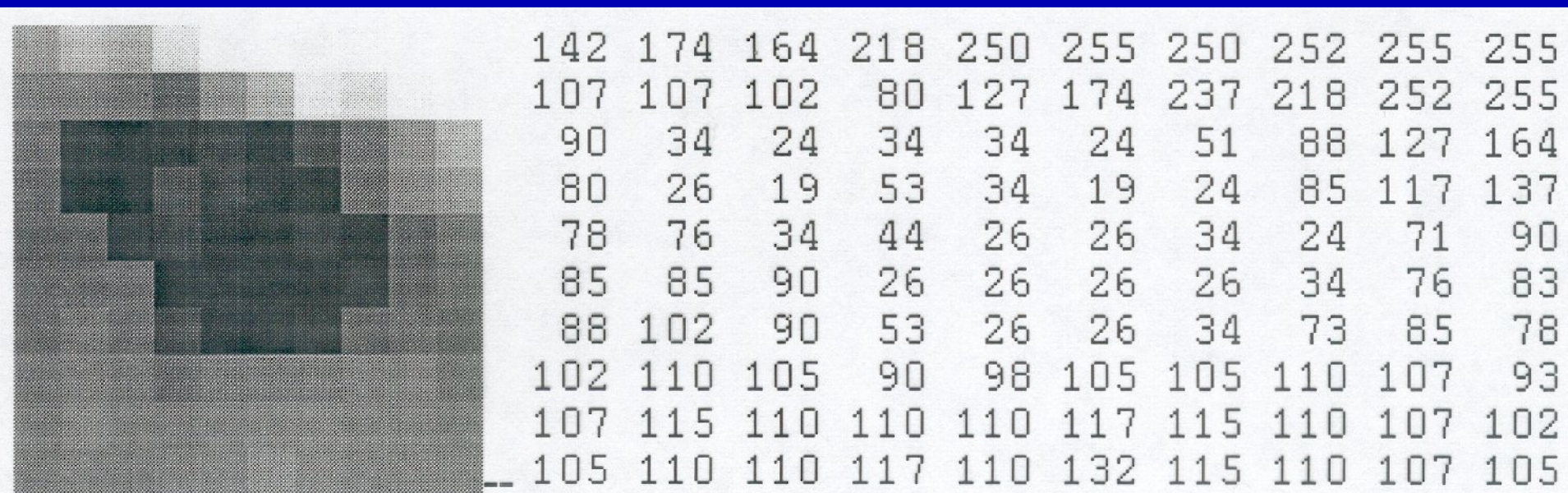
Definición

Conceptos Básicos



Conceptos Básicos

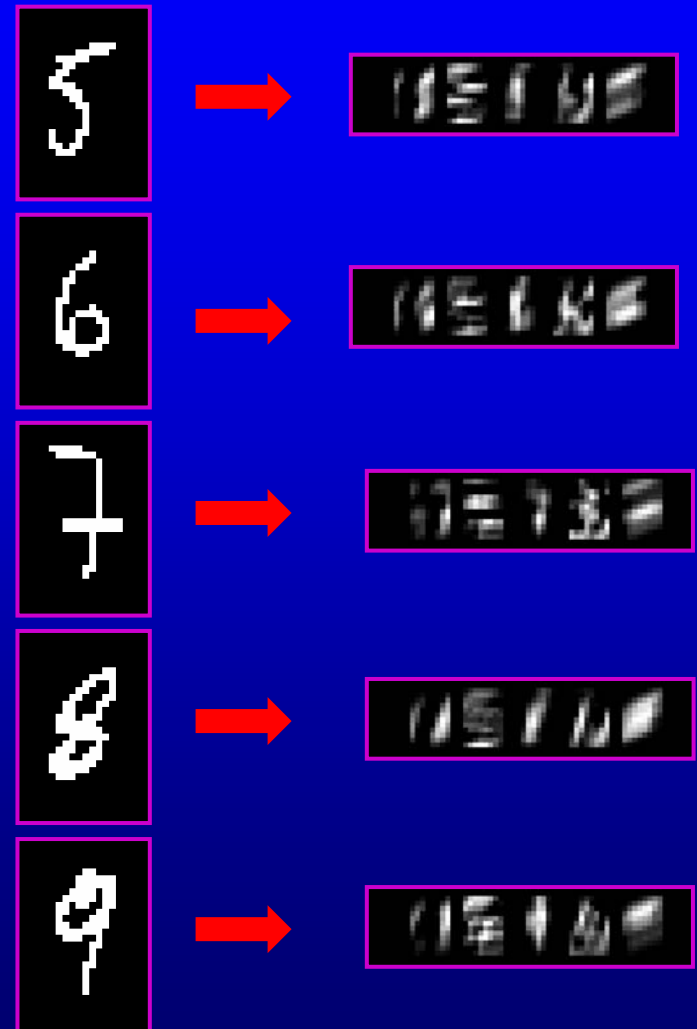
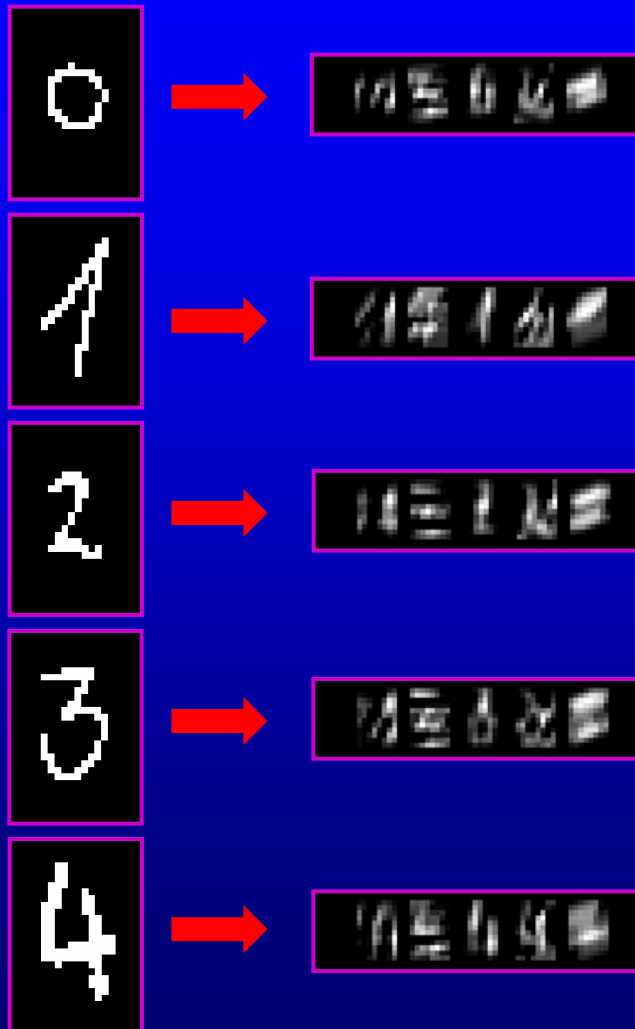
- Imagen Digital
- Pixel



Elementos básicos para el proc. de imágenes

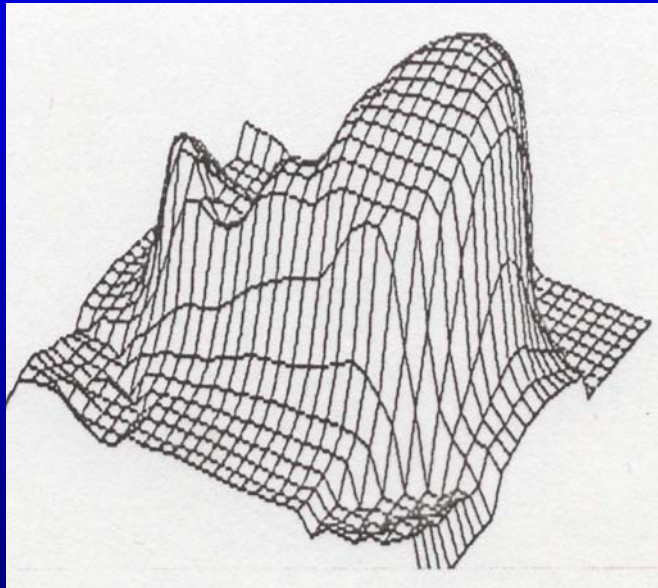
- * Señales en función del espacio
 - * muestreo espacial
 - * representación de la muestra
- * Señales 2D

Transformaciones



Procesamiento Digital de Imágenes:

Representación



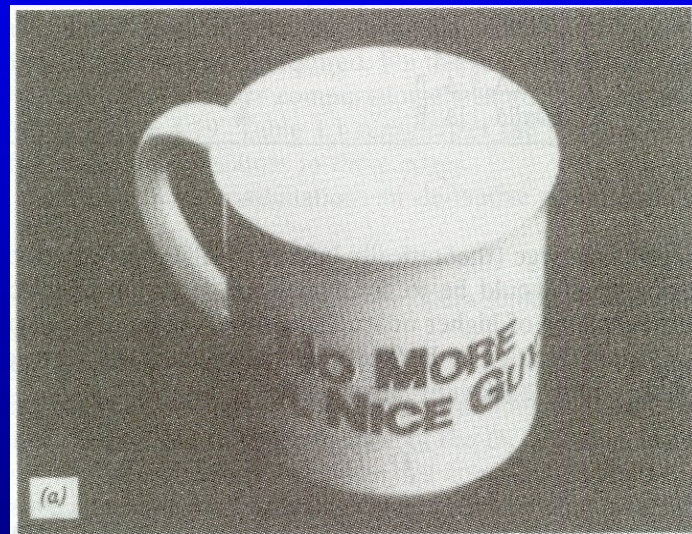
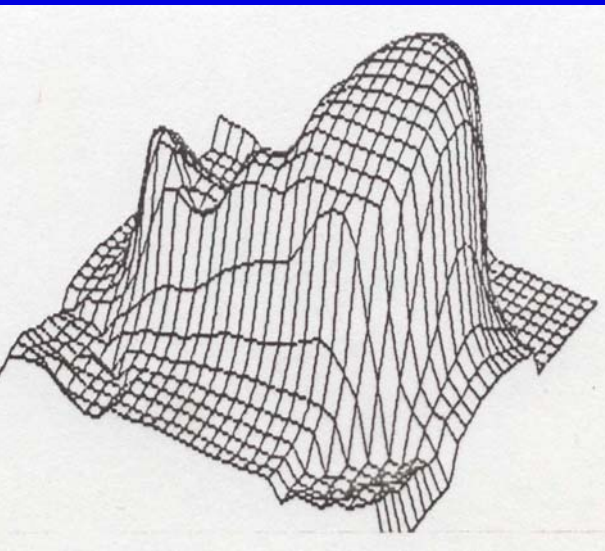
Procesamiento Digital de Imágenes:

Representación



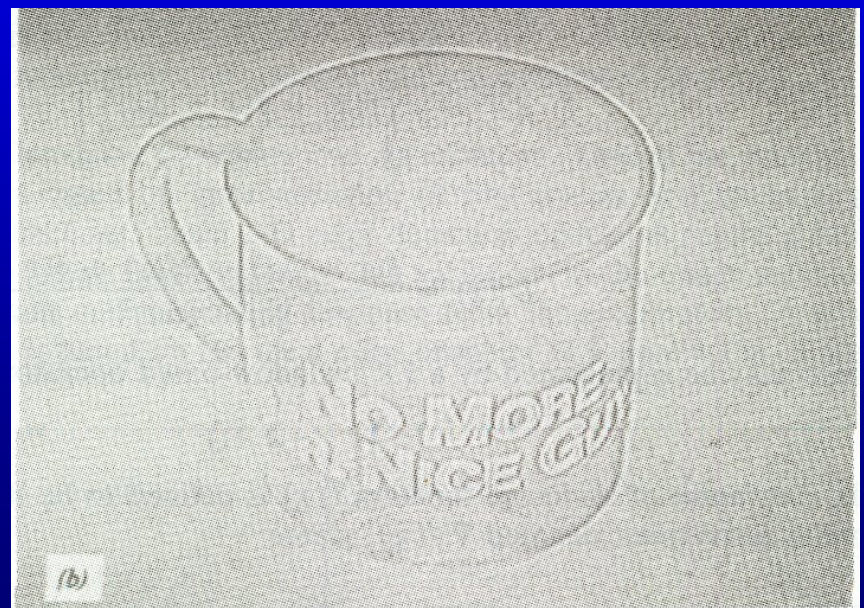
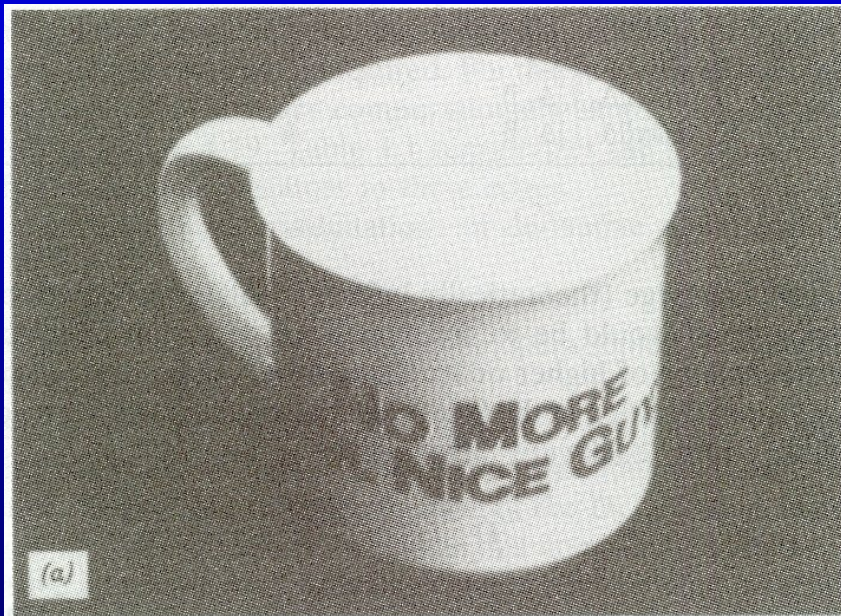
Procesamiento Digital de Imágenes:

Representación



Procesamiento Digital de Imágenes:

Representación



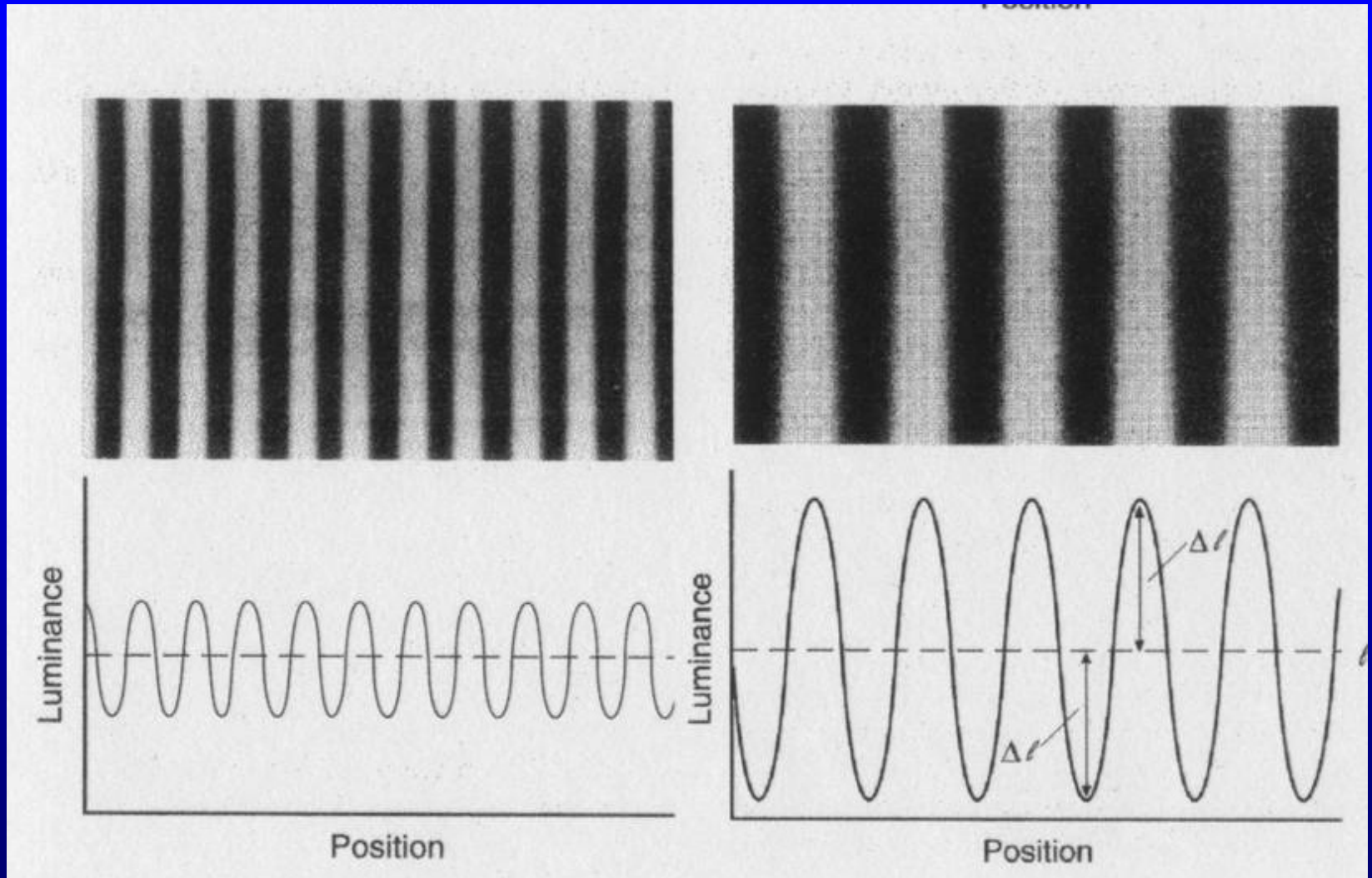
Resumen

- Objetivos de la visión artificial (definición)
- Imagen Digital
- Iluminación (espectro)
- Muestreo
- Representación (transformaciones)

Definición de Imagen:

- * cualquier función bidimensional 2-D (o 3D)
- * luminancia, absorción R-X, perfil de T, impedancia eléctrica, etc.
- * gran cantidad de aplicaciones

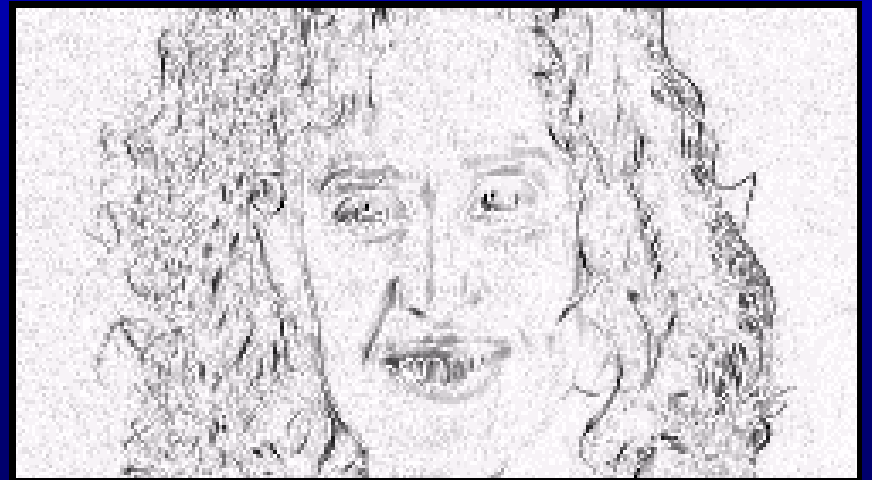
- **Señales espacio-tiempo, dimensiones**



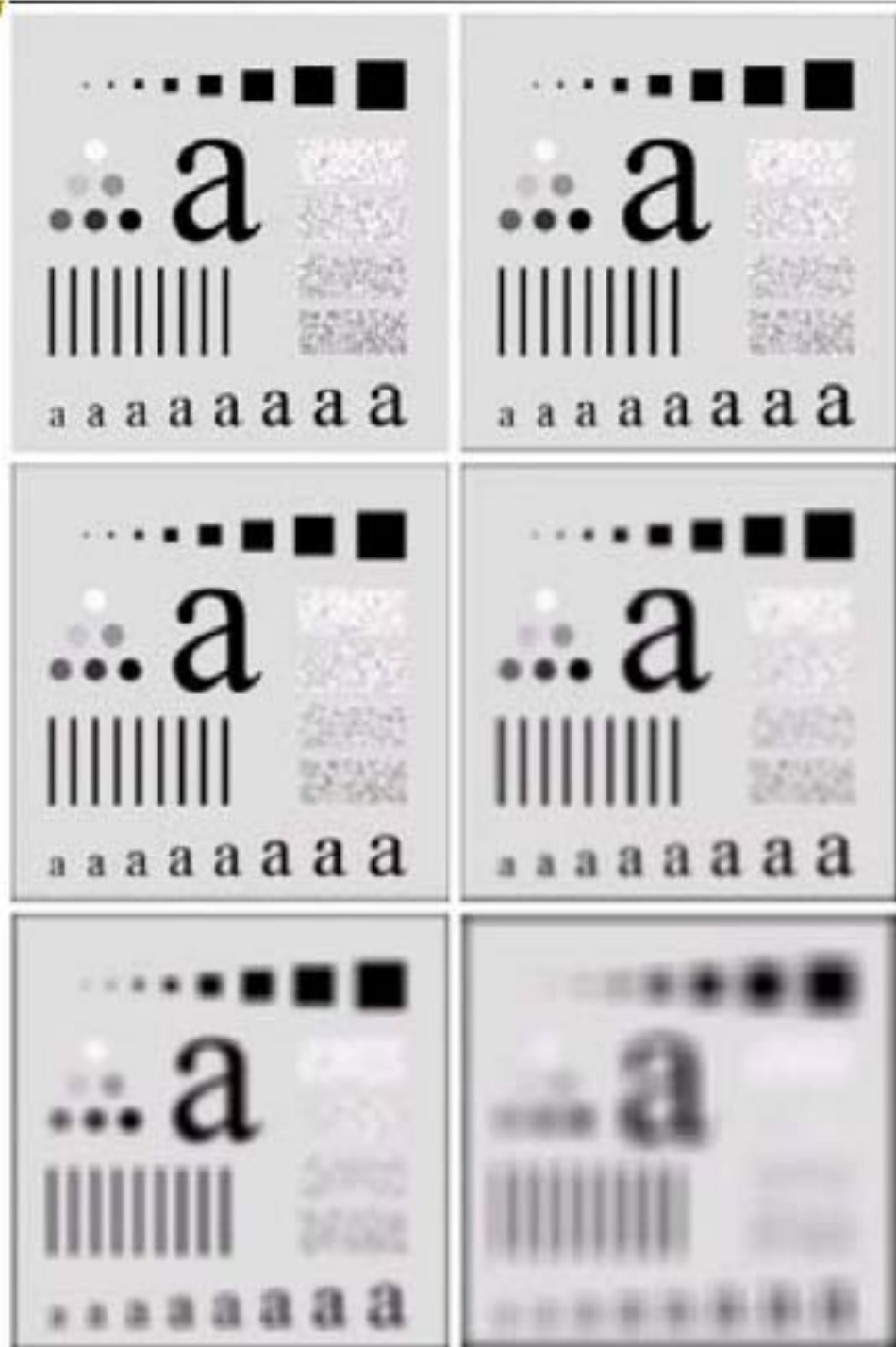
Filtrado



Filtros



Filtro rect:
3x3,5x5,9x9,15x15, 35x35



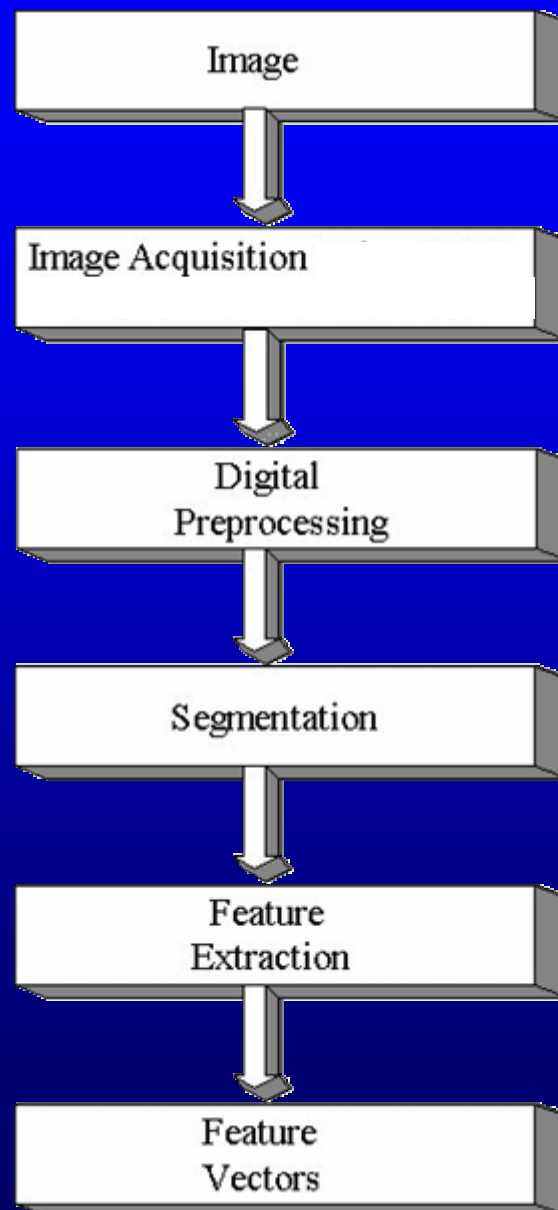
Sistemas de Visión Artificial:

- * Complejidad – Motor de desarrollo
- * Éxito en dominios restringidos

Guía de vehículos



Conceptos Básicos (2)



Aplicaciones:

- * Sondeo remoto
- * Tx y comunicaciones con imágenes
 - * fax, video, TV digital, monitoreo de seguridad, etc.
- * Medicina: R-x, TAC, MRI, US, Endoscopía, etc
- * Radar – sonar
- * Robótica
- * Industria editorial/arte gráfico
- * Síntesis de imágenes/animación

Adquisición de Imágenes

- **Sensores**

- Cámaras estándares, barrido progresivo, barrido de línea
- Analógica/digital

- **Frame Grabber**

- **Preprocesamiento**

- Mejoras

- Eliminación de ruido

- **Operaciones entre puntos $v=f(u)$**

- **Operaciones espaciales**

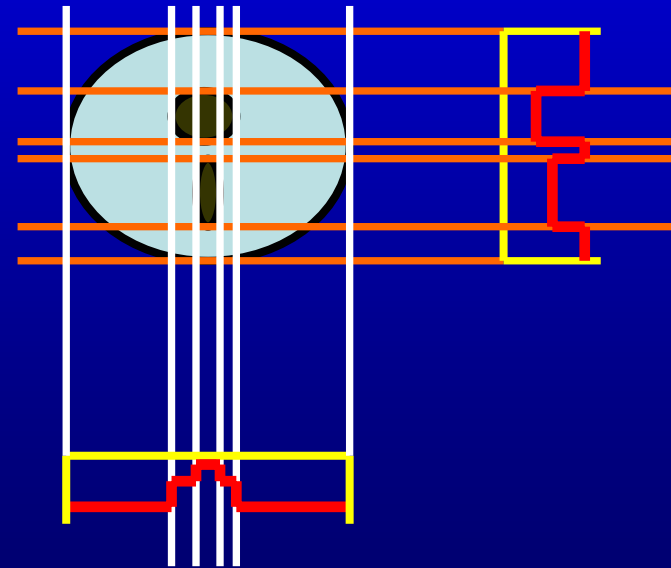
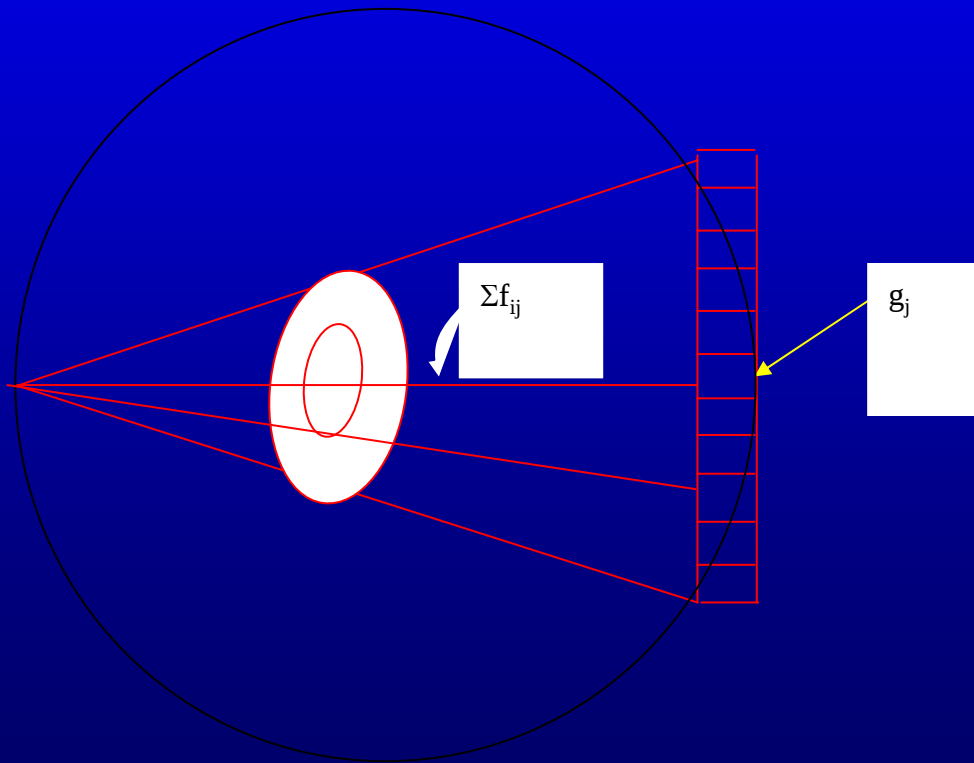
Conceptos Básicos

- **Sistemas para procesamiento de imágenes**
- **Criterios de Segmentación**
- **Criterios para extracción de características**
- **Selección de características**
- **Vectores de características – Clases**
- **Niveles de abstracción – pixeles - símbolos**
- **Base de datos - Partición**

Reconstrucción de Imágenes

Reconstrucción Iterativa ART (Adaptive Reconstruction Technique)

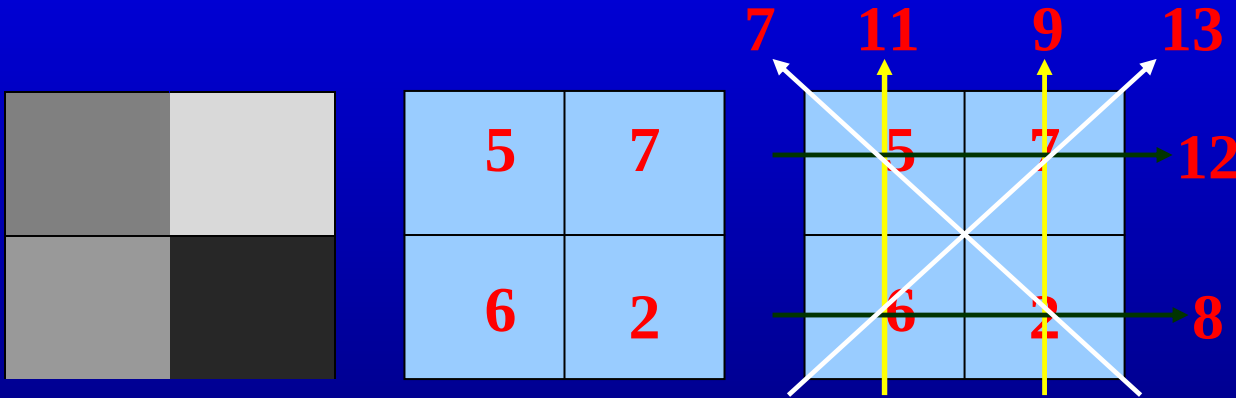
$$f_{ij}^{q+1} = f_{ij}^q + \frac{g_j - \sum_{i=1}^N f_{ij}^q}{N}$$



Reconstrucción de Imágenes

Reconstrucción Iterativa ART (Adaptive Reconstruction Technique)

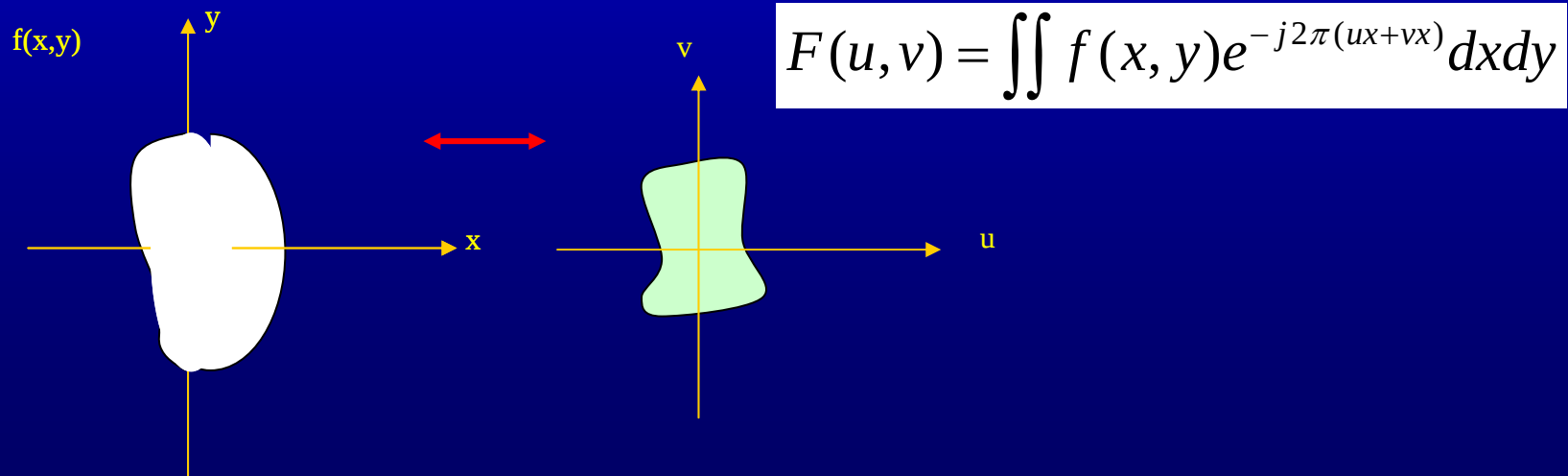
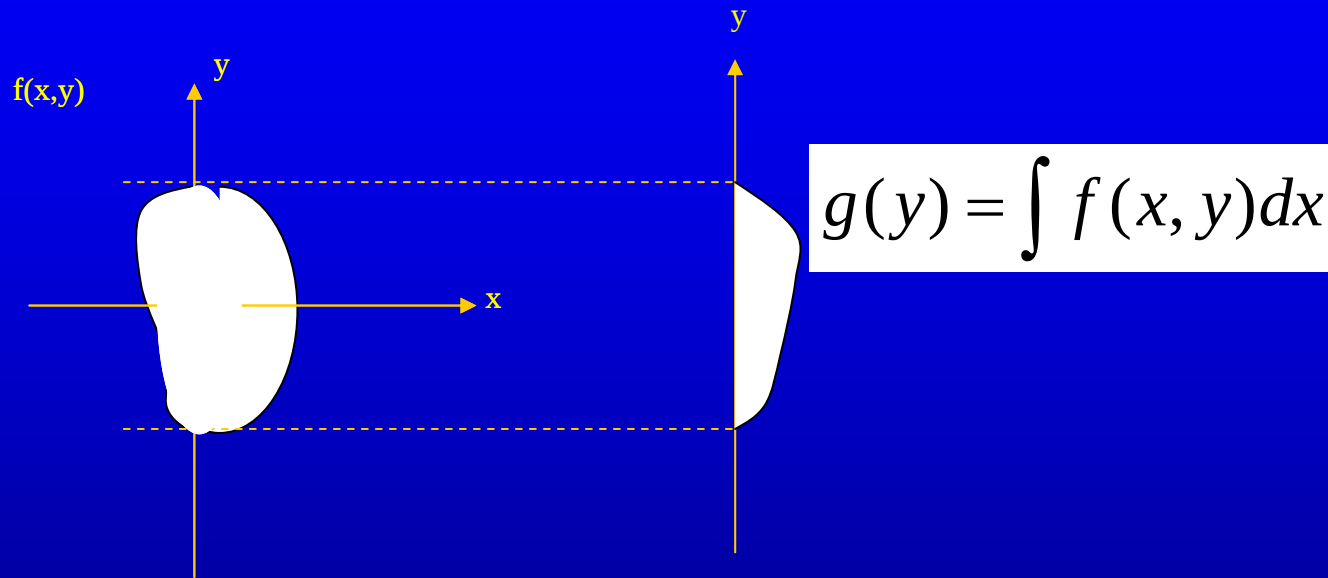
$$f_{ij}^{q+1} = f_{ij}^q + \frac{g_j - \sum_{i=1}^N f_{ij}^q}{N}$$



$f_1^0 = 0$	$f_2^0 = 0$	$f_1^1 = 5,5$	$f_2^1 = 4,5$	$f_1^2 = 6,5$	$f_2^2 = 5,5$	$f_1^3 = 5$	$f_2^3 = 7$
$f_3^0 = 0$	$f_4^0 = 0$	$f_3^1 = 5,5$	$f_4^1 = 4,5$	$f_3^2 = 4,5$	$f_4^2 = 3,5$	$f_3^3 = 6$	$f_4^3 = 2$

Reconstrucción de Imágenes

Reconstrucción Directa: T. de Fourier

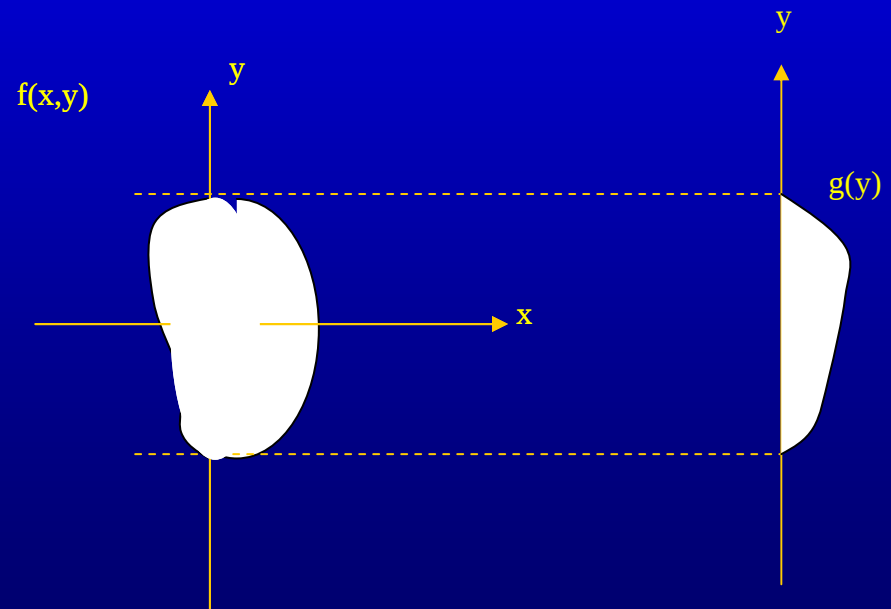
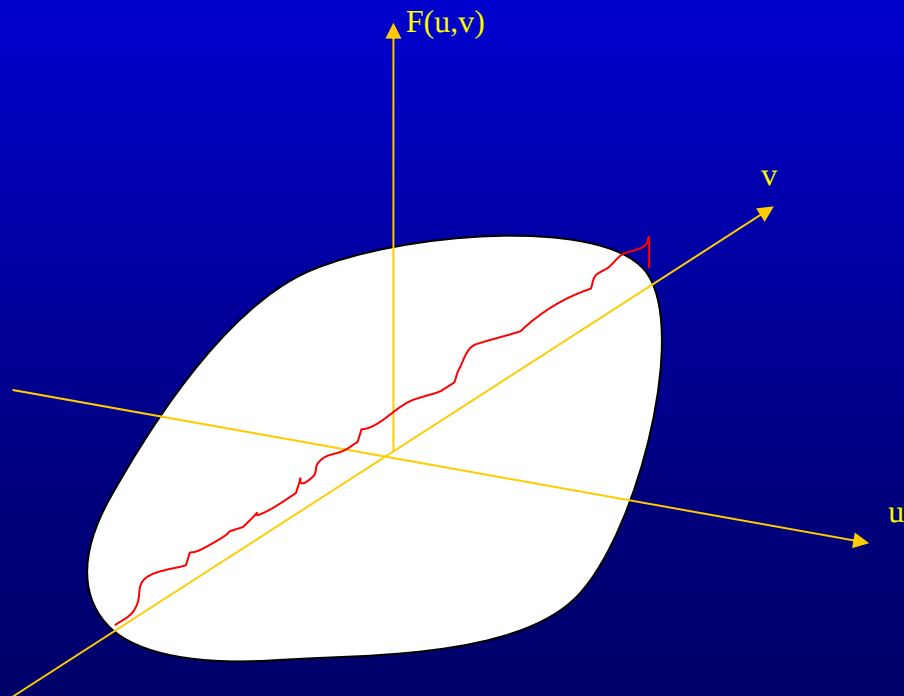


Reconstrucción de Imágenes

Reconstrucción Directa: T. de Fourier

Para $u = 0$

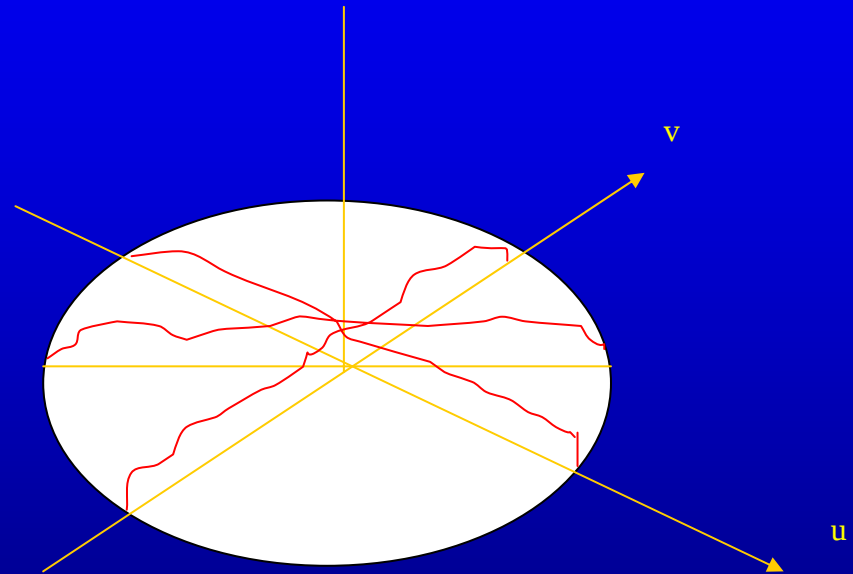
$$\begin{aligned} F(0, v) &= \iint f(x, y) e^{-j2\pi v y} dx dy = \int \left[\int f(x, y) dx \right] e^{-j2\pi v y} dy = \int g(y) e^{-j2\pi v y} dy \\ &= F_{1-D}\{g(y)\} \end{aligned}$$



Reconstrucción de Imágenes

Reconstrucción Directa: T. de Fourier

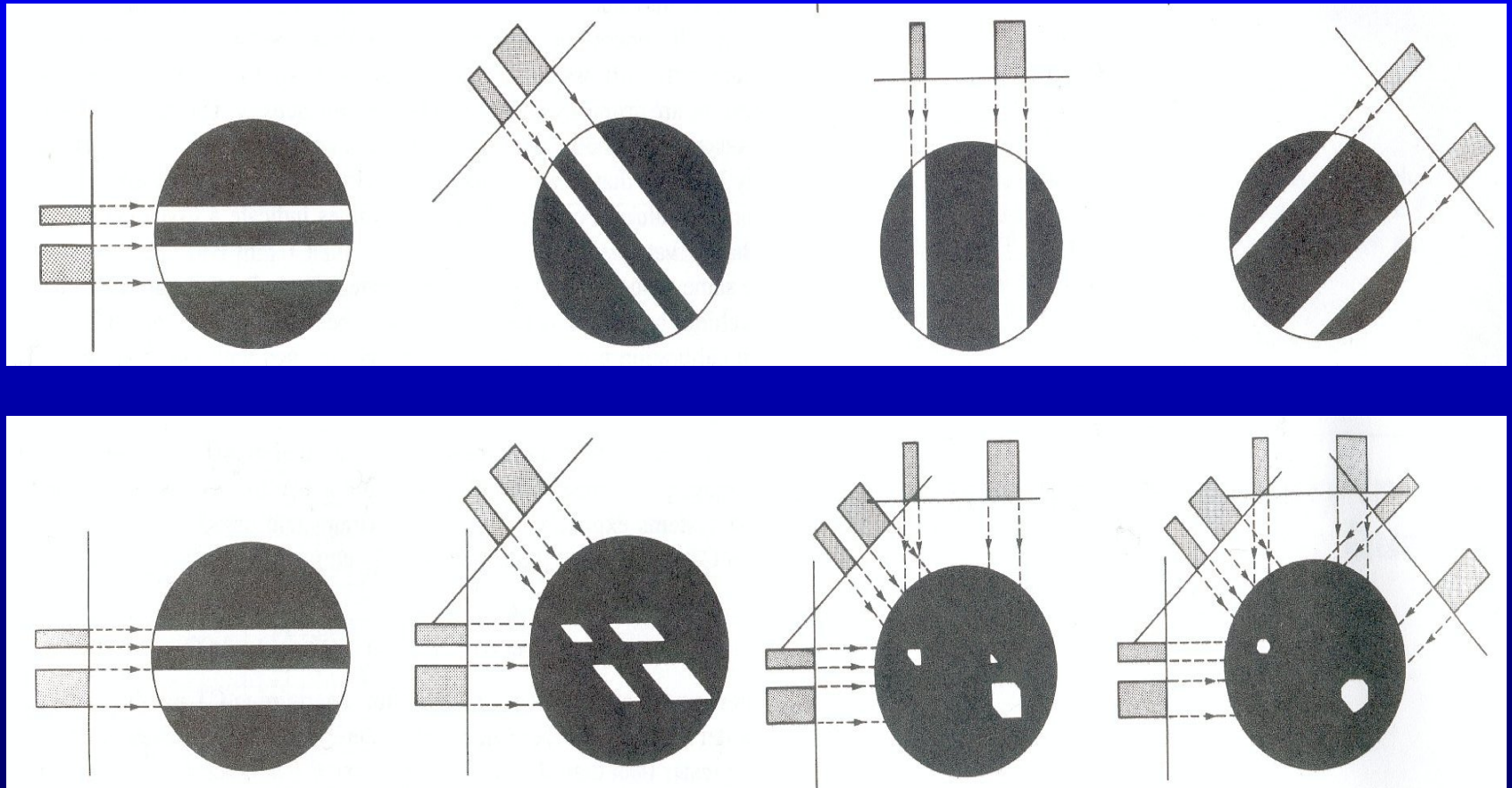
Para muchas proyecciones



$$f(x, y) = F_{2-D}^{-1} \{F(u, v)\}$$

Reconstrucción de Imágenes

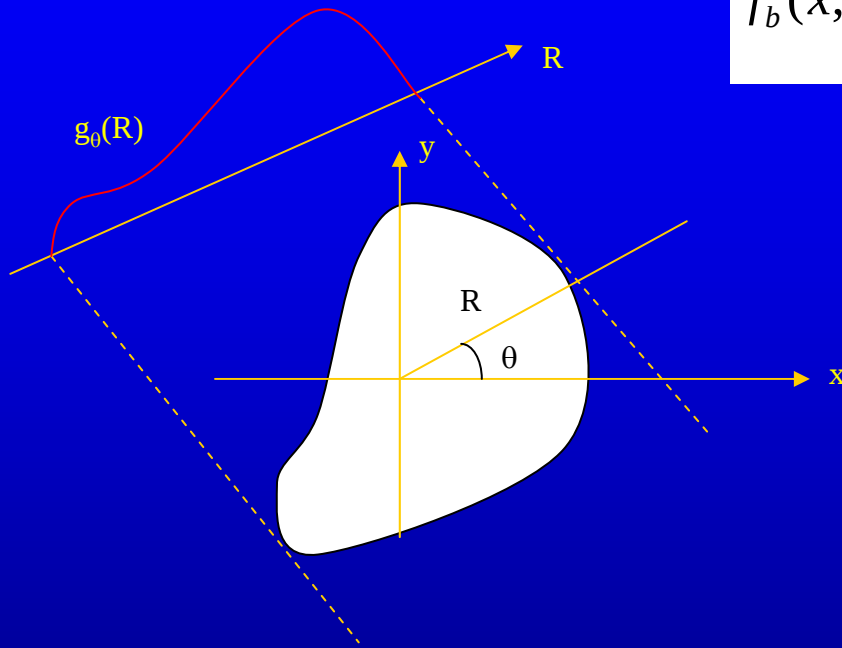
Retroproyección: Las medidas realizadas en cada proyección son proyectadas hacia atrás asignando el valor medido a cada línea.



Reconstrucción de Imágenes

Retroproyección:

$$f_b(x, y) = \int_0^\pi \int_{-\infty}^{\infty} g_\theta(R) \delta(x \cos \theta + y \sin \theta - R) dR d\theta$$



se puede demostrar que la retroproyección de una función δ corresponde a la respuesta al impulso

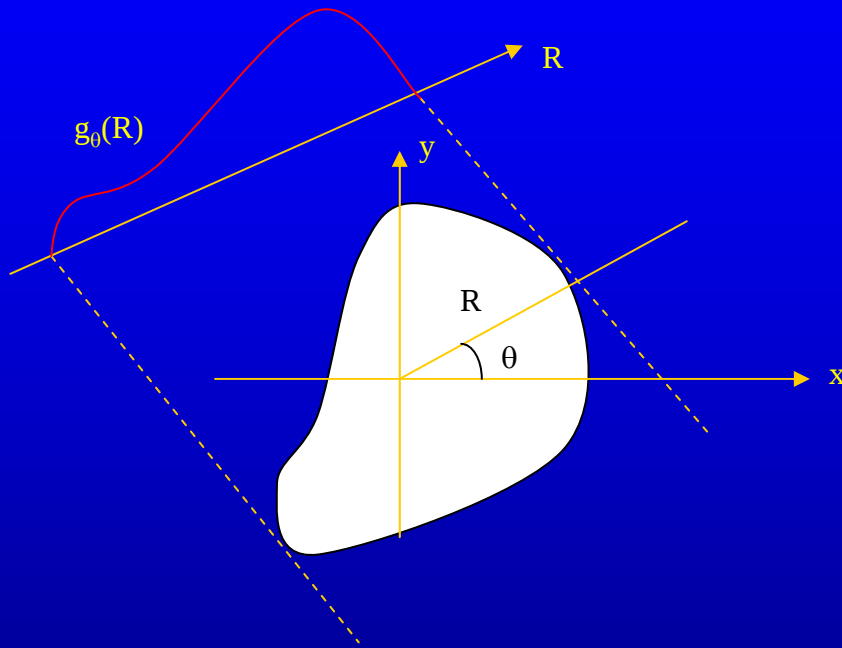
$$h_b(r) = \frac{1}{r}$$

$$\Rightarrow f_b(x, y) = f(x, y) * \frac{1}{r} \leftrightarrow \frac{F(\rho, \theta)}{\rho}$$

$$f(x, y) \approx F_{2-D}^{-1} \{F_b(\rho, \theta) \rho\}$$

Reconstrucción de Imágenes

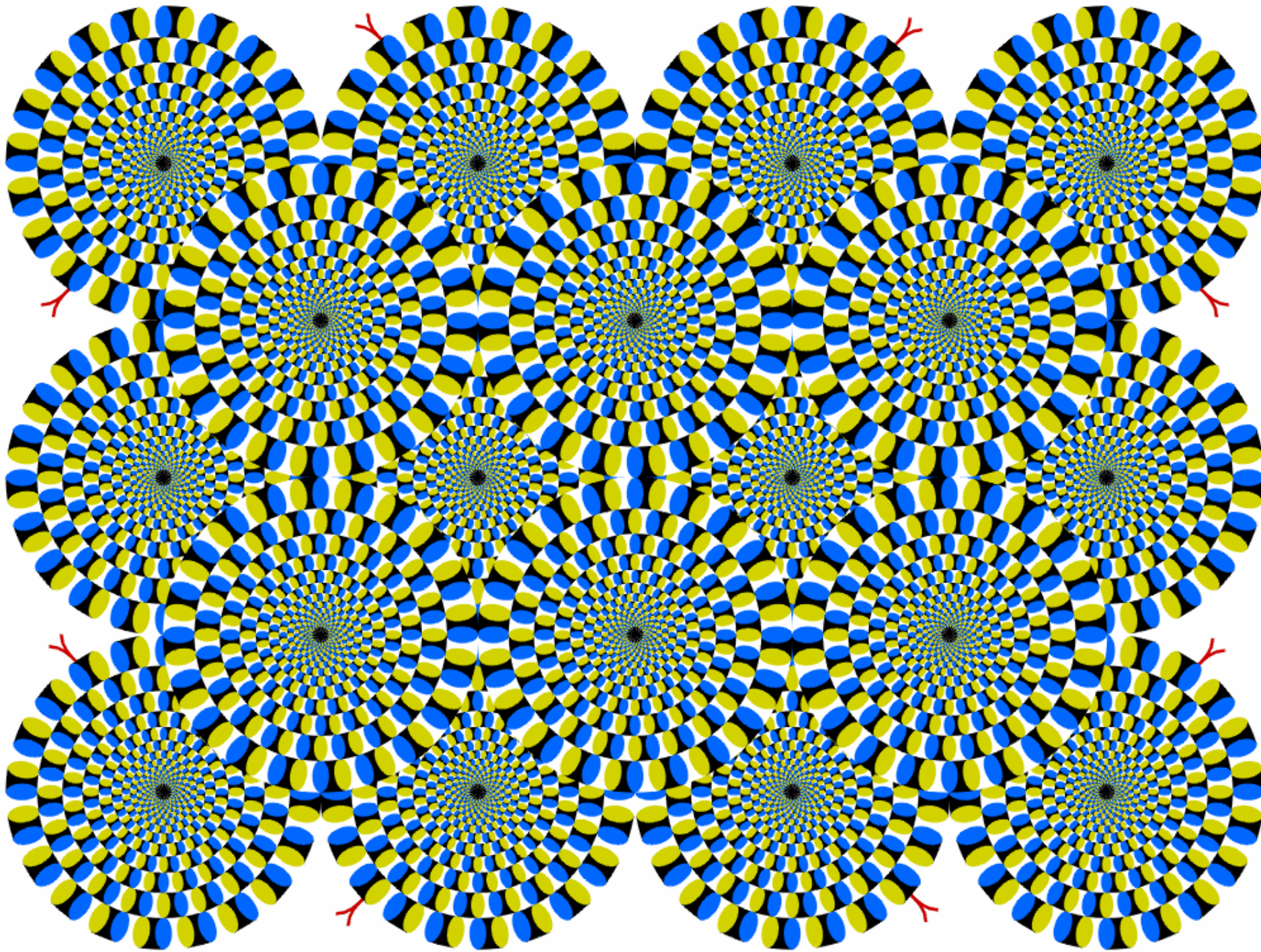
Retroproyección Filtrada:



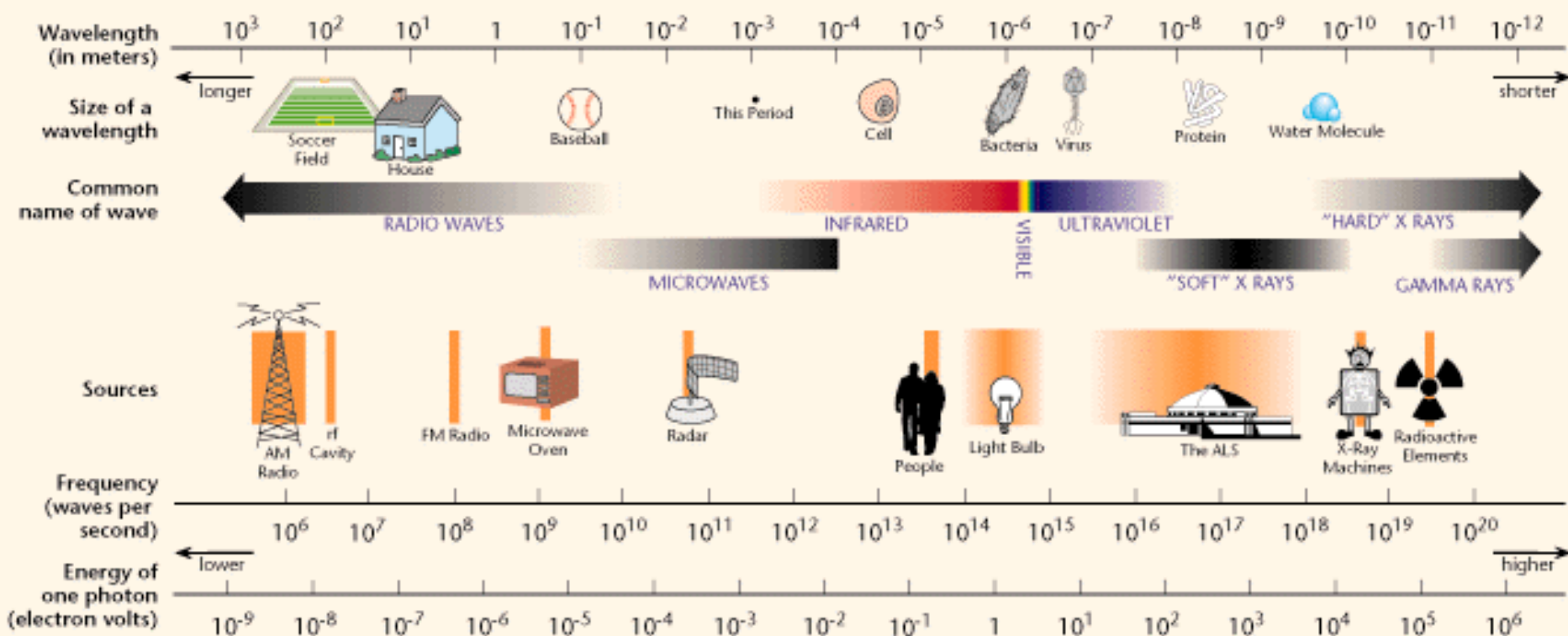
$$f(x, y) \approx F_{2-D}^{-1} \{F_b(\rho, \theta) \rho\}$$

Cada proyección se transforma individualmente se pondera por $|\rho|$ y se hace la T inversa y luego se retroproyecta.





THE ELECTROMAGNETIC SPECTRUM



The Eye's Neural Network

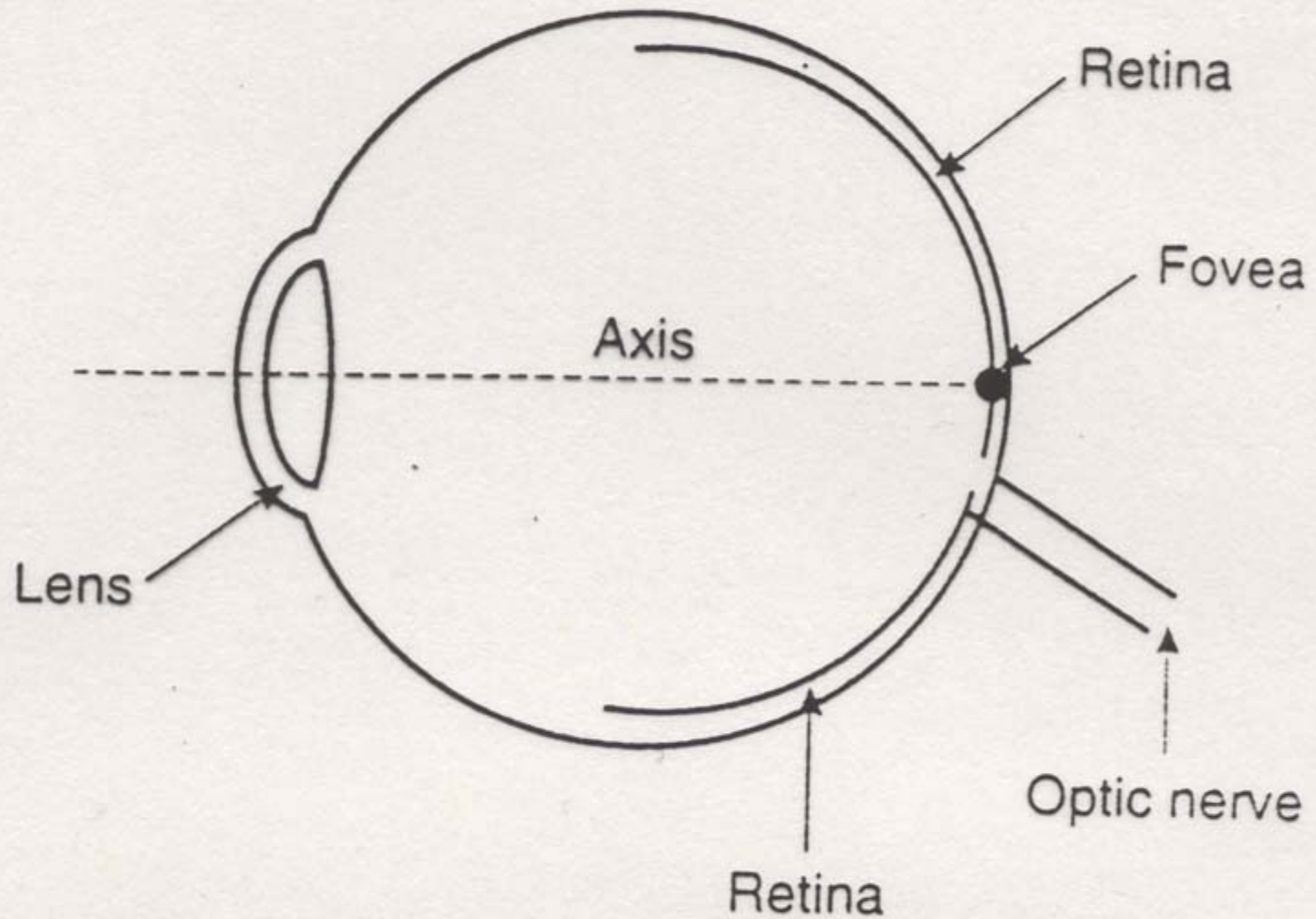
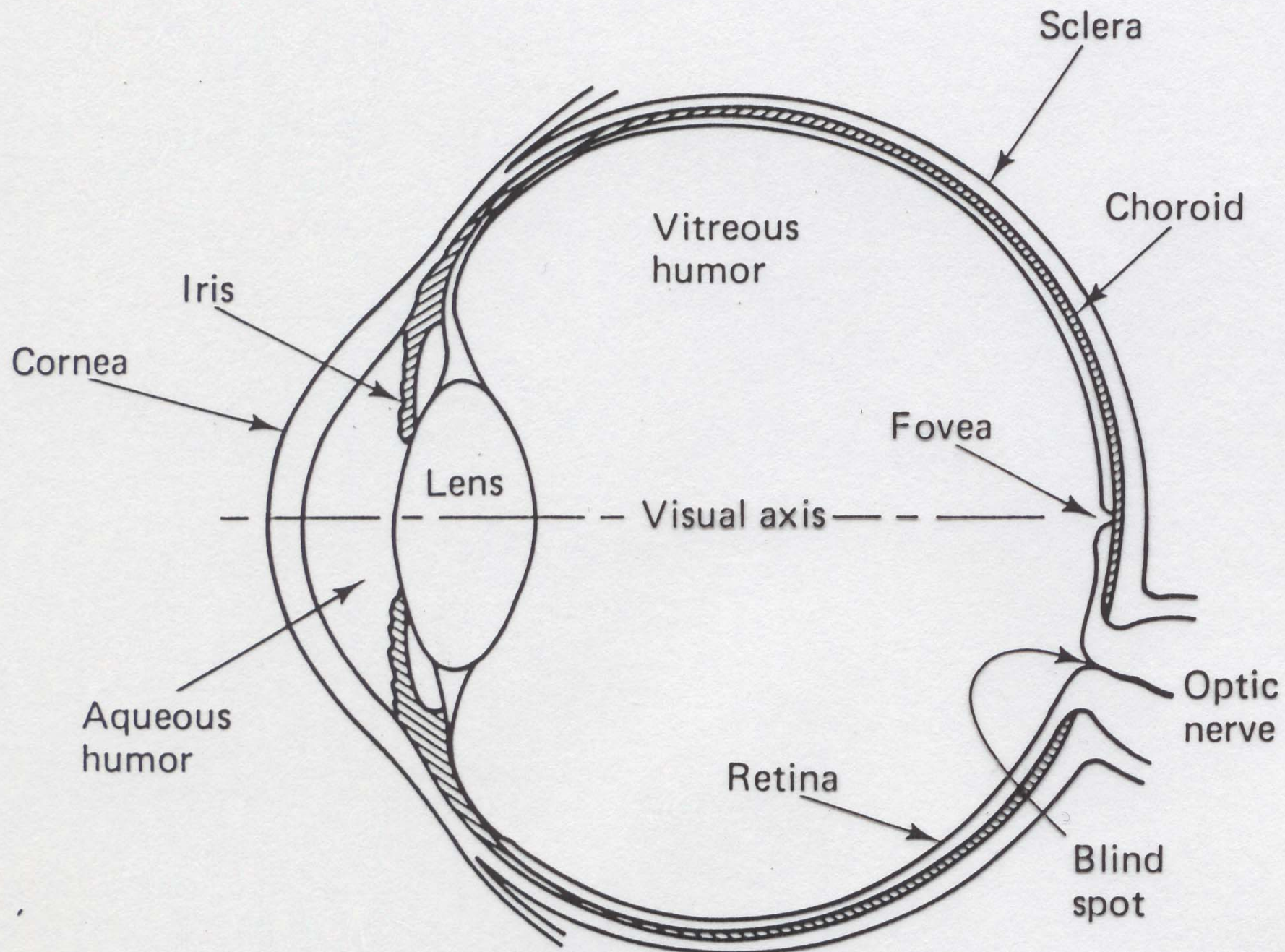
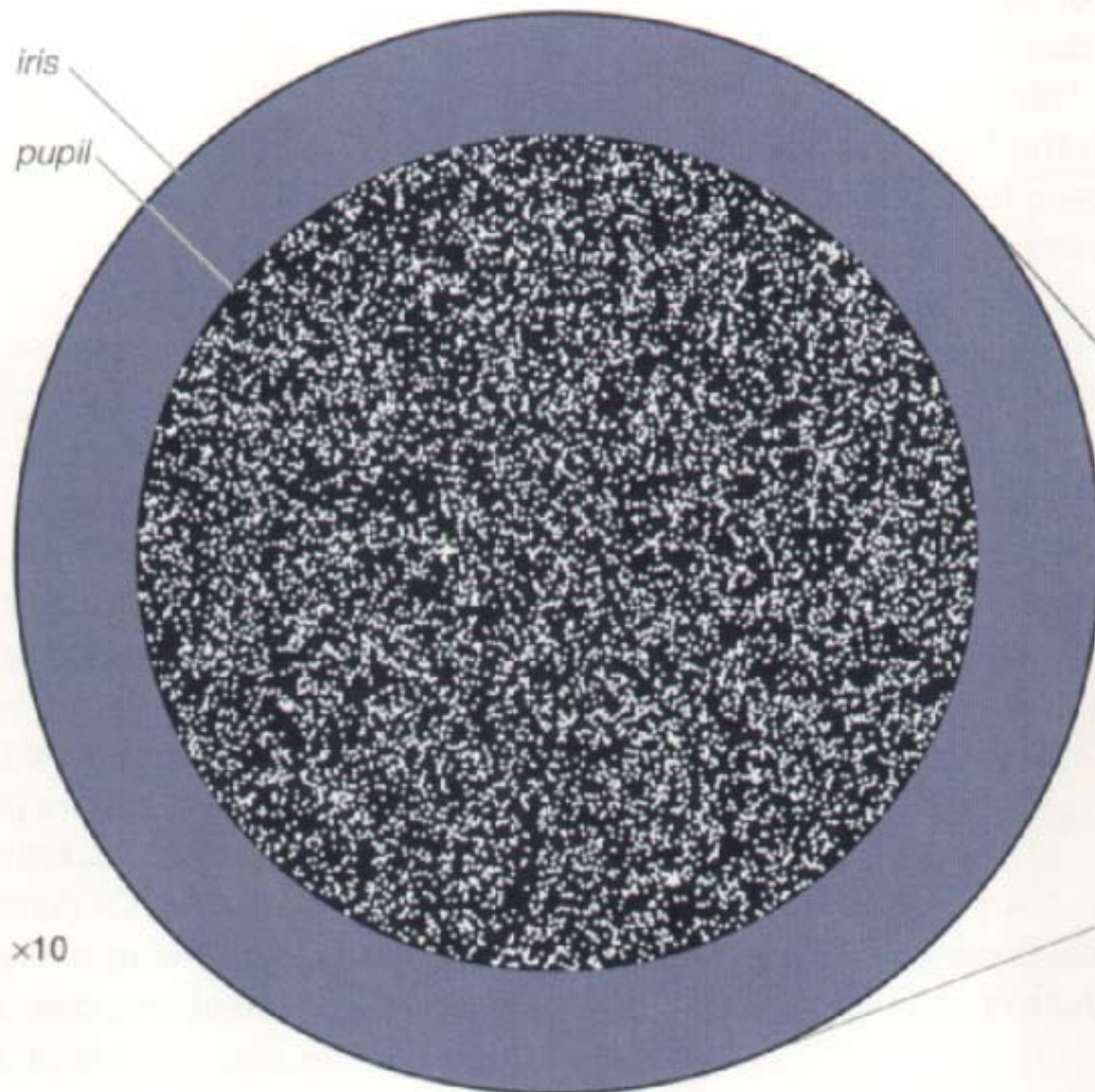
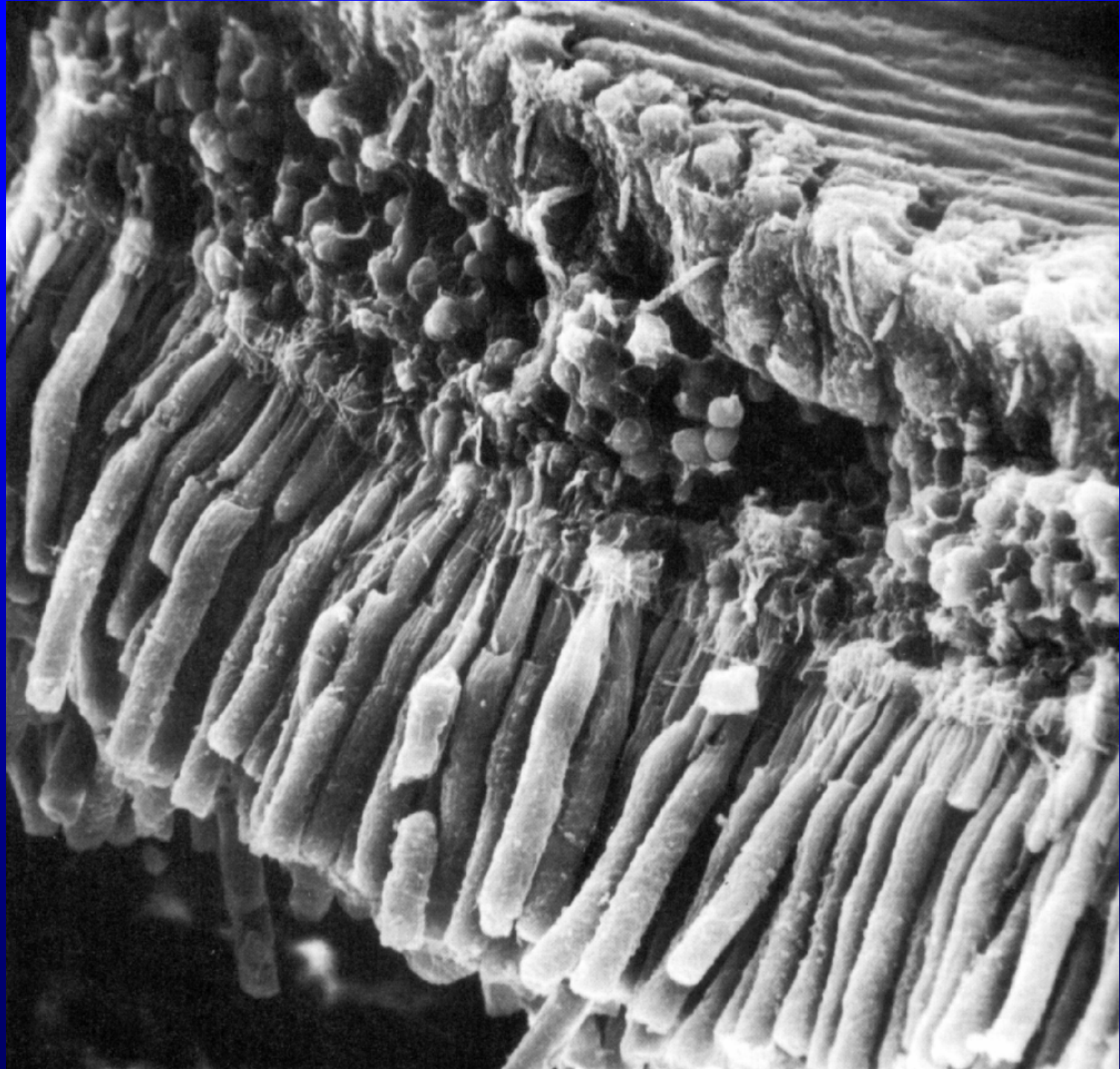


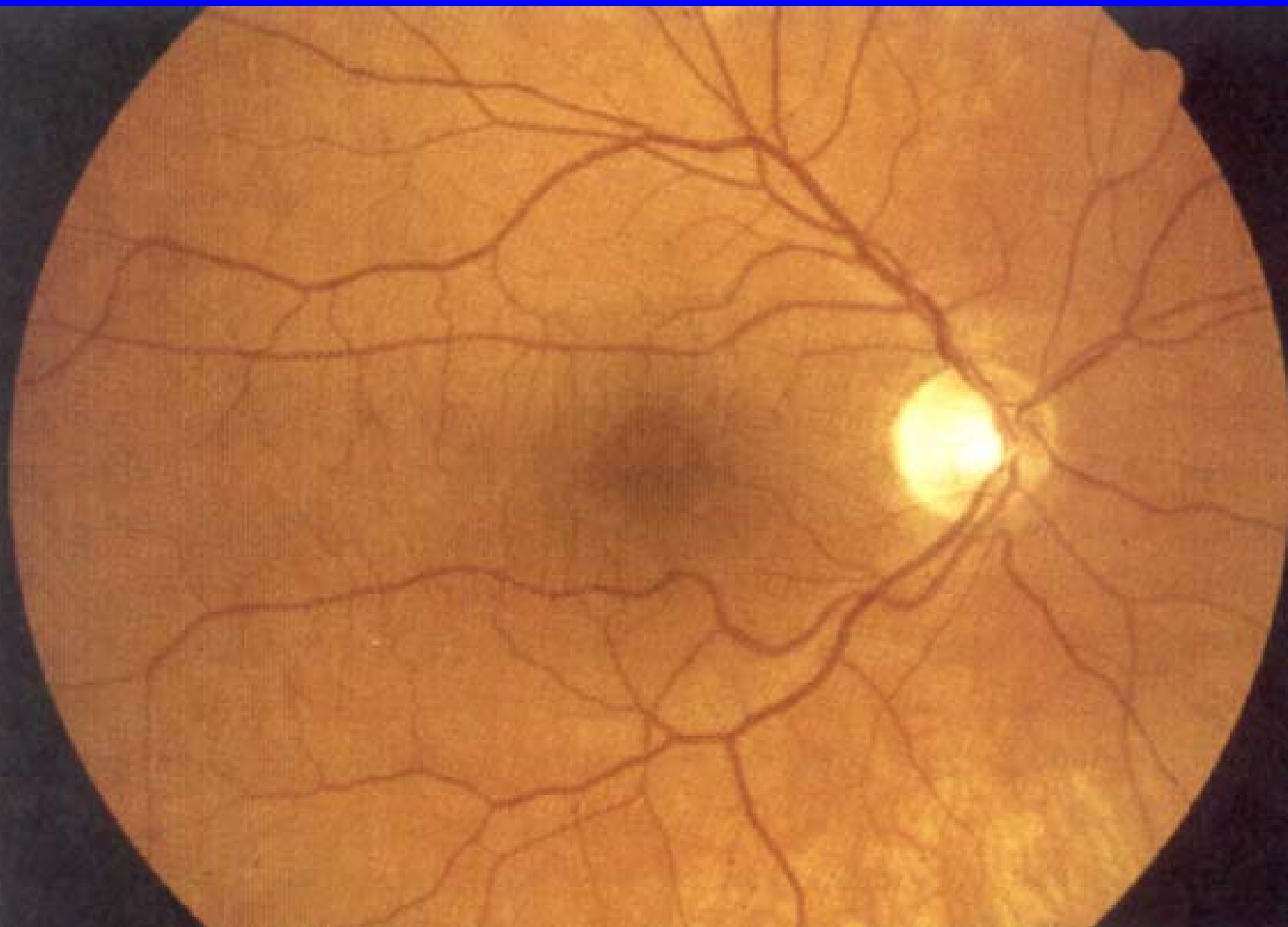
Figure 1-8 Simplified cross section of the eye.

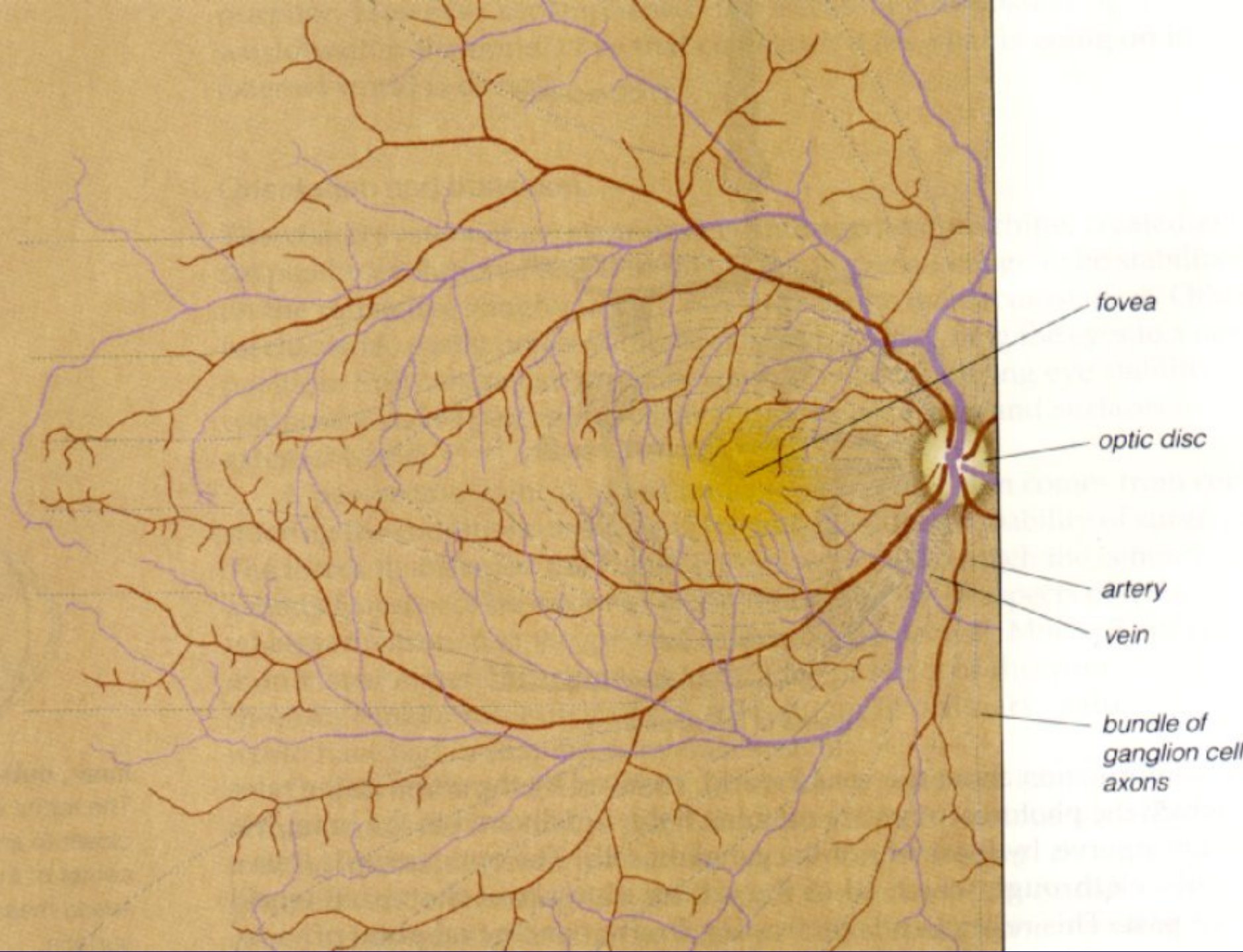




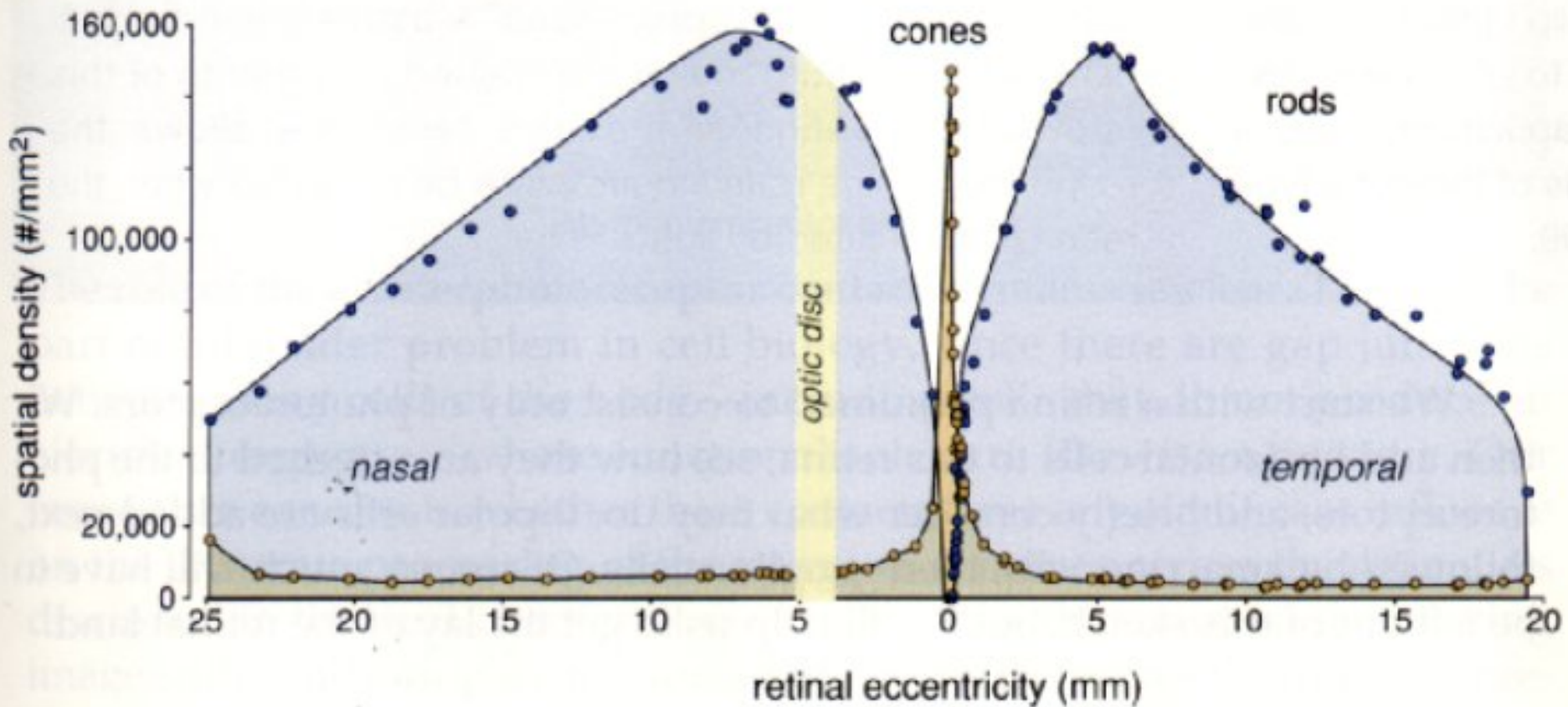
9,400 photons in plane of pupil

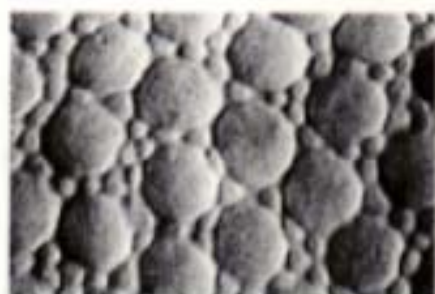
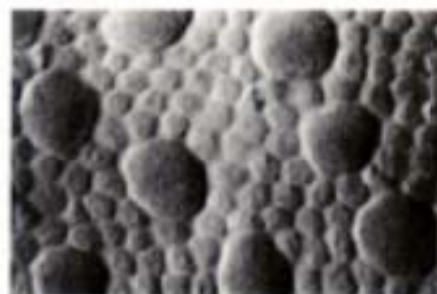




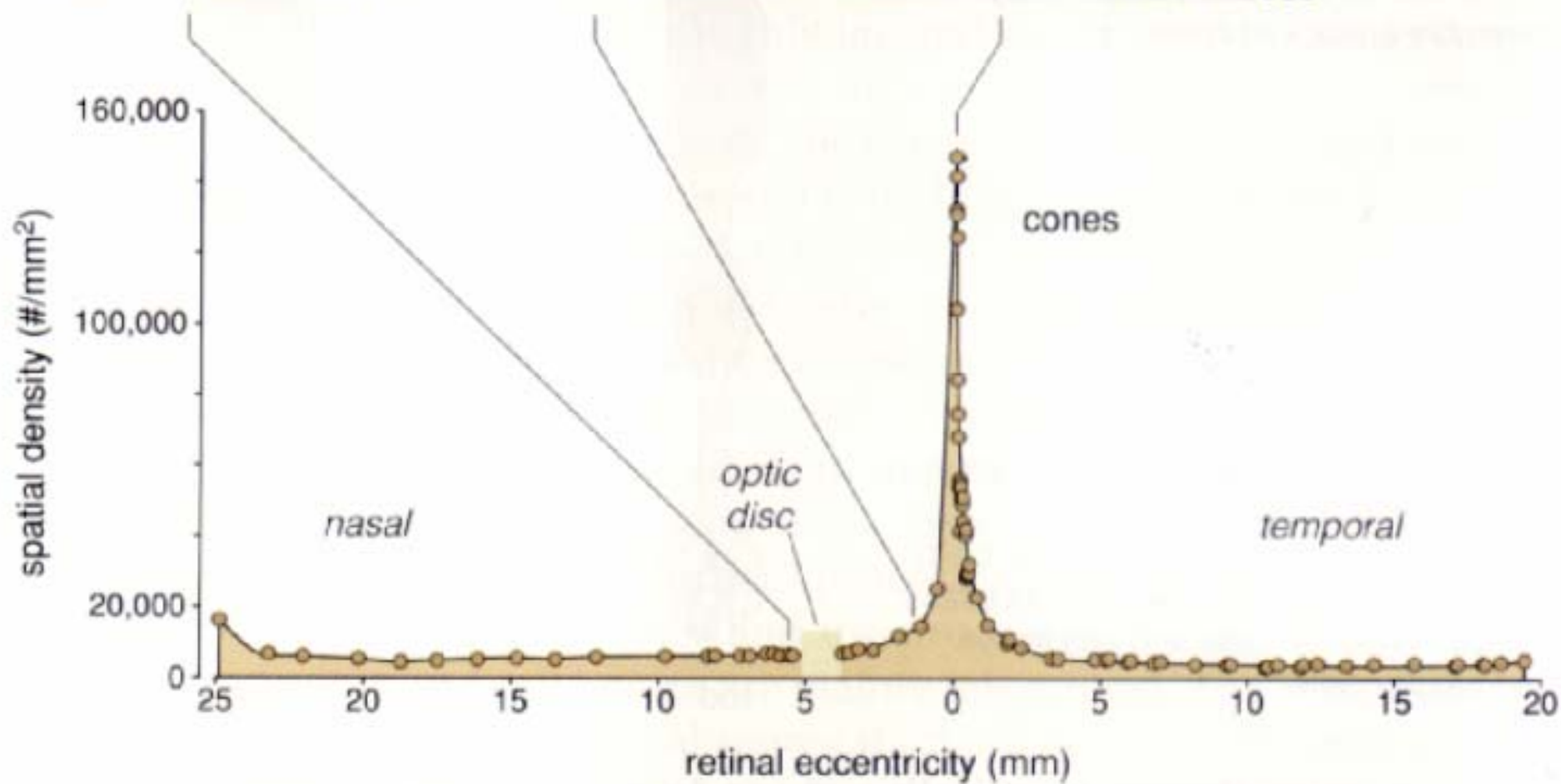


This diagram shows the spatial density of rods superimposed upon that of cones:

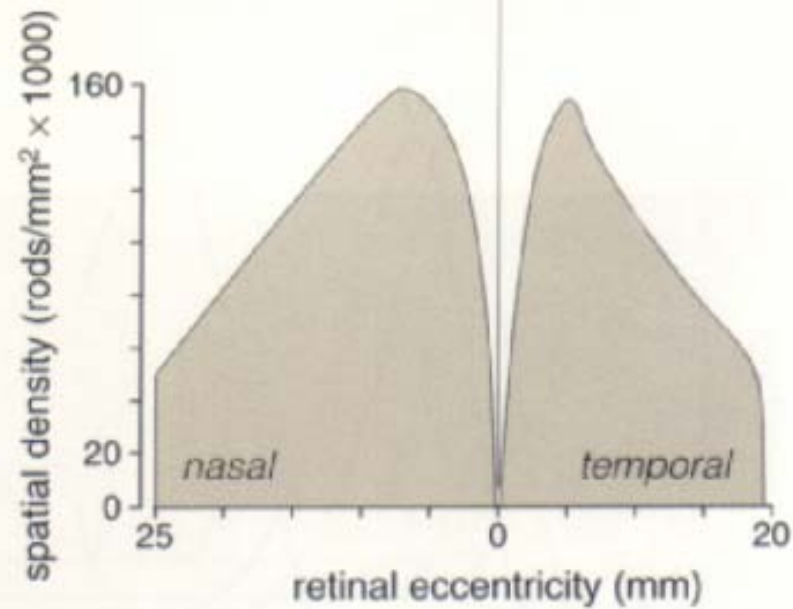
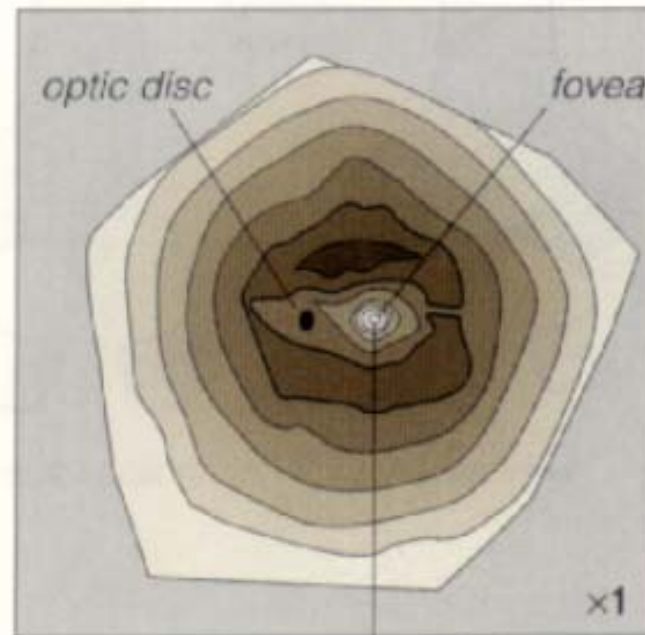




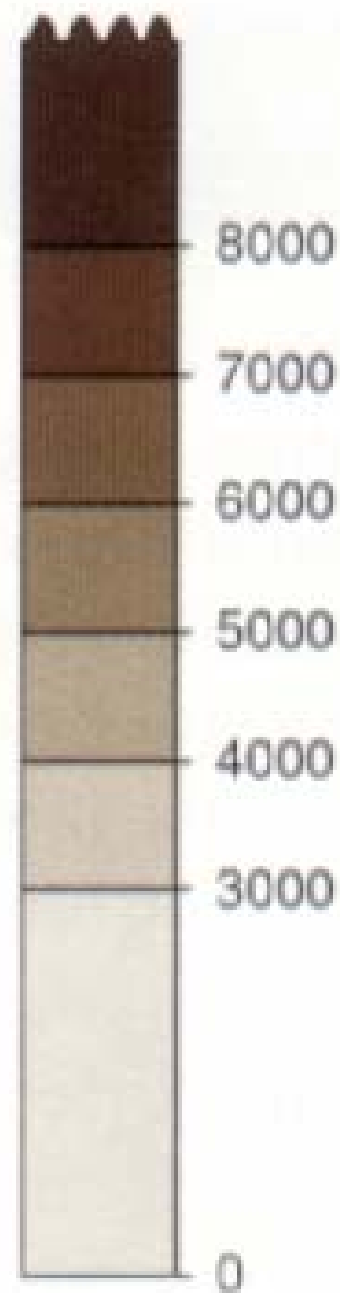
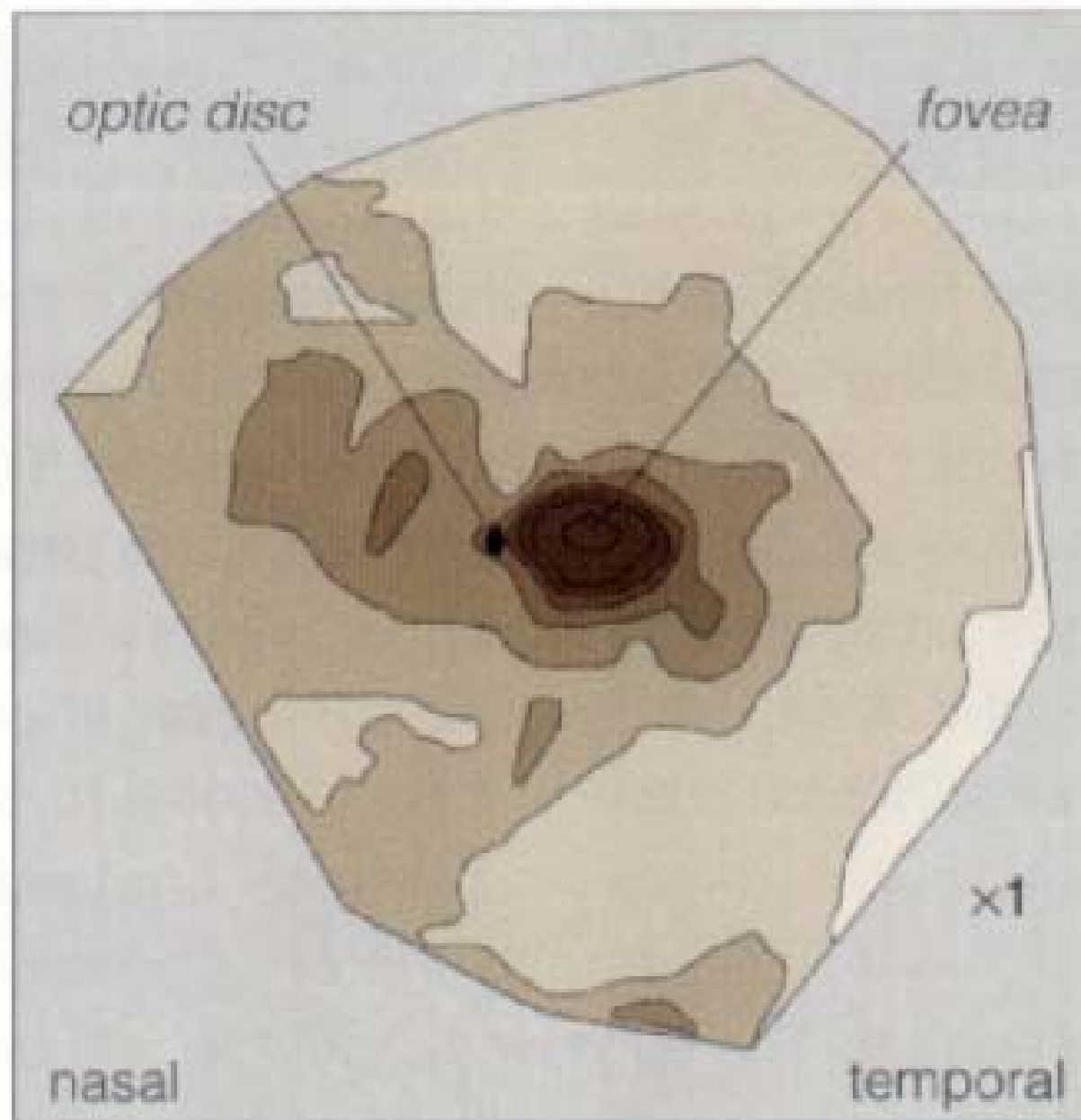
×1000



spatial density of rods

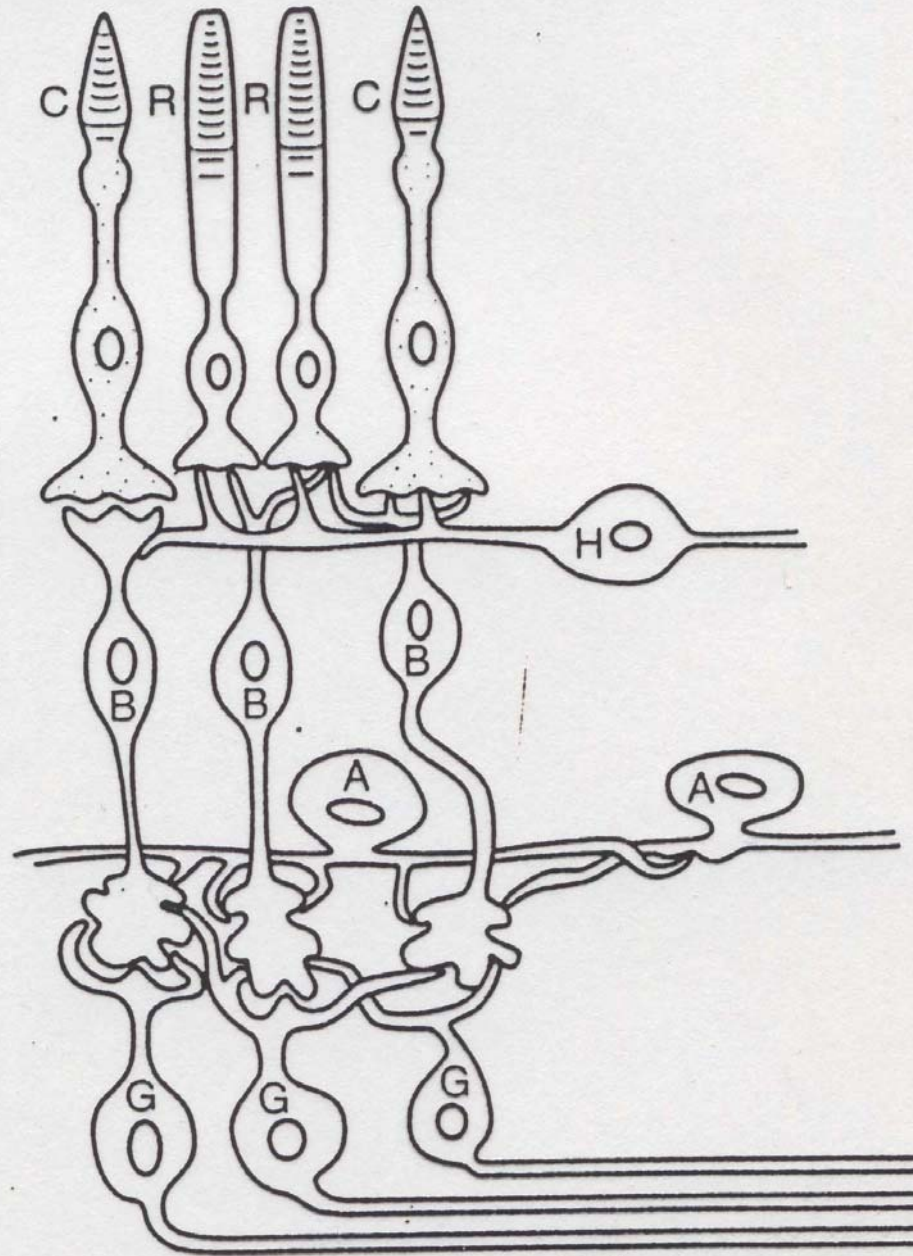


after Curcio et al., 1990

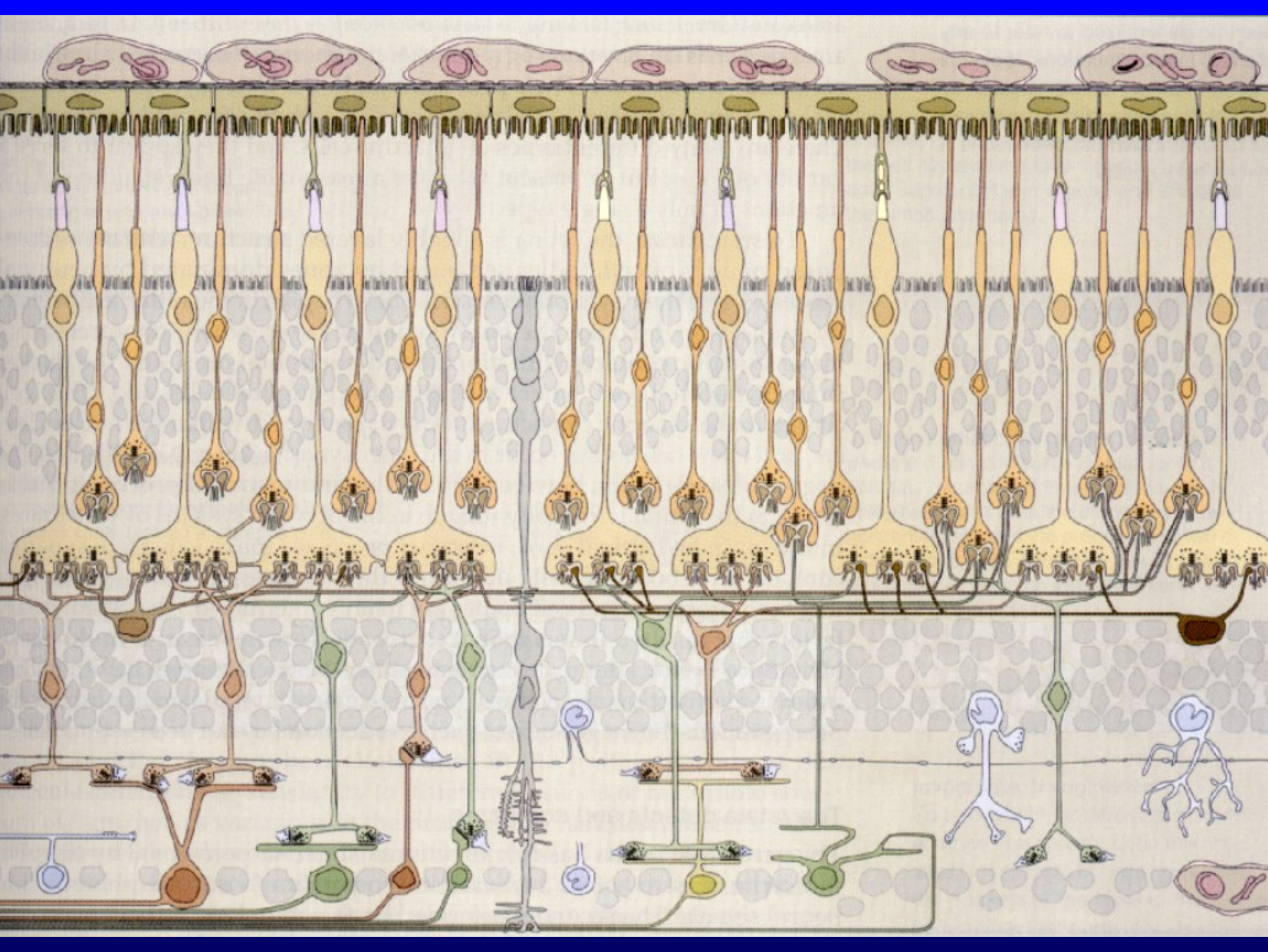


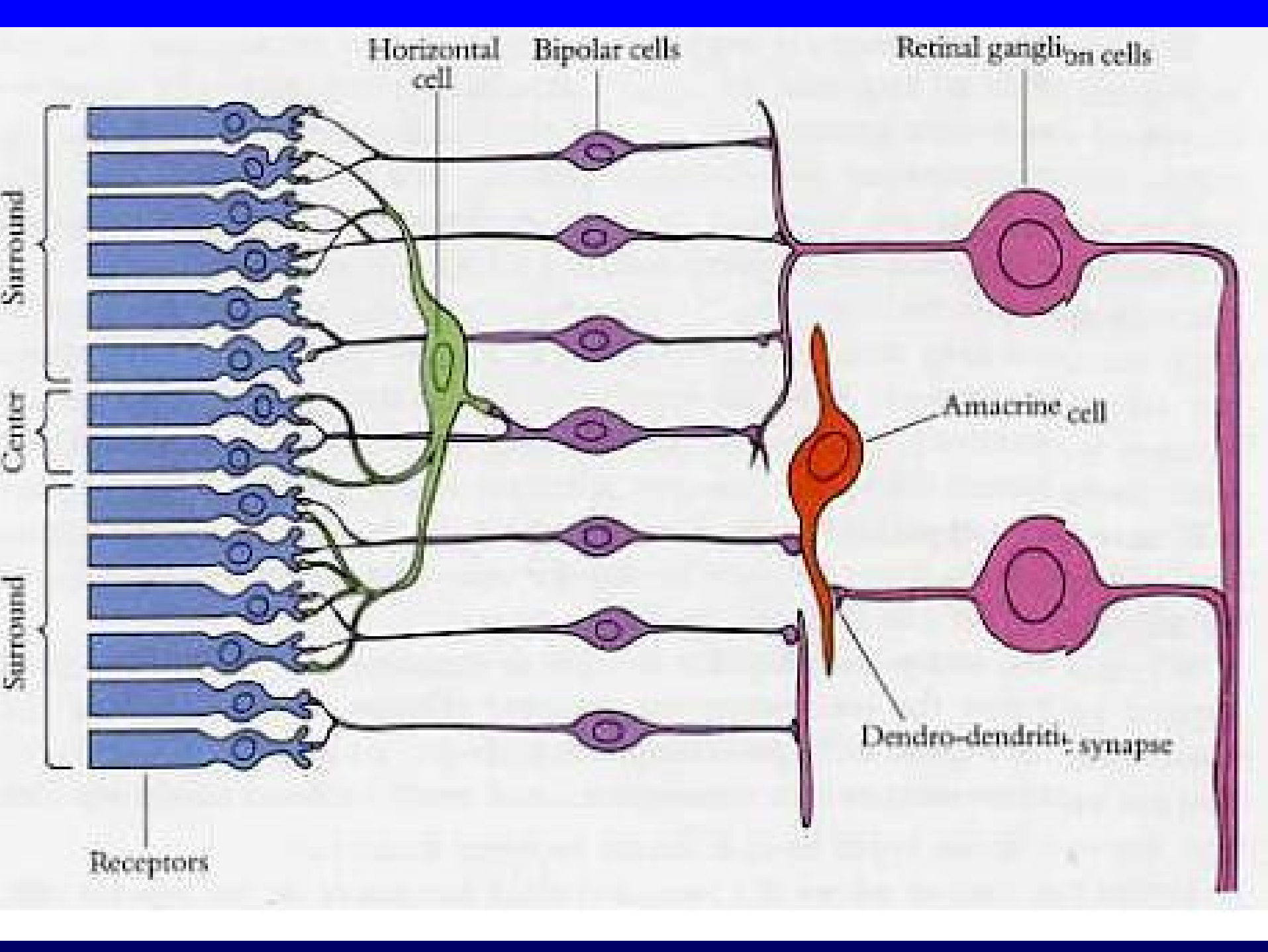
spatial density of cones

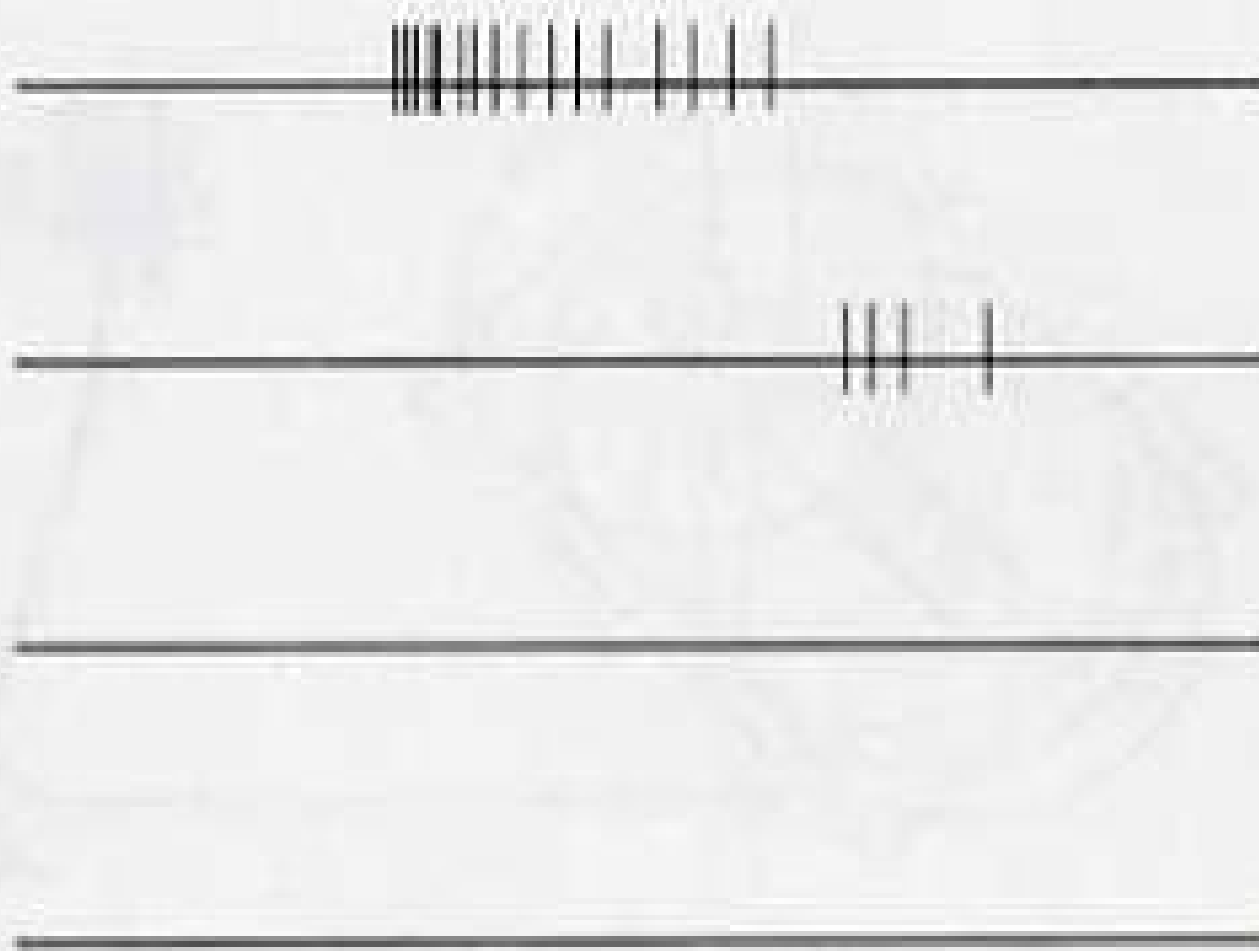
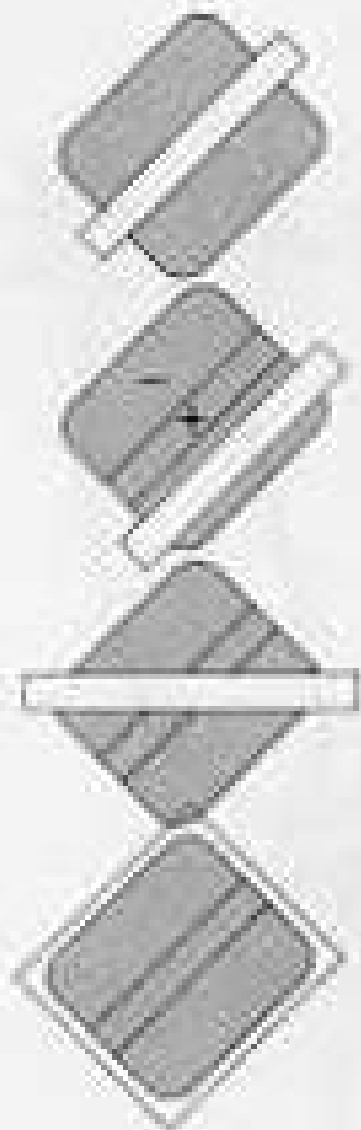
Choroid



Optic nerve



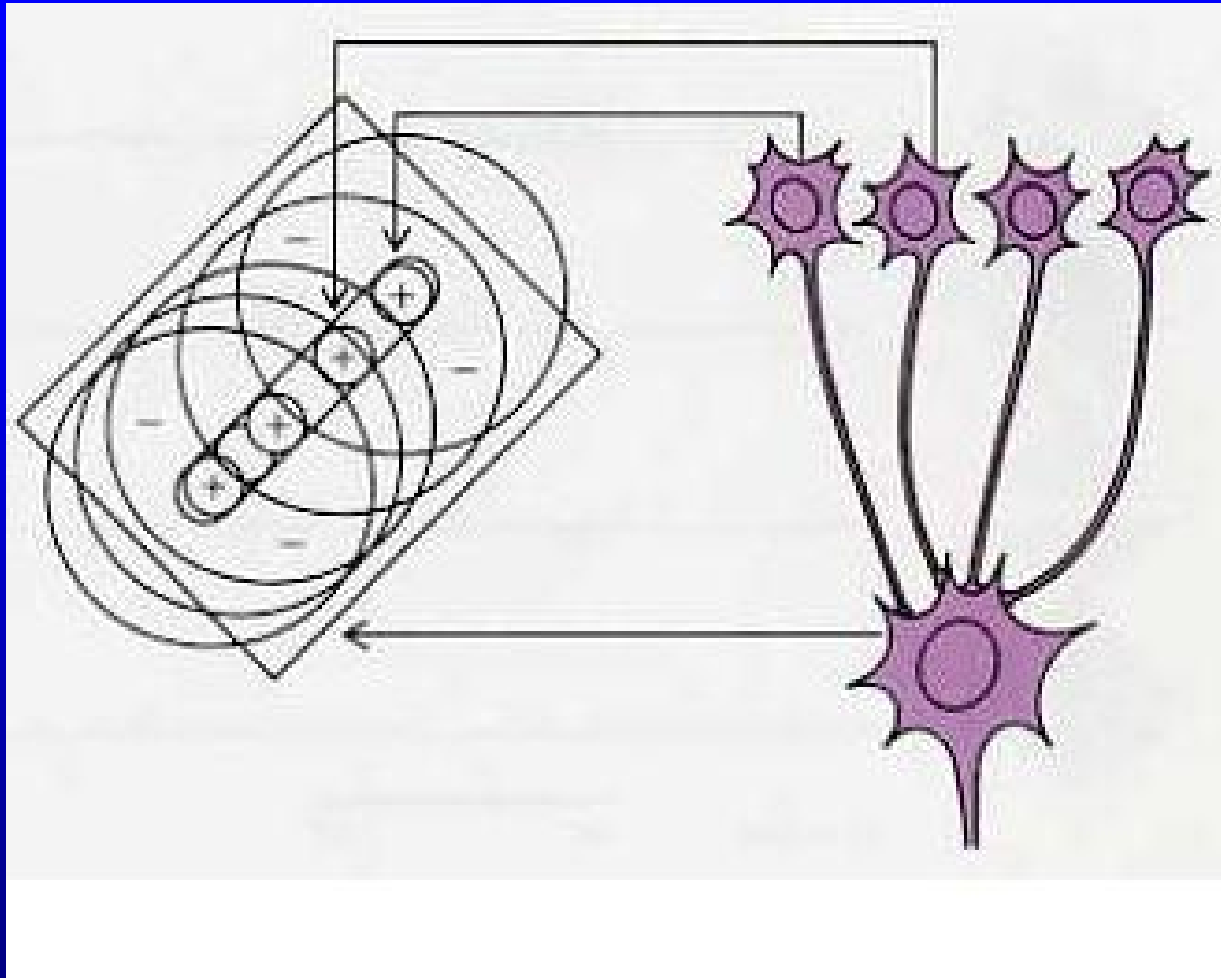




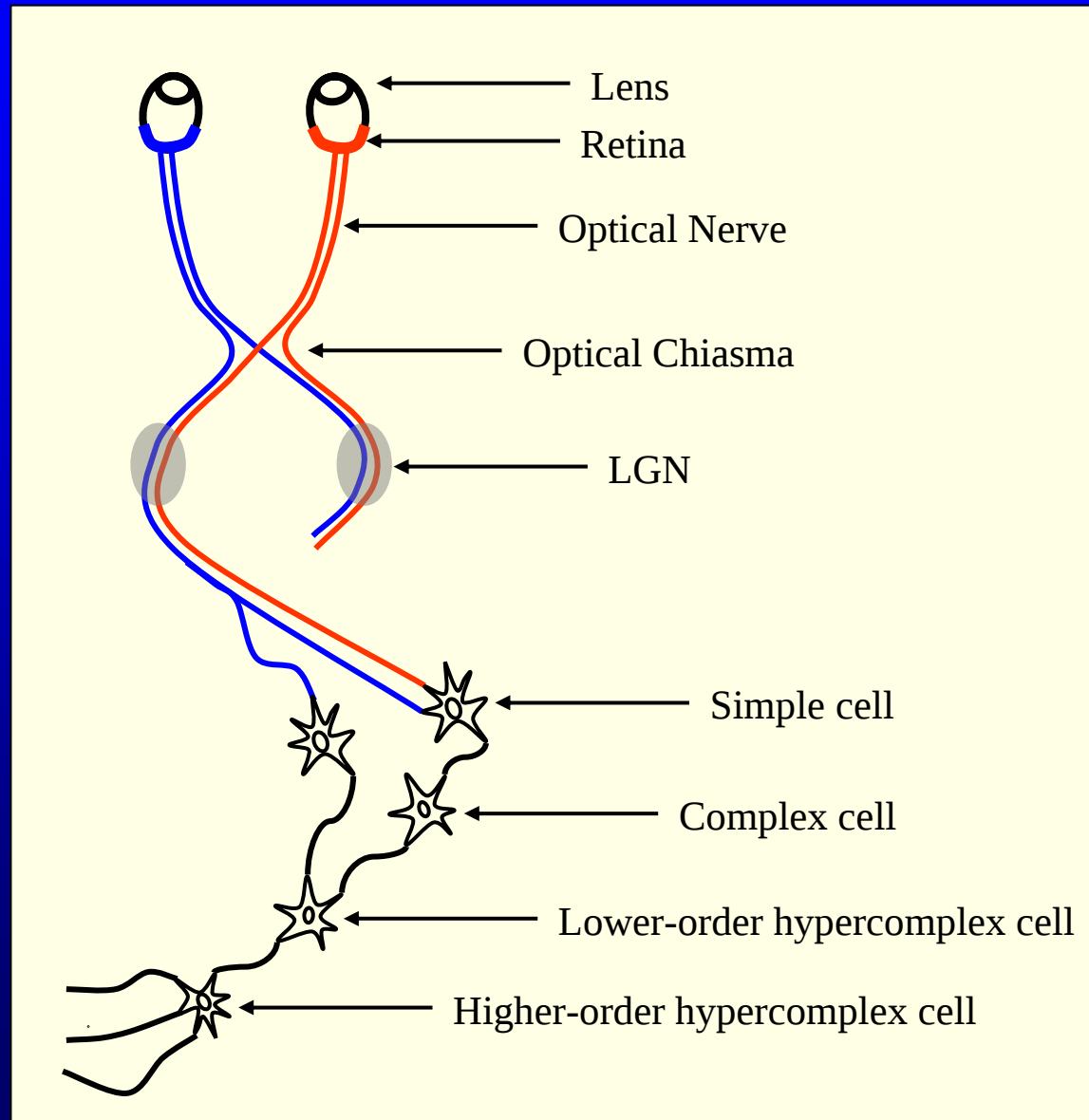
Stimulus:

on

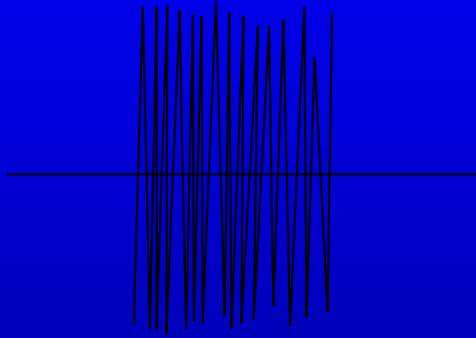
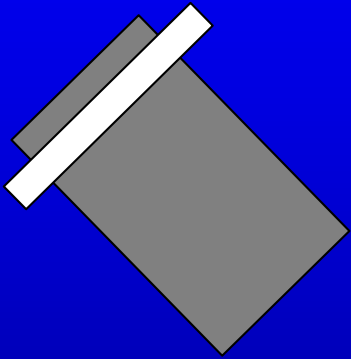
off



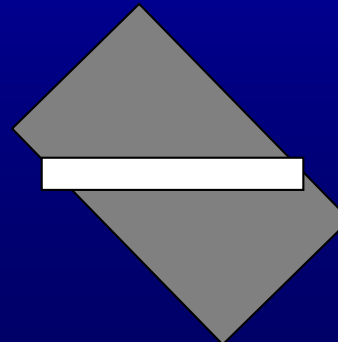
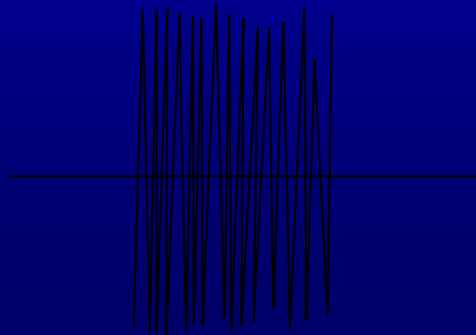
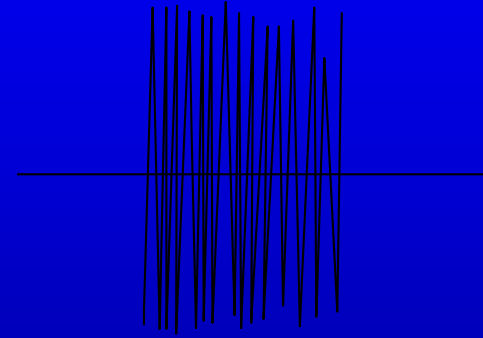
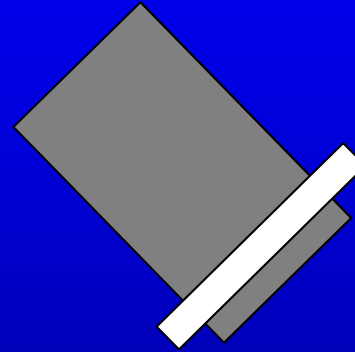
Introduction: Visual Path in Mammals



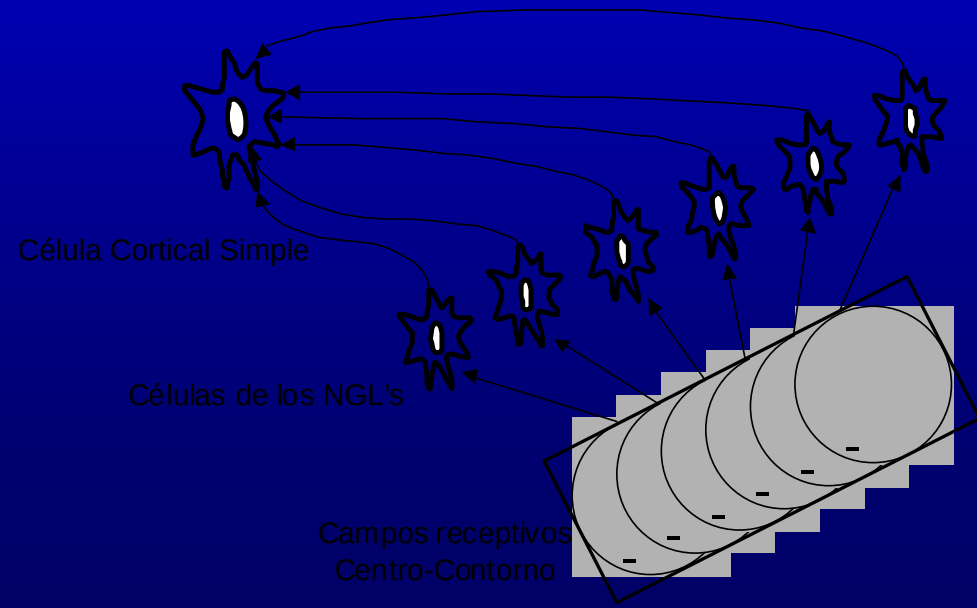
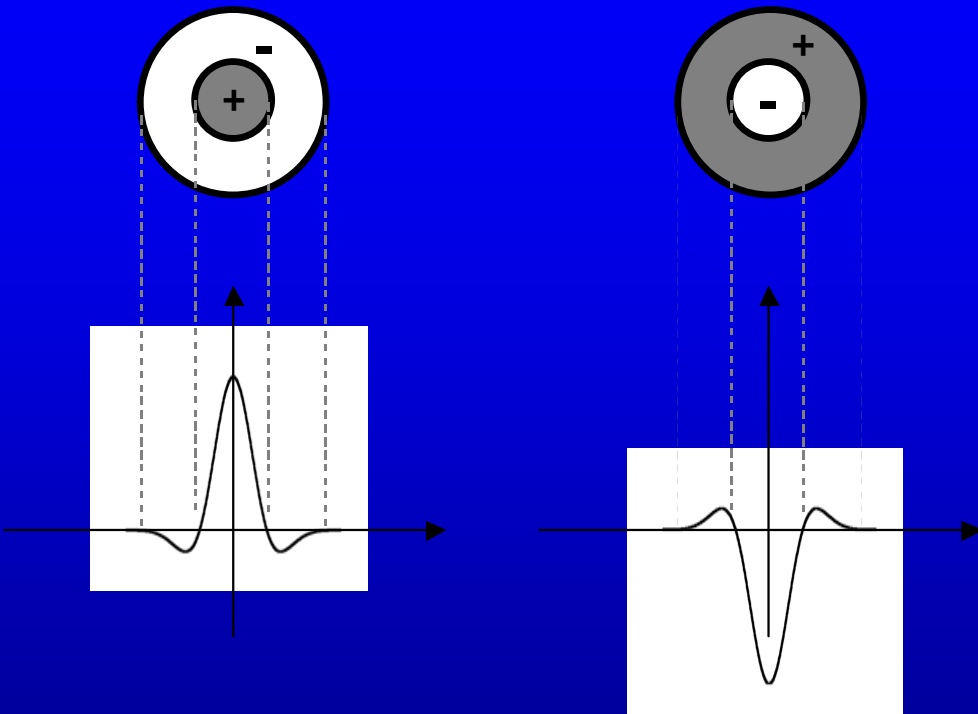
Introduction: Visual Cortex Receptive Field



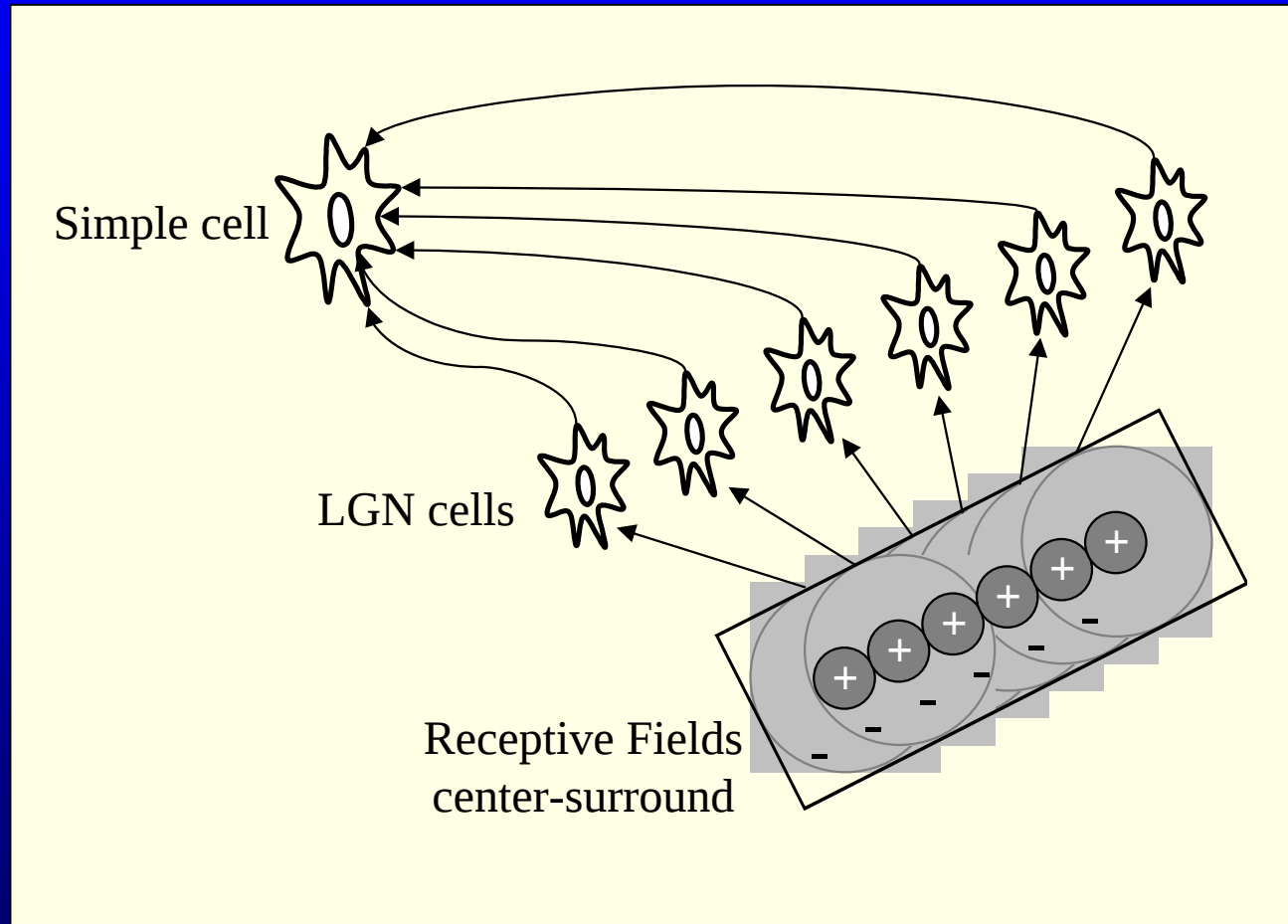
actividad



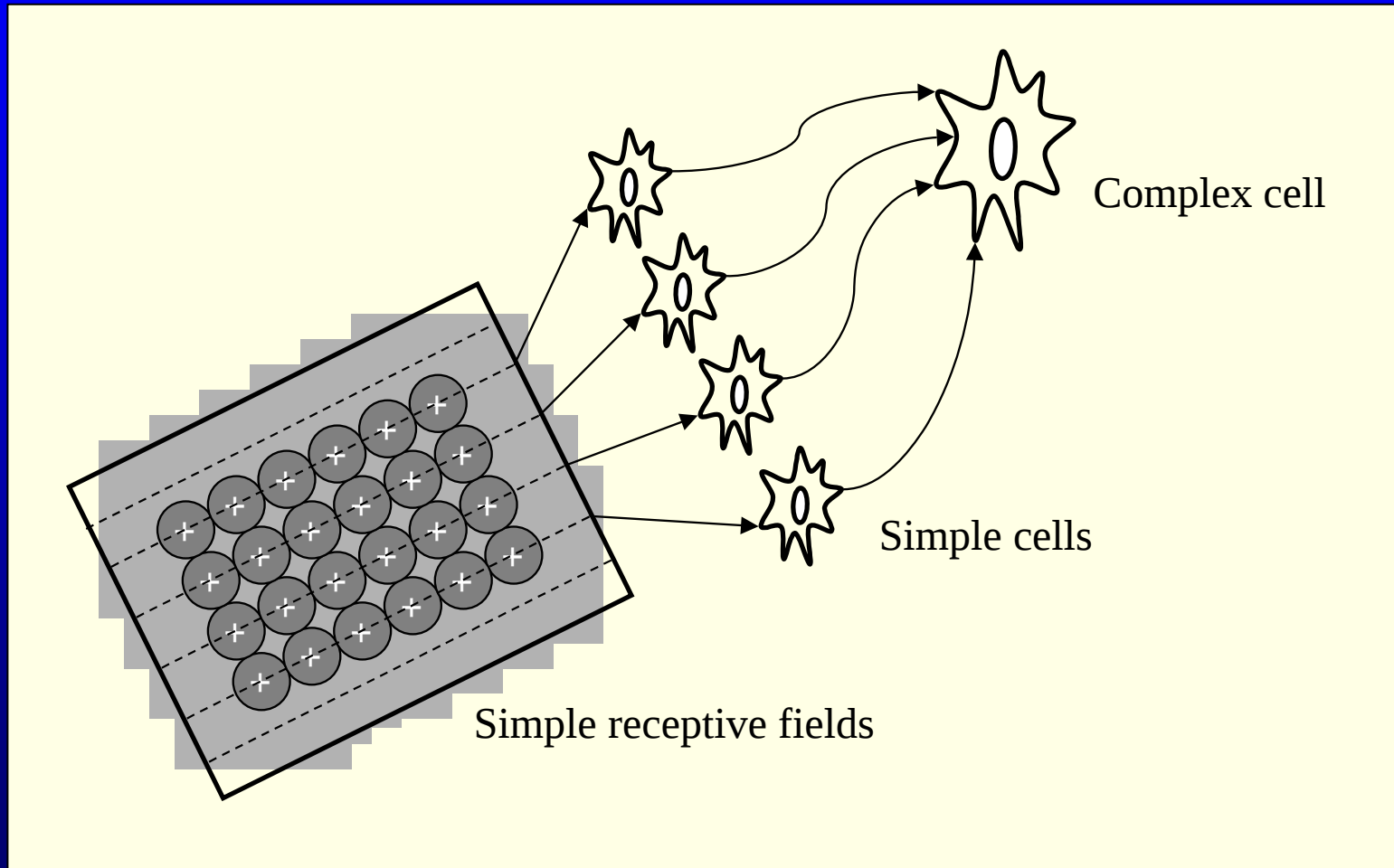
Introduction: Visual Path in Mammals



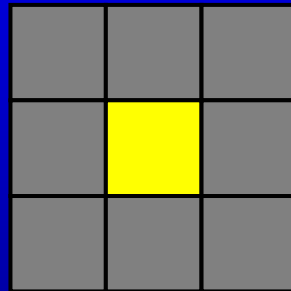
Introduction: Simple Cell Receptive Field



Introduction: Complex Cell Receptive Field

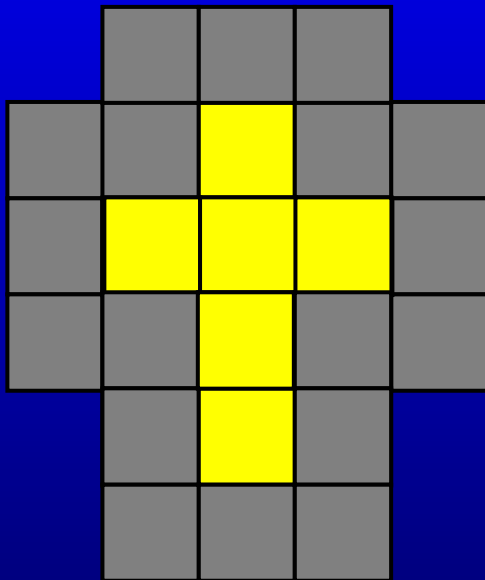


Introd.: Mathematical Representation of Receptives Fields Center-Surround



-1	-1	-1
-1	8	-1
-1	-1	-1

Introd.: “Cross” Detector using Center-Surround Receptives Fields



0	-1	-1	-1	0
-1	-3	5	-3	-1
-1	5	4	5	-1
-1	-4	4	-4	-1
0	-2	7	-2	0
0	-1	-1	-1	0

Complex Receptive Field

-1	-1	-1
-1	8	-1
-1	-1	-1

Simple Receptive Field

Introd.: Numeric example of correlation using the “Cross” detector

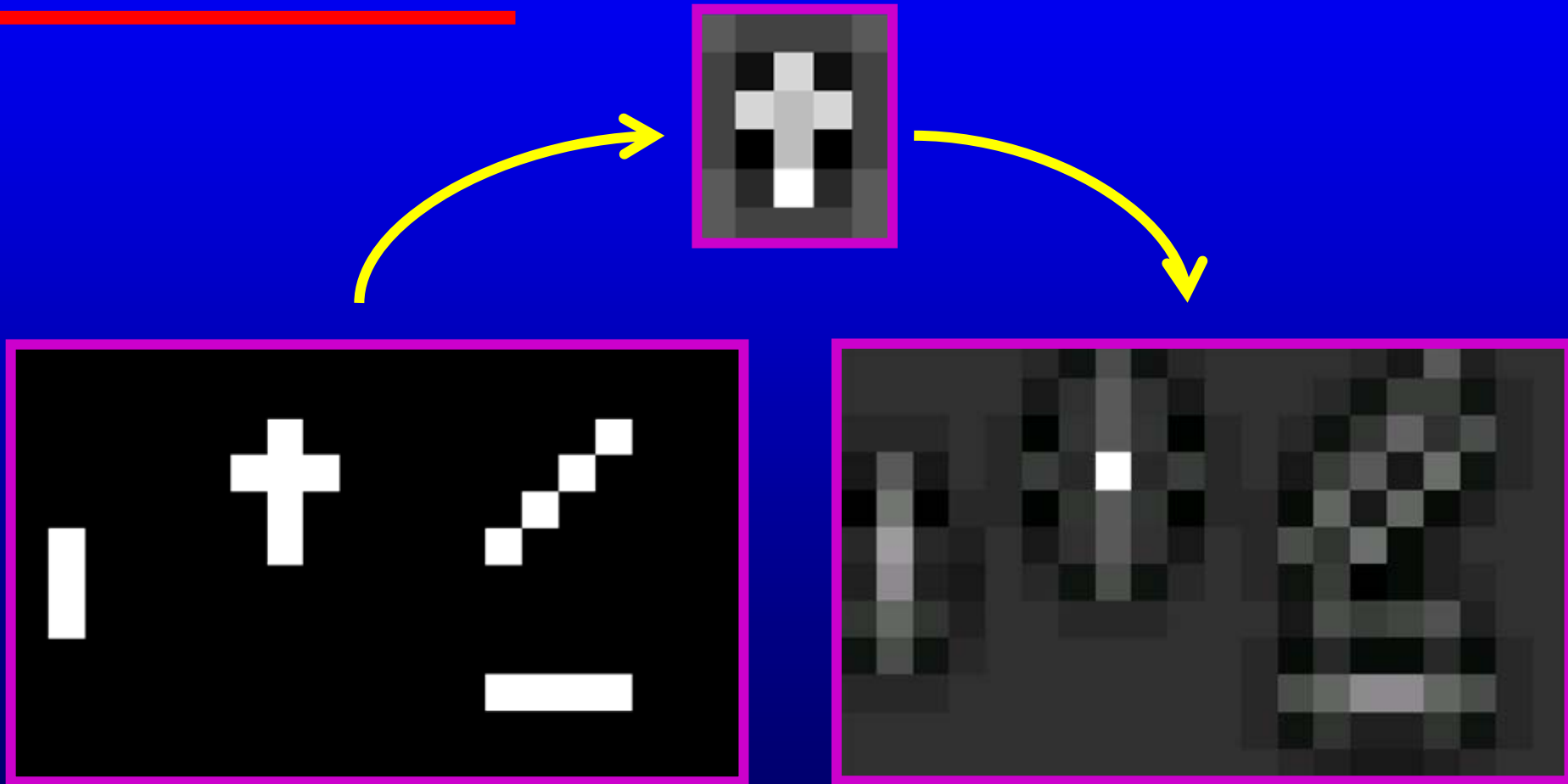
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	1	0	0	1	1	1	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0

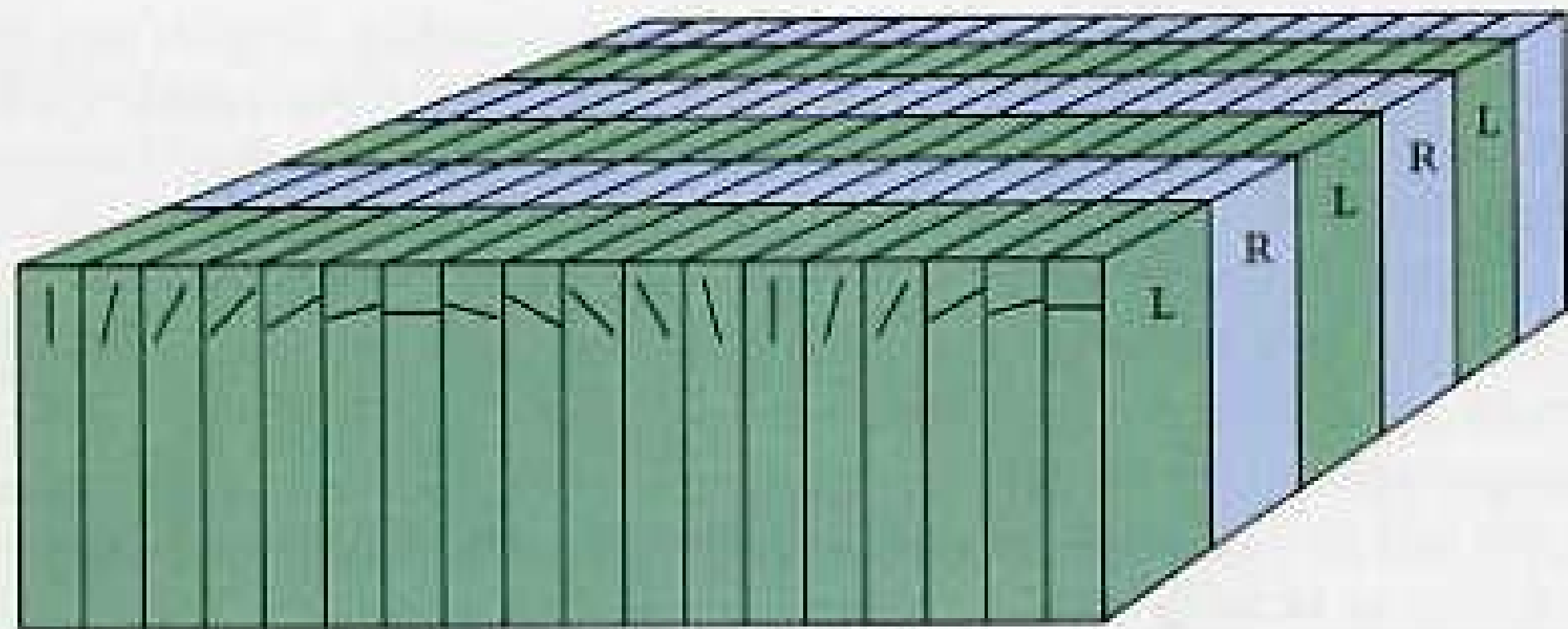
0	-1	-1	-1	0
-1	-3	5	-3	-1
-1	5	4	5	-1
-1	-4	4	-4	-1
0	-2	7	-2	0
0	-1	-1	-1	0

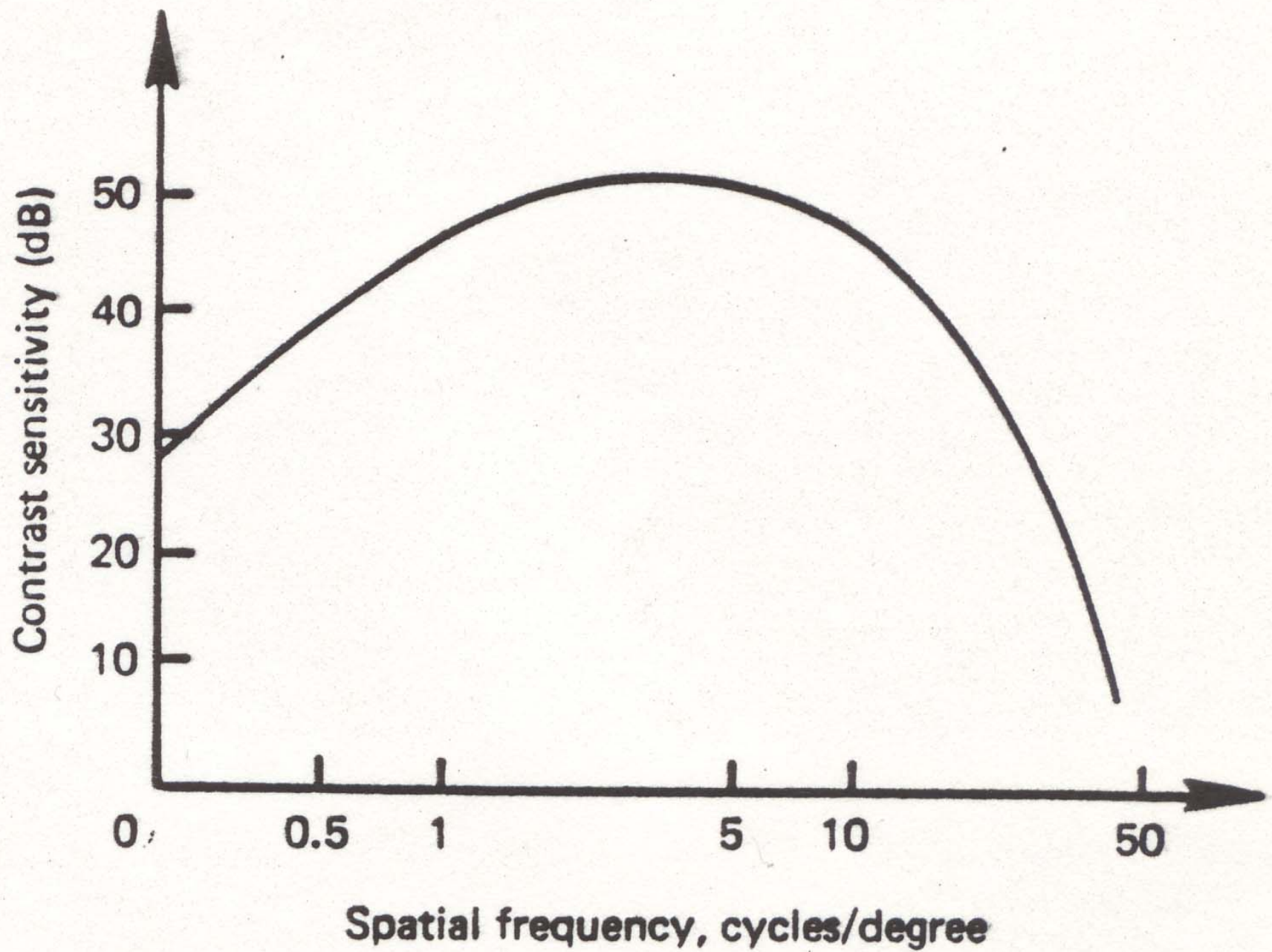
0	0	-3	6	-3	-1	-4	4	-4	-1	0
0	-1	-7	10	-7	-4	0	6	0	-3	0
0	-2	-2	14	-3	-8	1	6	1	-6	-1
0	-3	-4	20	-5	-1	-1	30	-1	2	-1
0	-3	-3	12	-4	-9	1	6	1	-6	-1
0	-2	1	8	1	-5	0	6	0	-3	0
0	-1	-4	4	-4	-2	-4	4	-4	-1	0

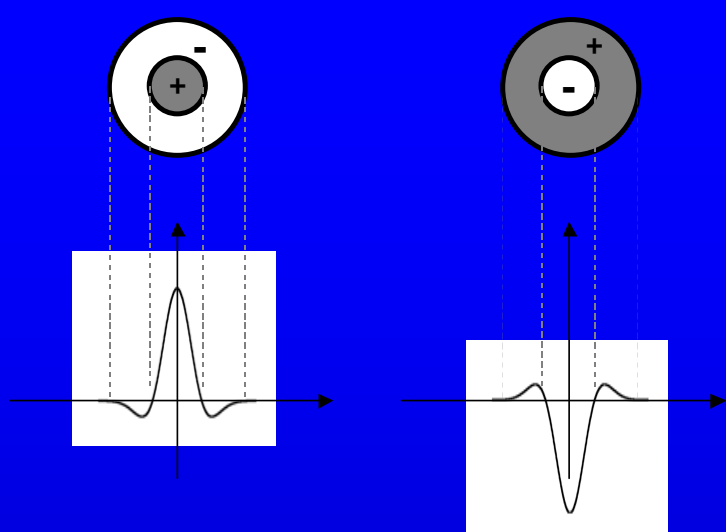
Maximum

Introduction: “Cross” Detector

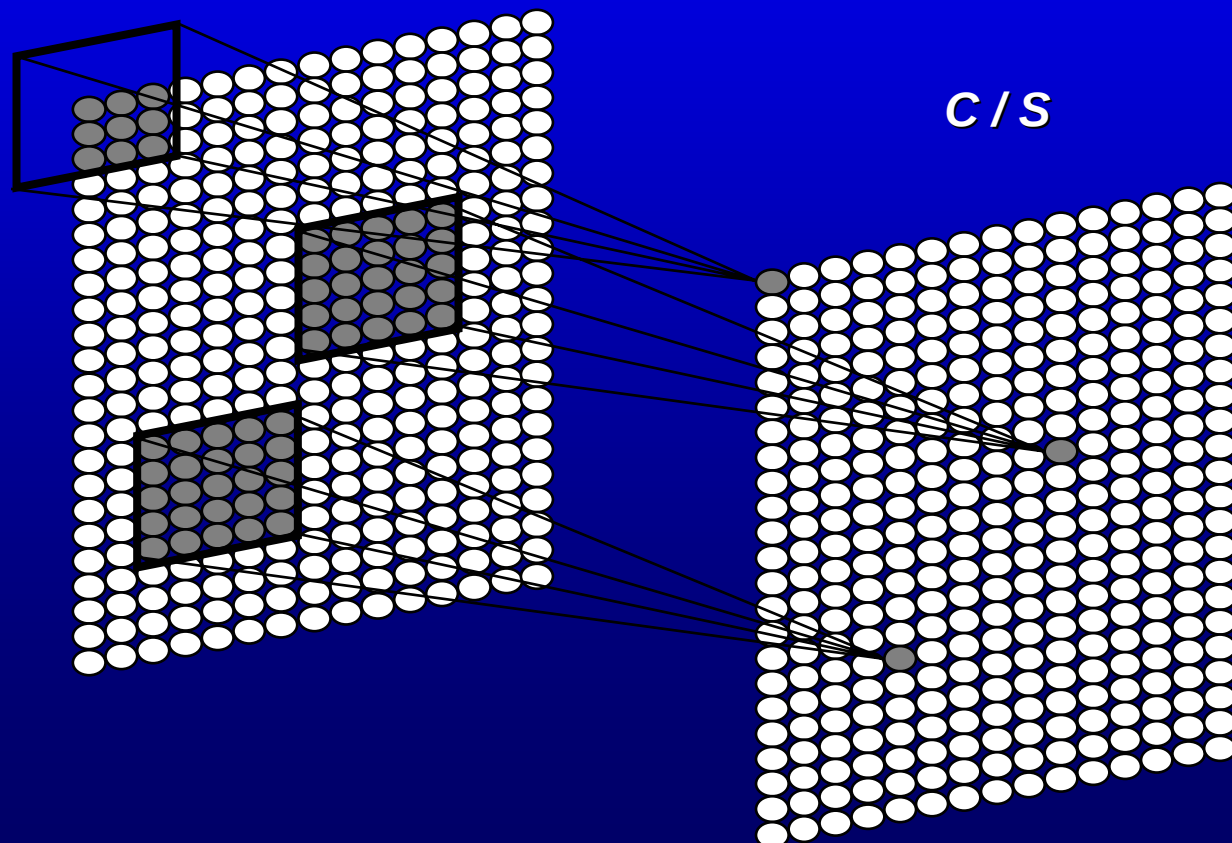




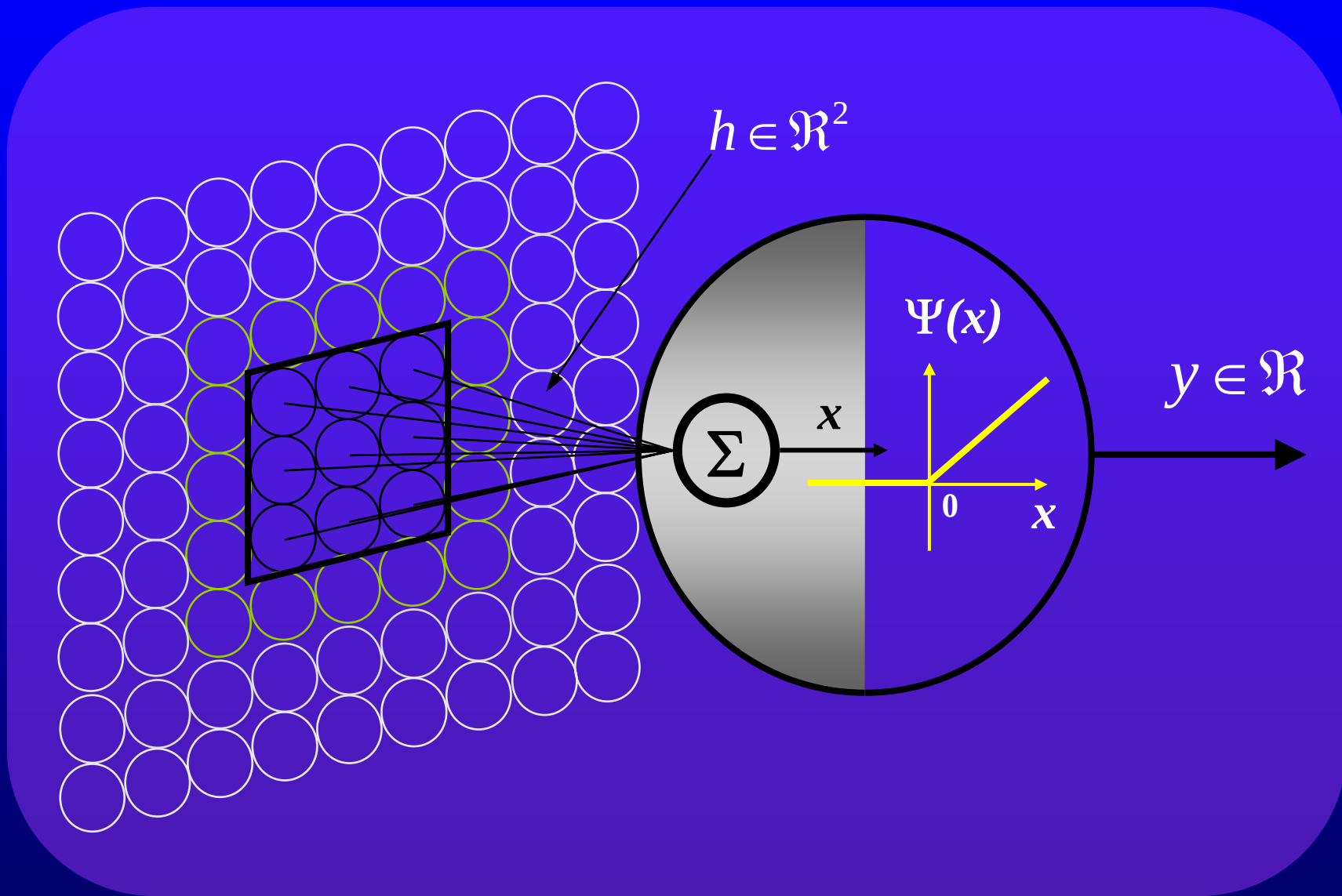




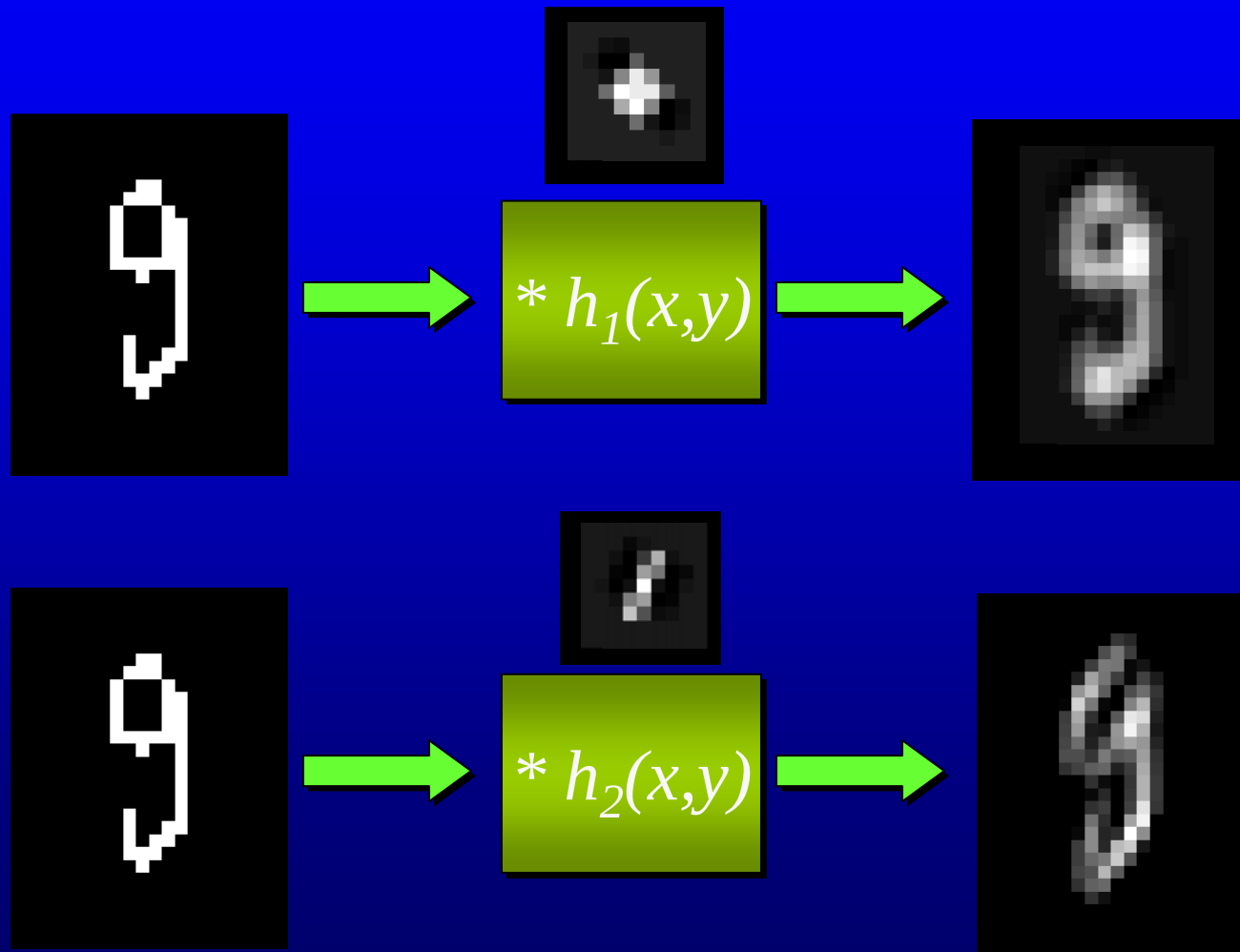
S/C



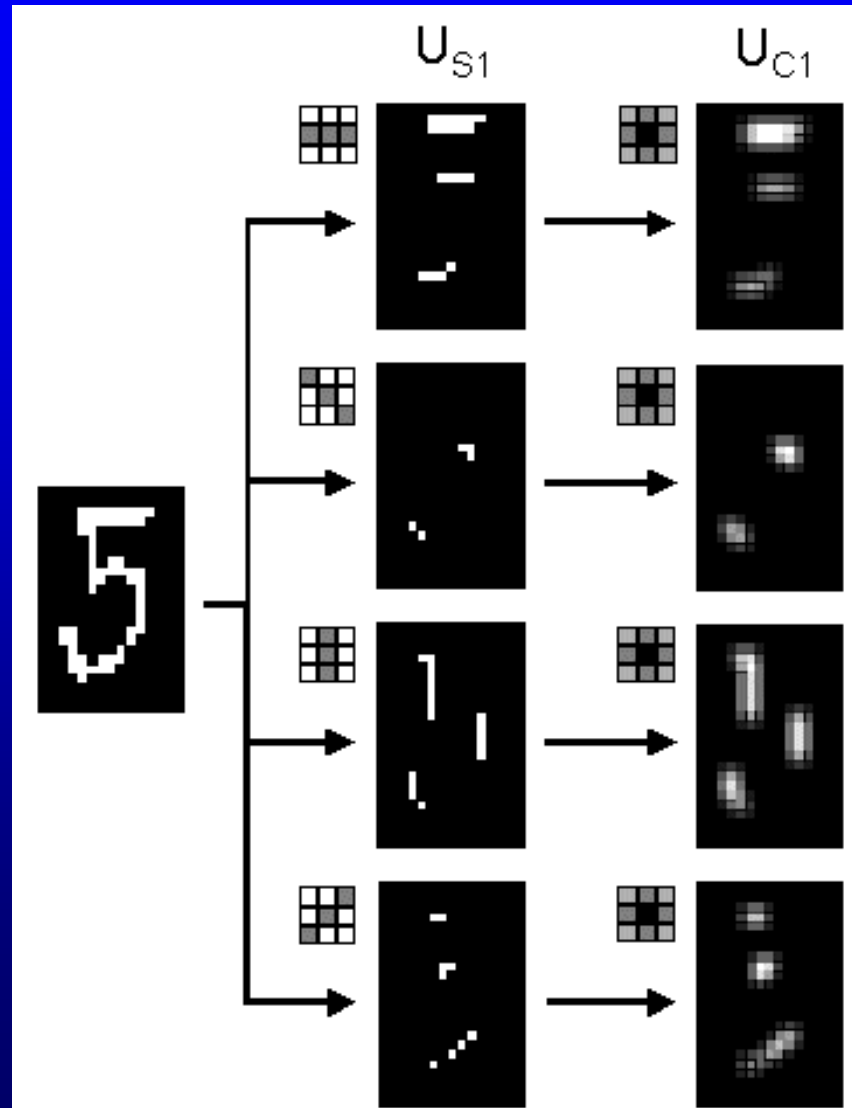
C/S

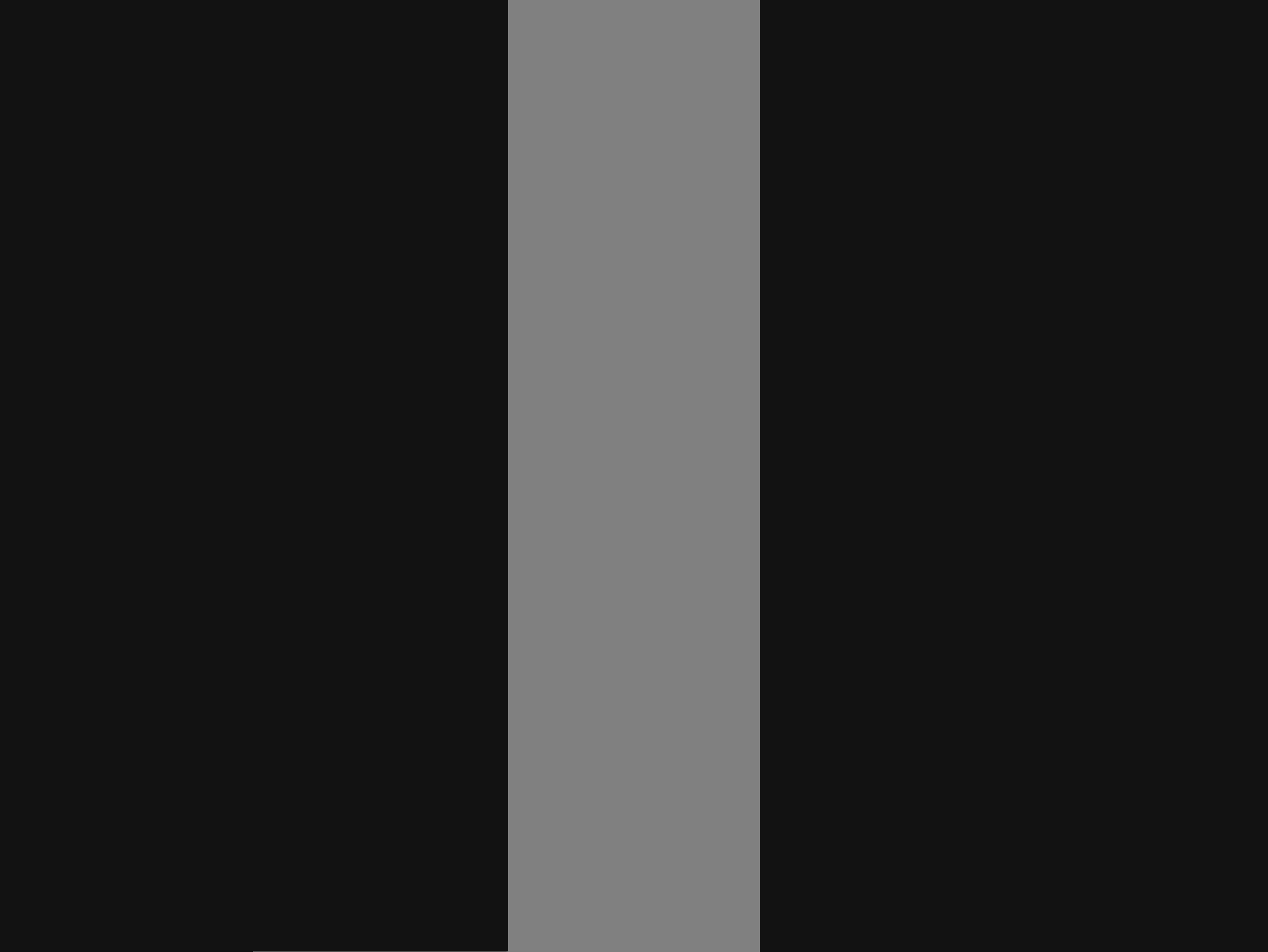


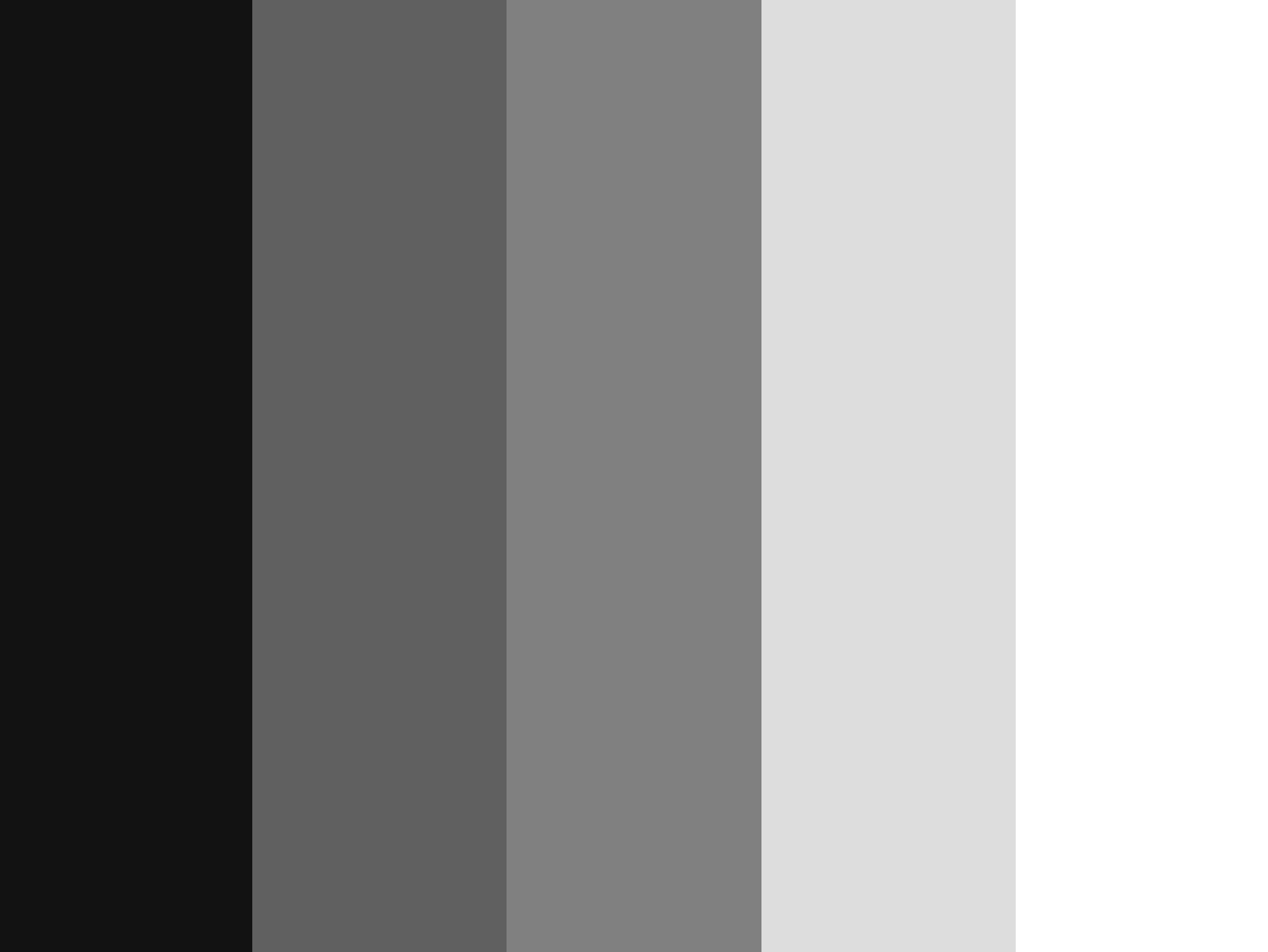
Receptive fields as filters

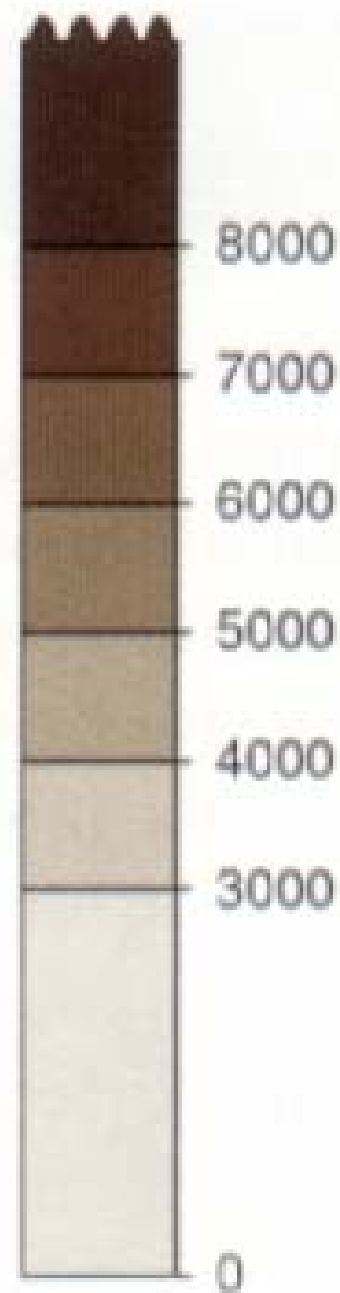
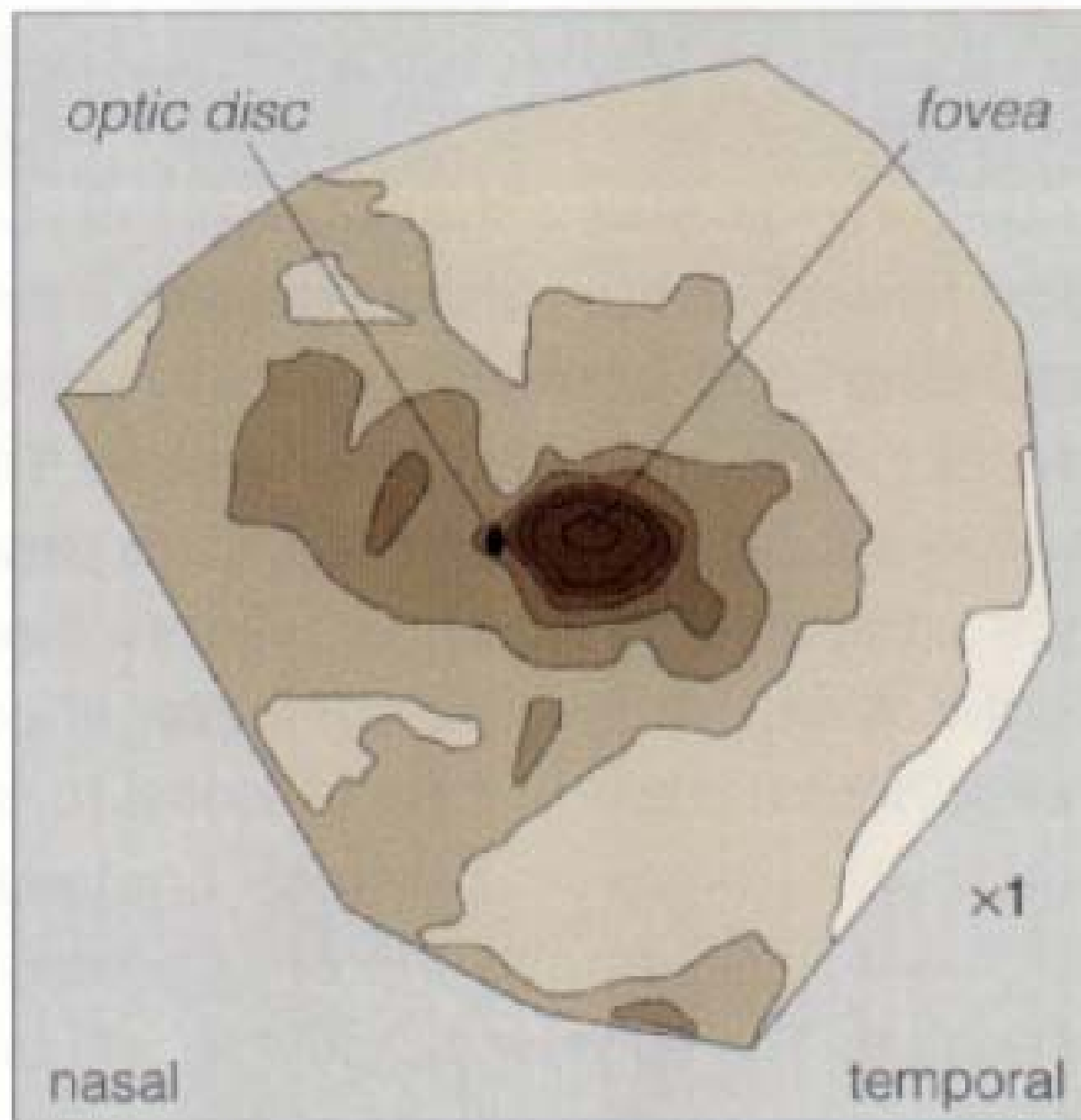


Introduction: Non-Linear Filters

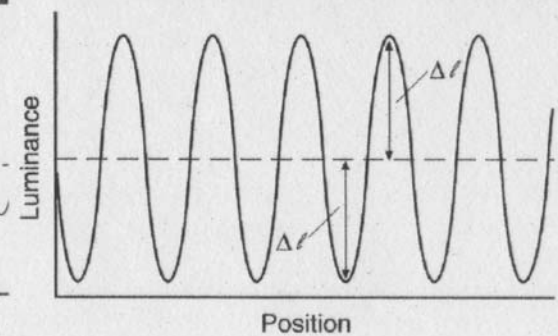
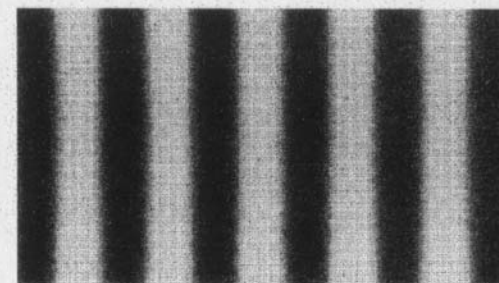
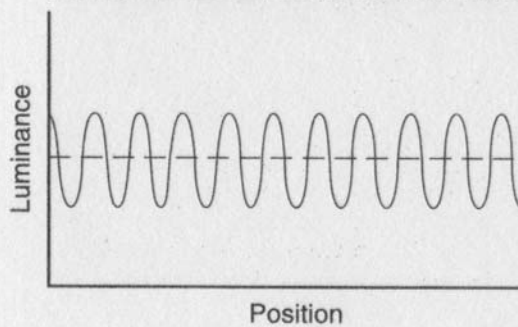
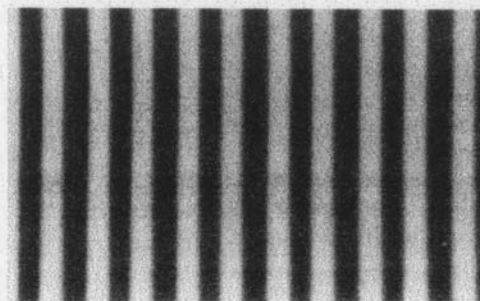
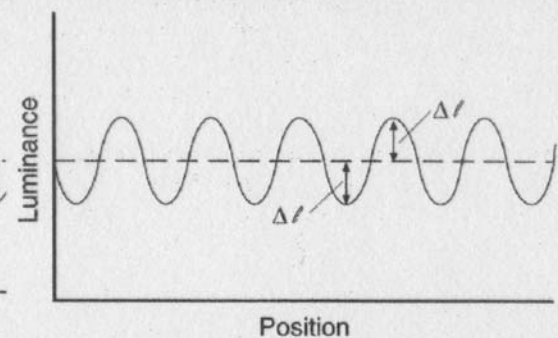
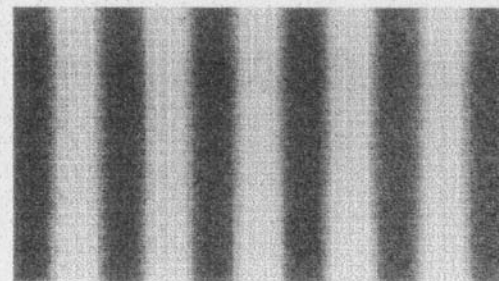
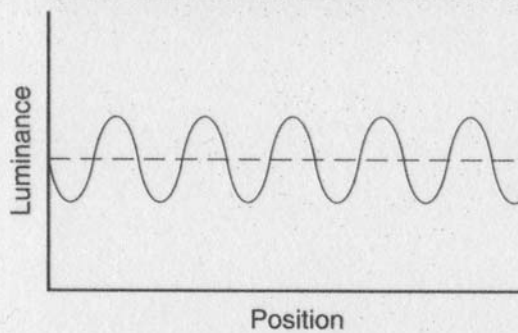
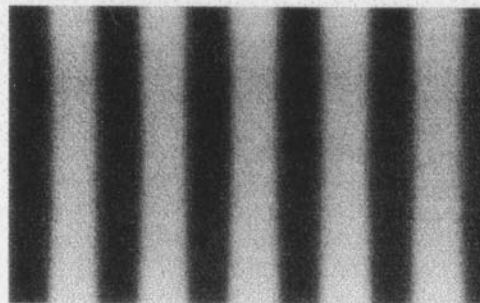




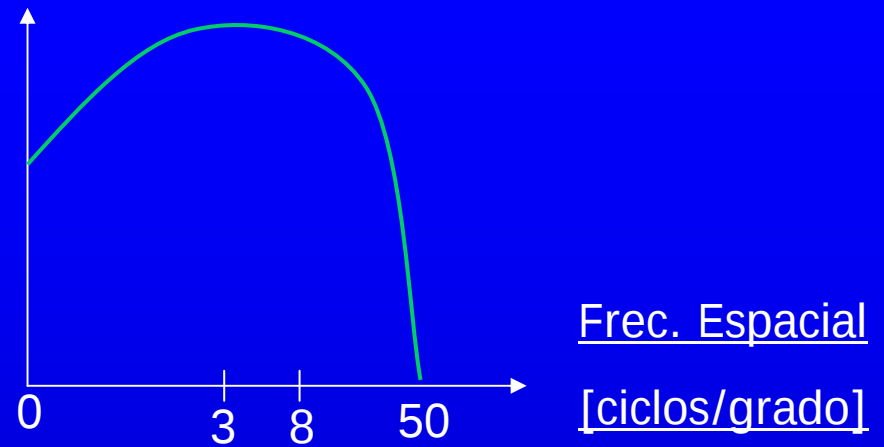




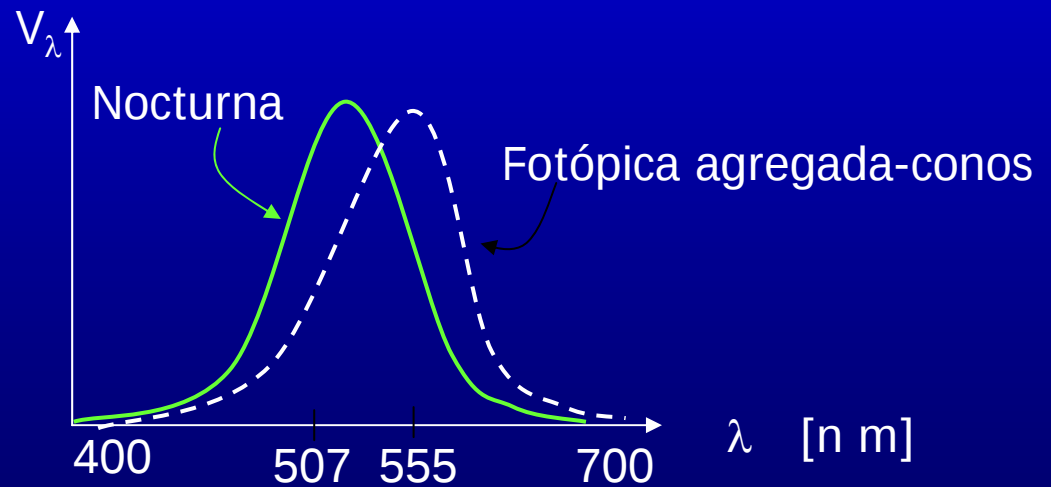
spatial density of cones



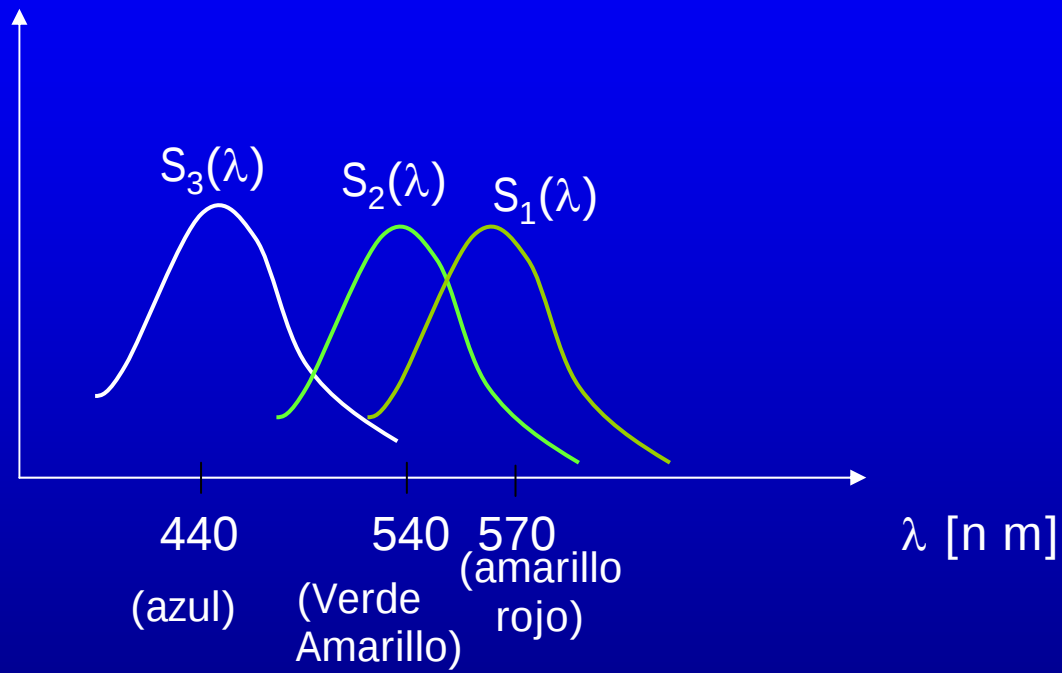
- Sensibilidad al Contraste

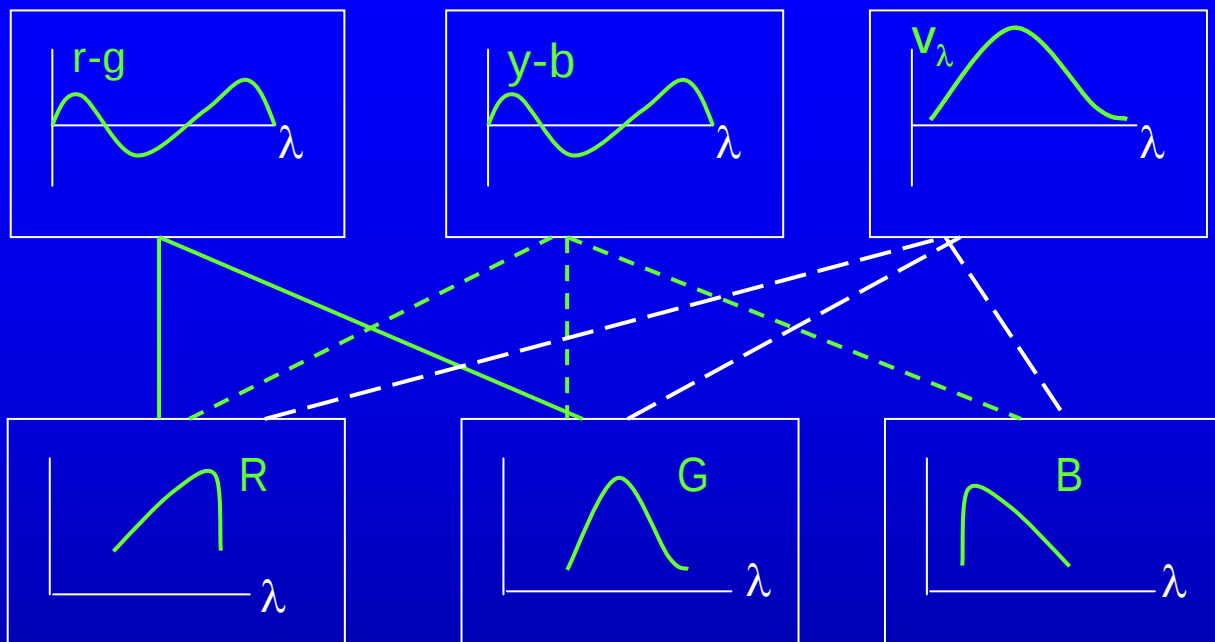


- Función eficiencia luminosa relativa

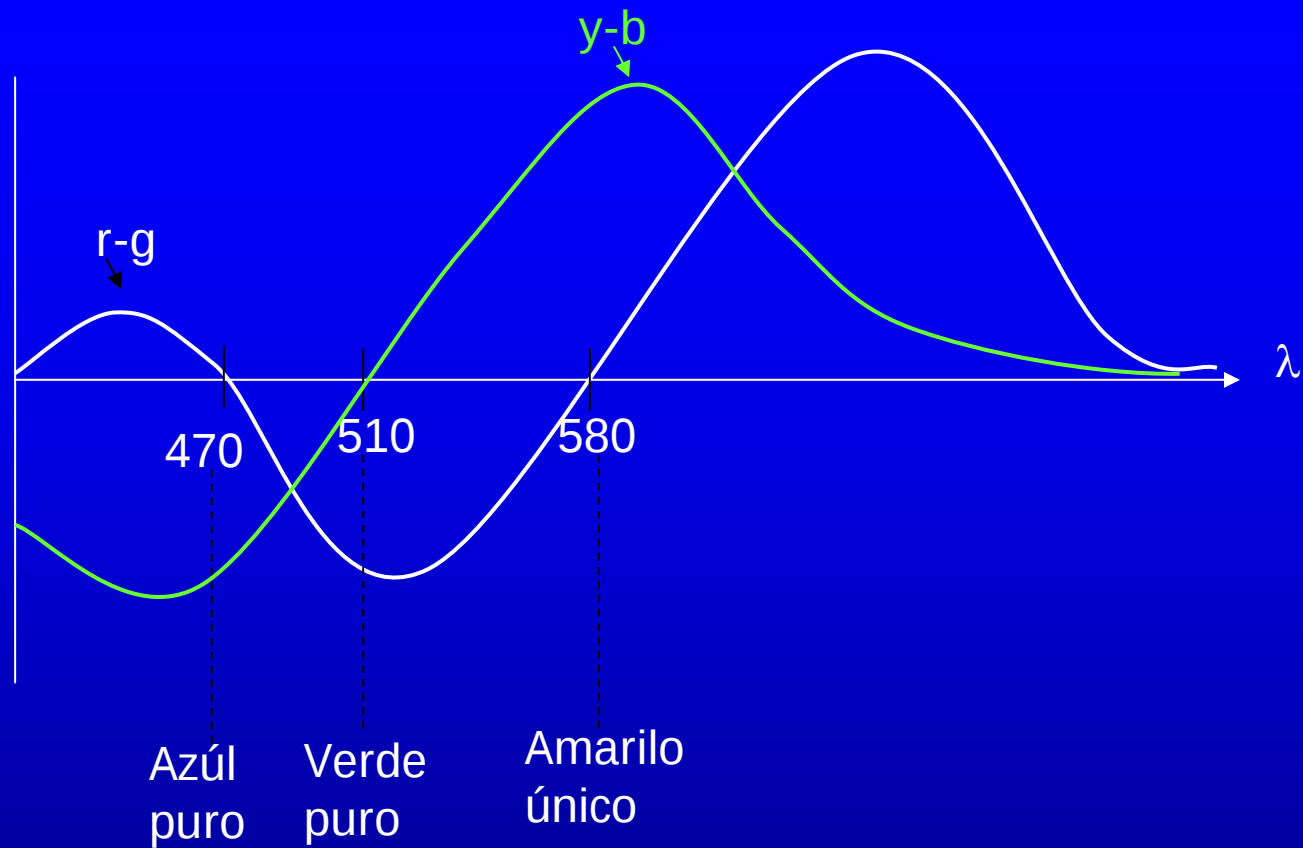


- Sensibilidad - Conos



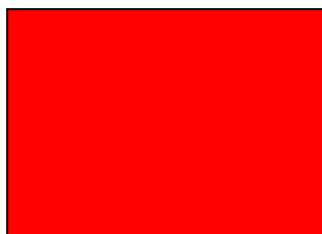


$$\begin{bmatrix} r-g \\ y-b \\ v_\lambda \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

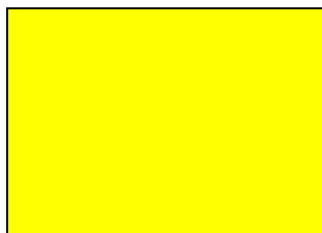


- Experimento

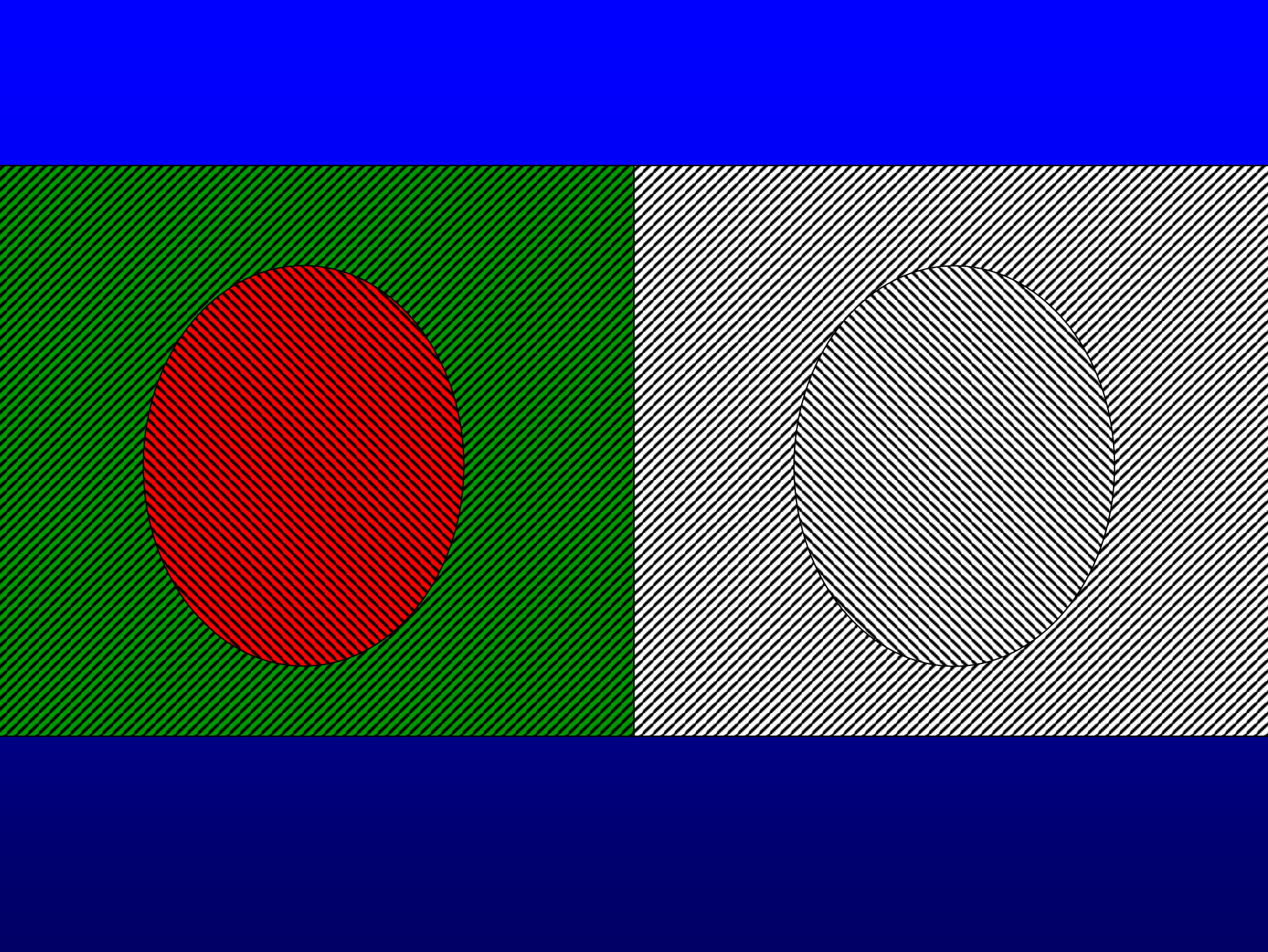
x



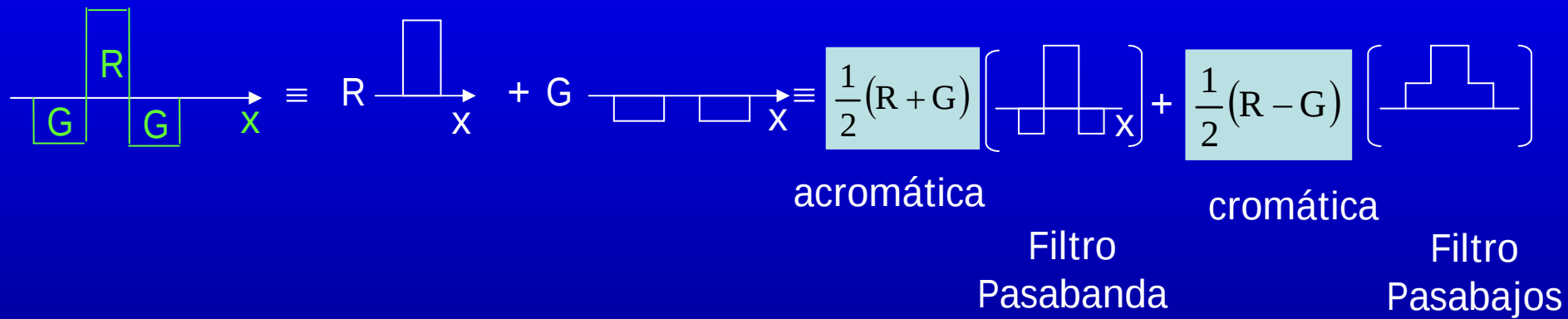
+



+

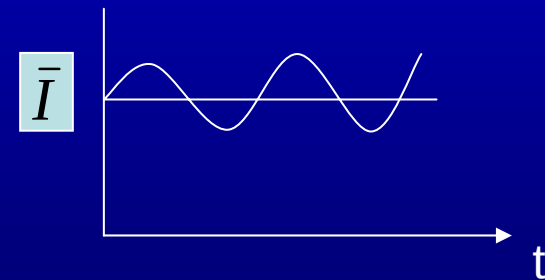
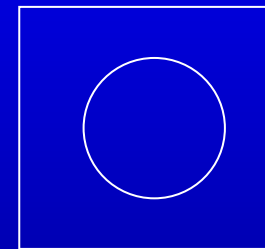
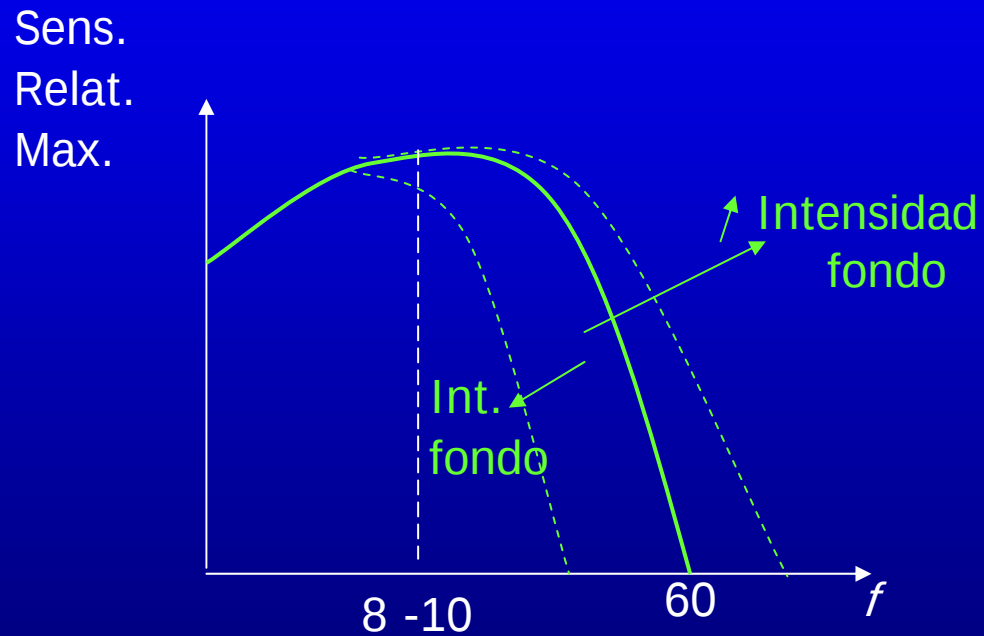


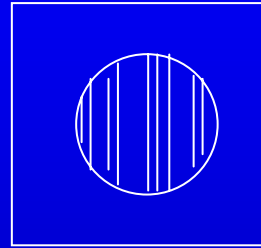
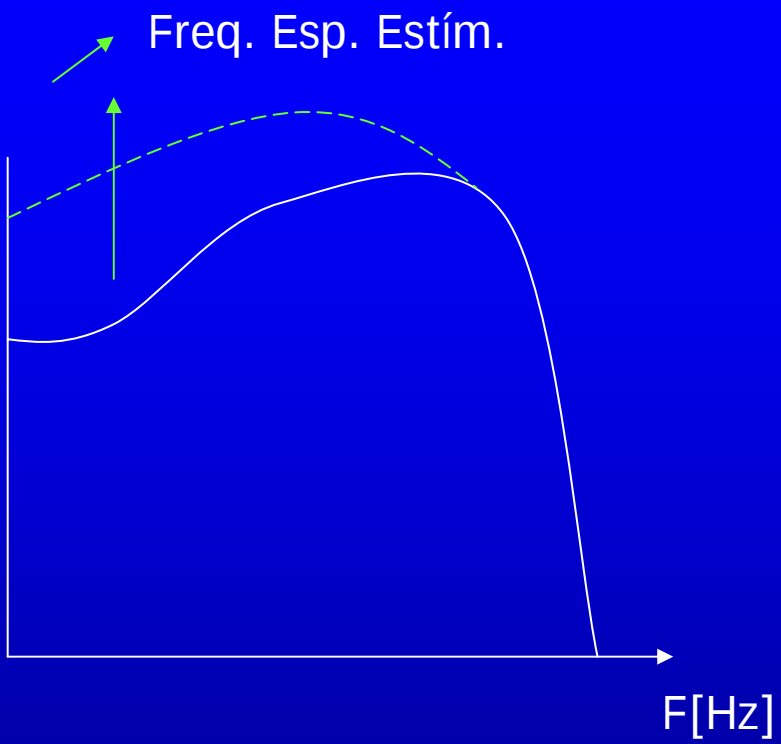
- Descomposición campo receptivo



- Propiedades Temporales

- Frec. Crítica de Fusión
- Función de Sensibilidad a la variación de contraste temporal





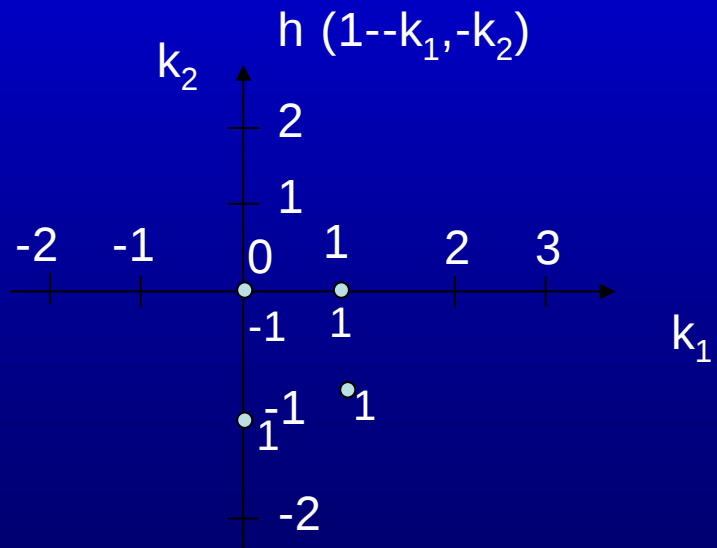
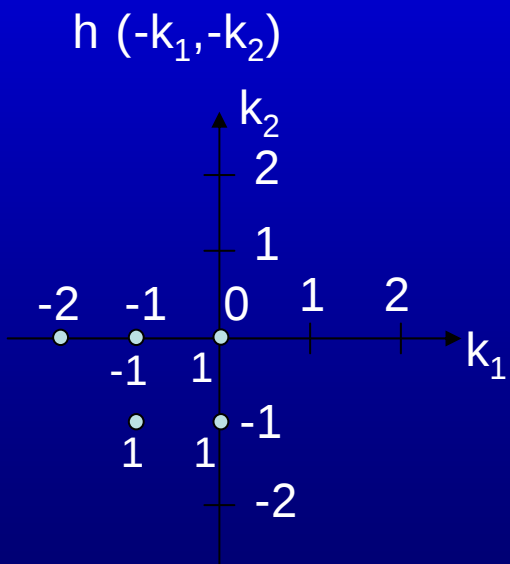
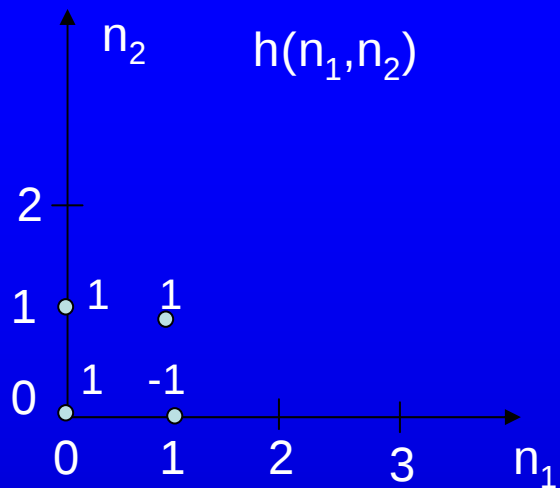
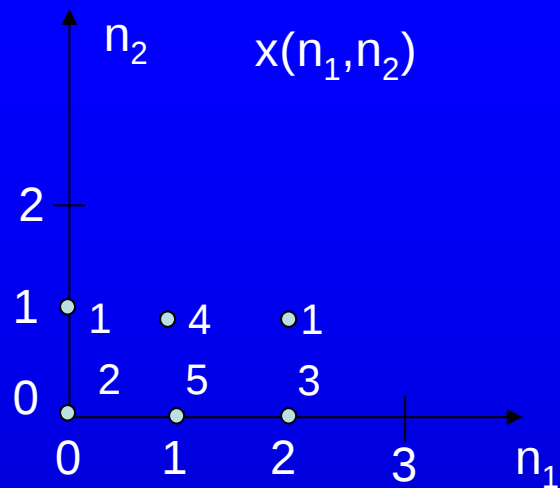
Señales 2-D

- Secuencia 2-D

$$\begin{matrix} \delta(n_1, n_2) \\ u(n_1, n_2) \end{matrix}$$

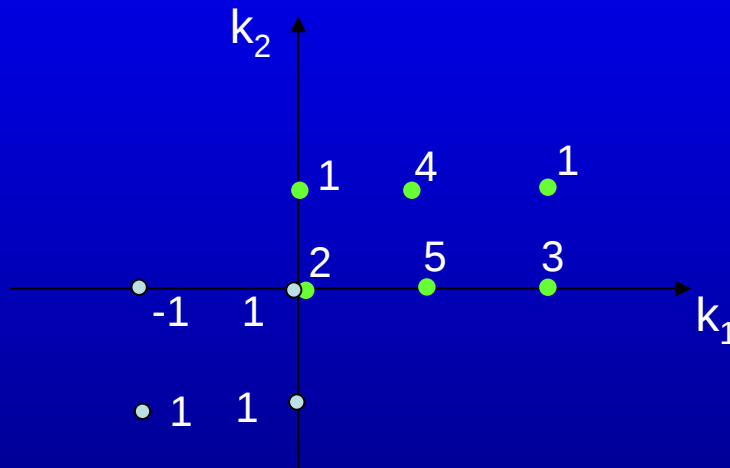
- Convolución 2-D

$$y(n_1, n_2) = x(n_1, n_2) * h(n_1, n_2) = \sum_{k_1} \sum_{k_2} x(k_1, k_2) h(n_1 - k_1, n_2 - k_2)$$



$$n_1 = n_2 = 0$$

$$y(0,0) = \sum_{k_1} \sum_{k_2} (-k_1, -k_2) x(k_1, k_2)$$



$$Y(0,0) = 1 \cdot 2 = 2$$

Adquisición de Imágenes

- **Sensores**

- Cámaras estándares, barrido progresivo, barrido de línea
- Analógica/digital

- **Frame Grabber**

$$|H(\omega_1, \omega_2)|$$

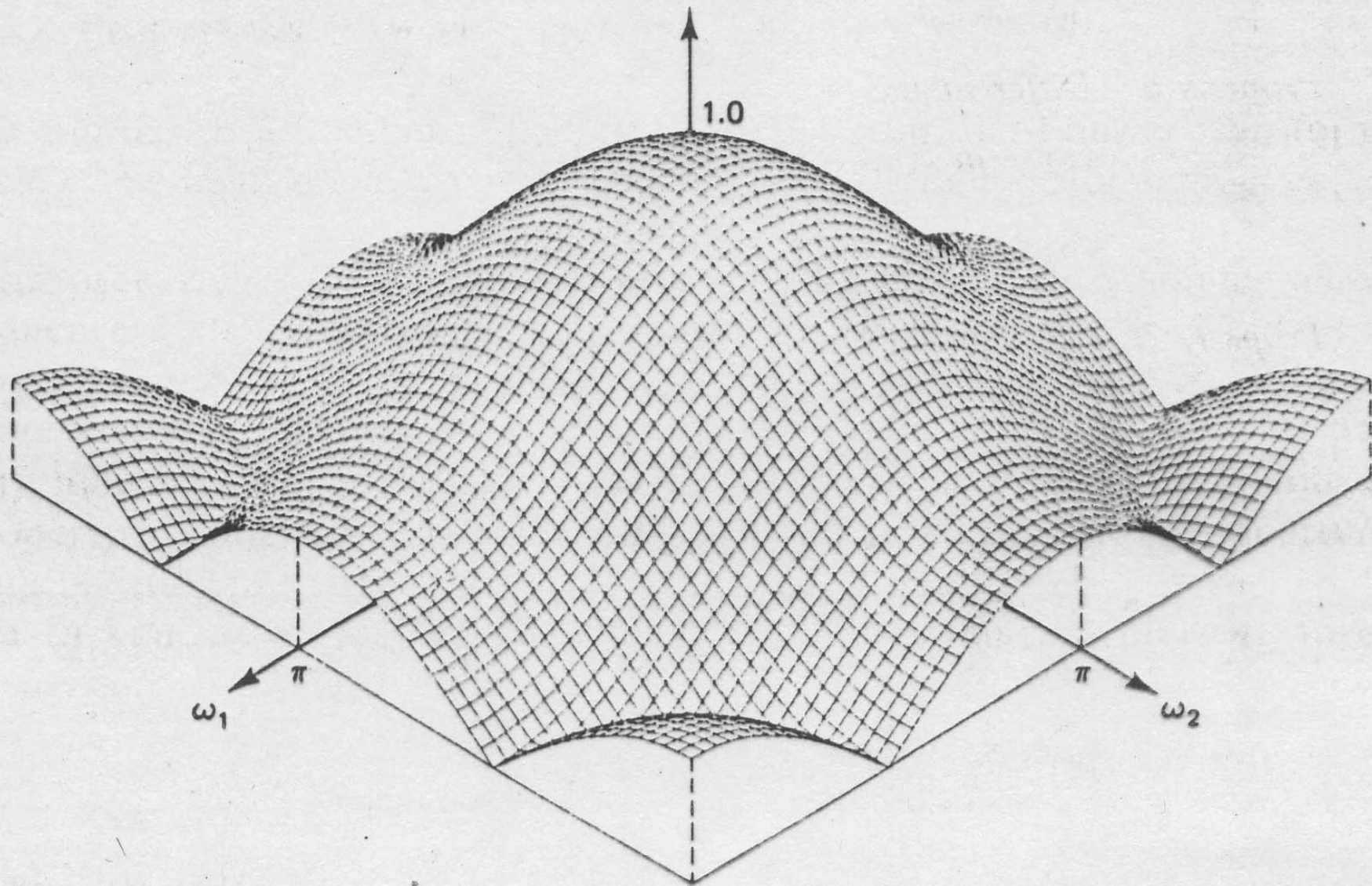
1.0

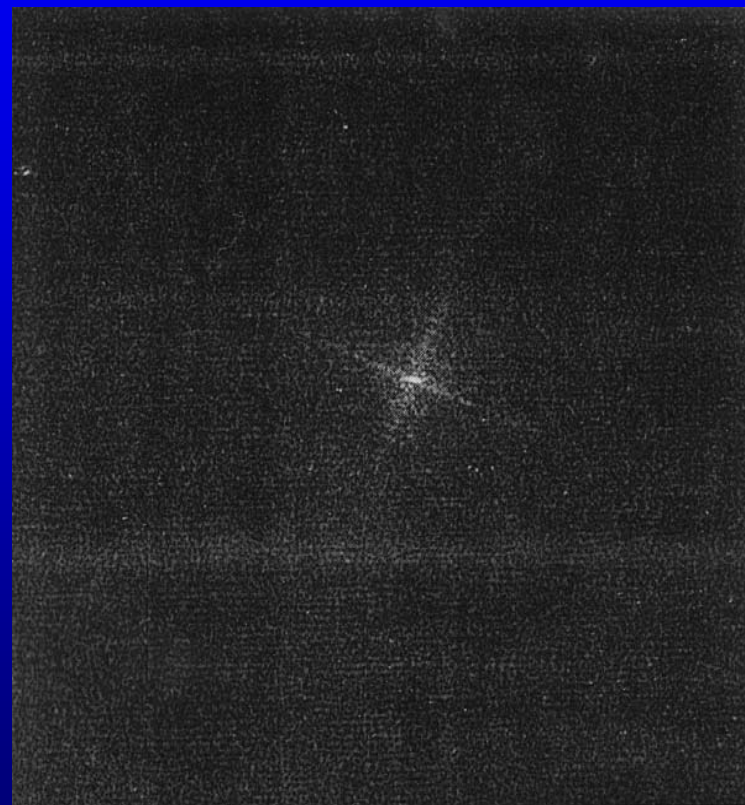
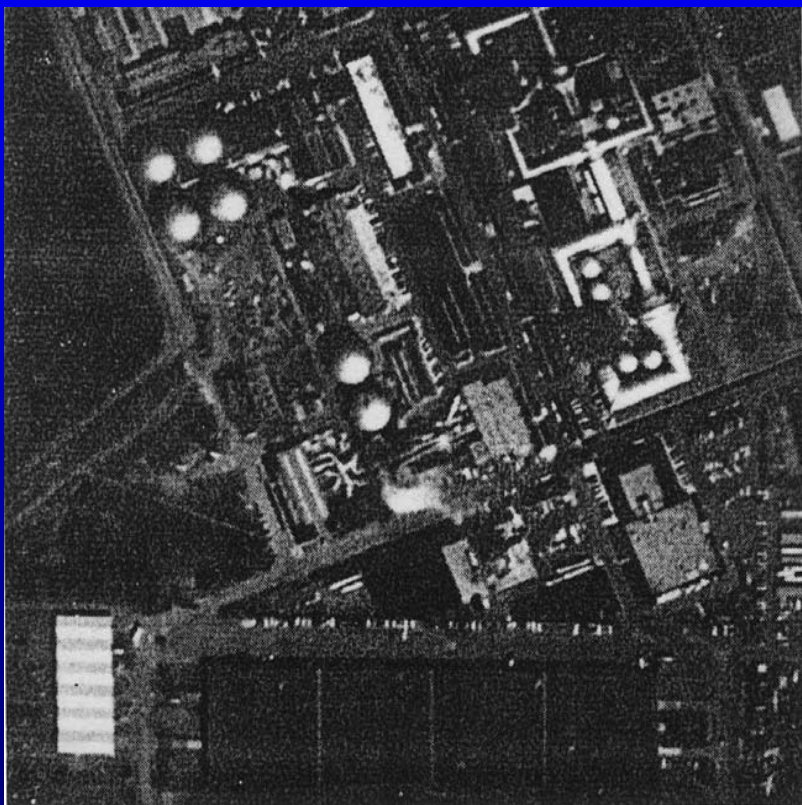
ω_1

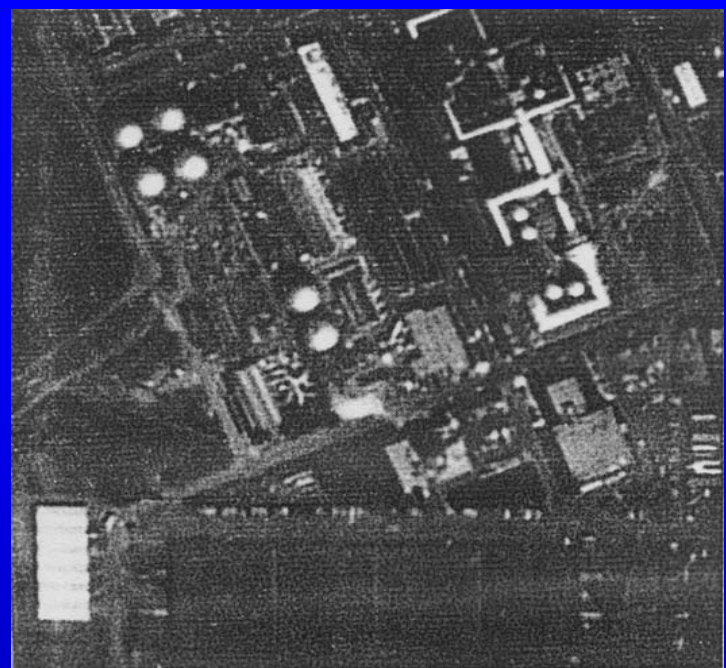
π

π

ω_2

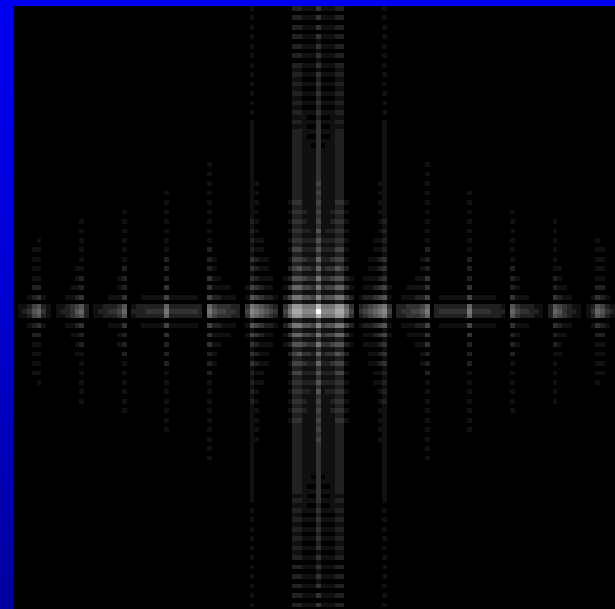








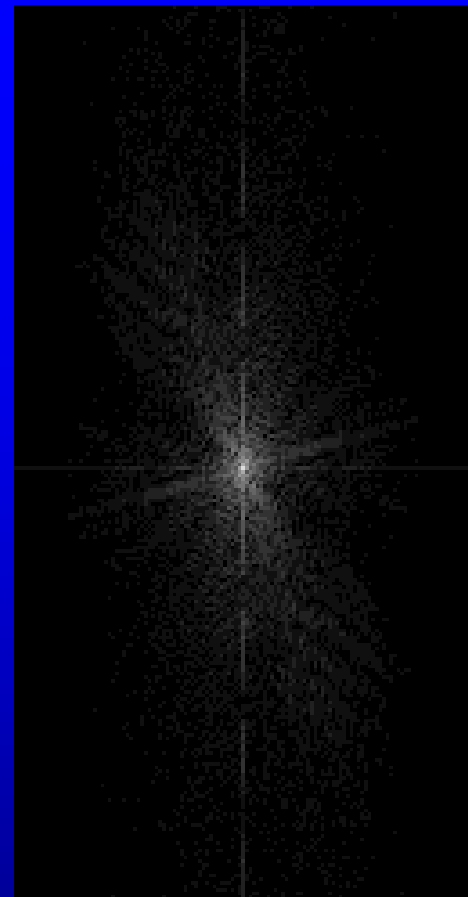
plano (n_1, n_2)



plano (k_1, k_2)



plano (n_1, n_2)



plano (k_1, k_2)



(a)



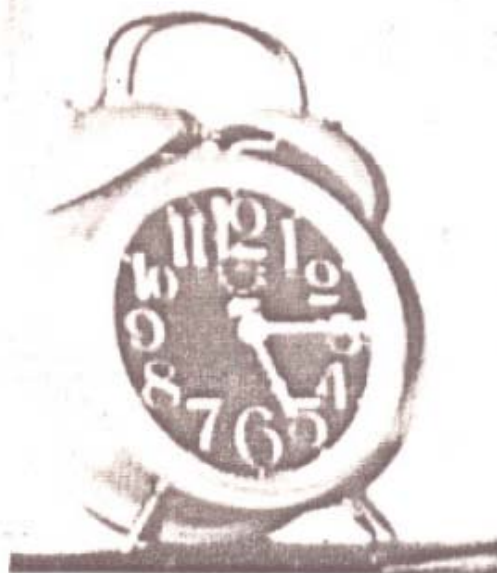


(a)



(b)





(a)

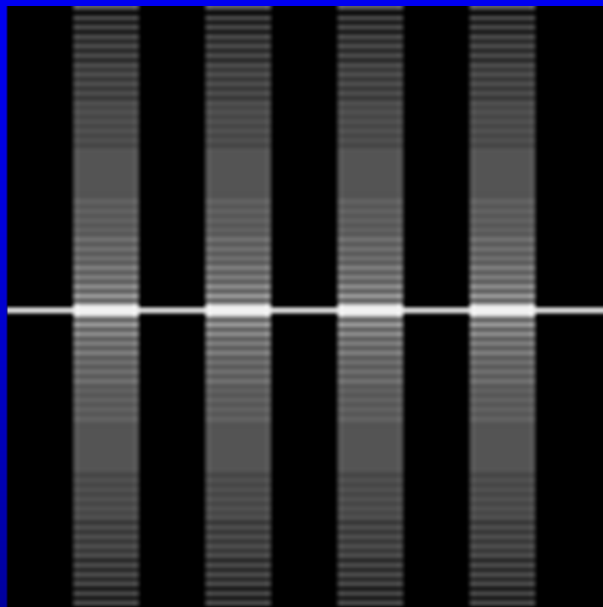


(b)

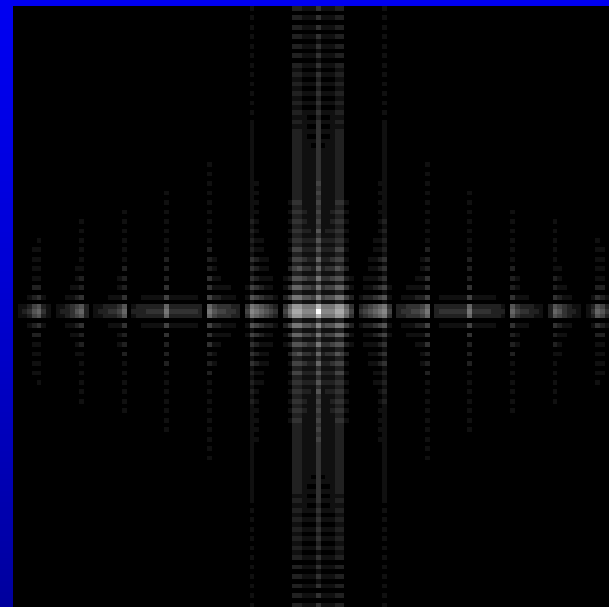




plano (n_1, n_2)



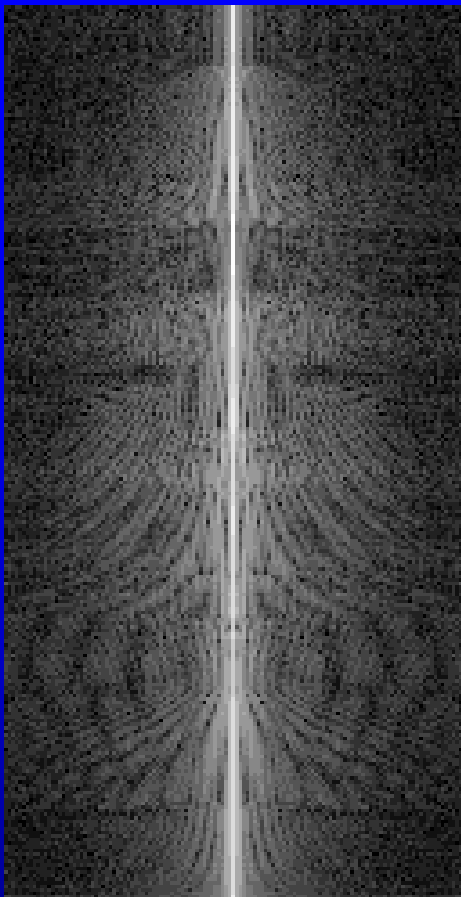
plano (k_1, n_2)



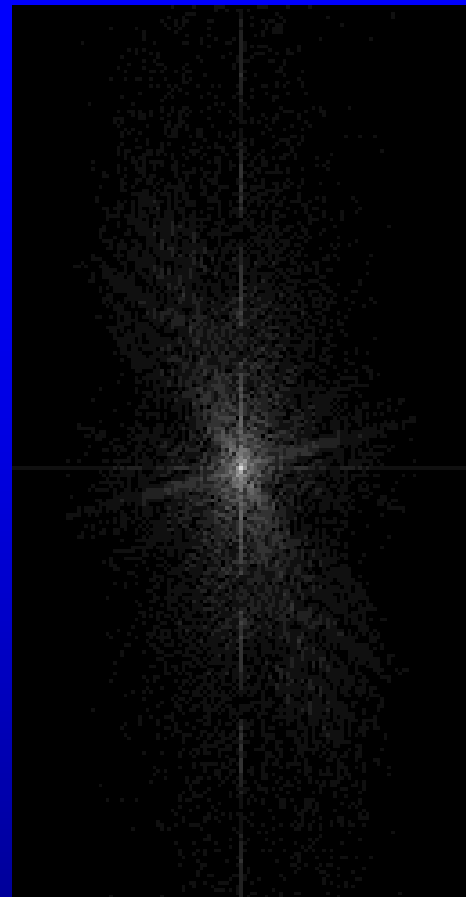
plano (k_1, k_2)



plano (n_1, n_2)

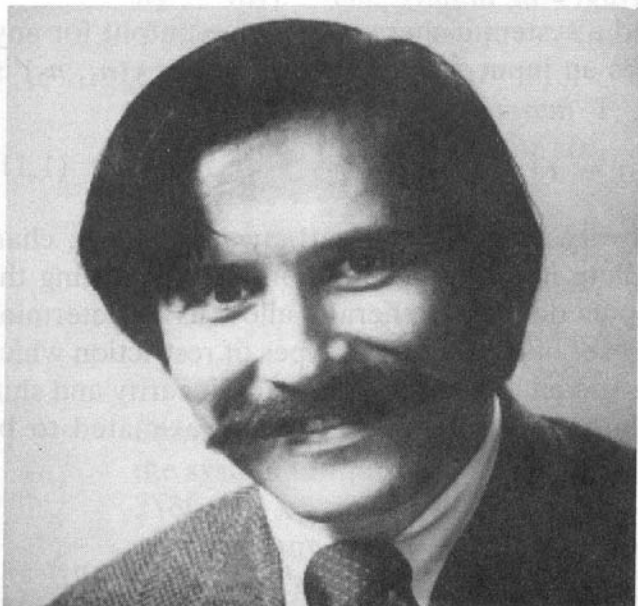


plano (k_1, n_2)

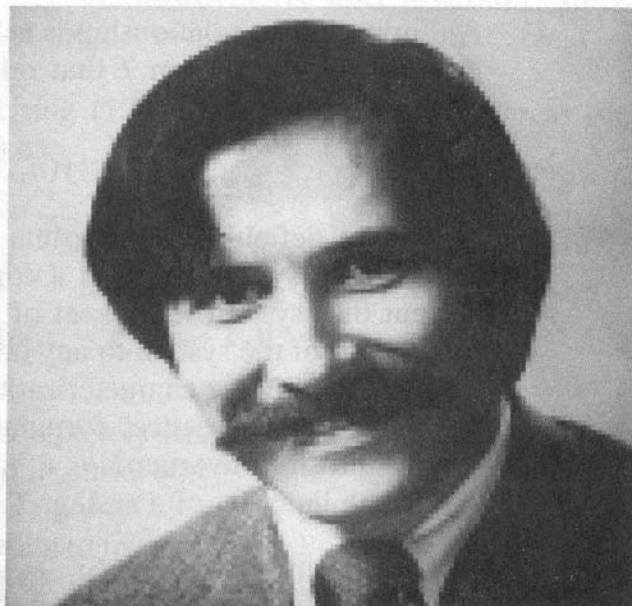


plano (k_1, k_2)

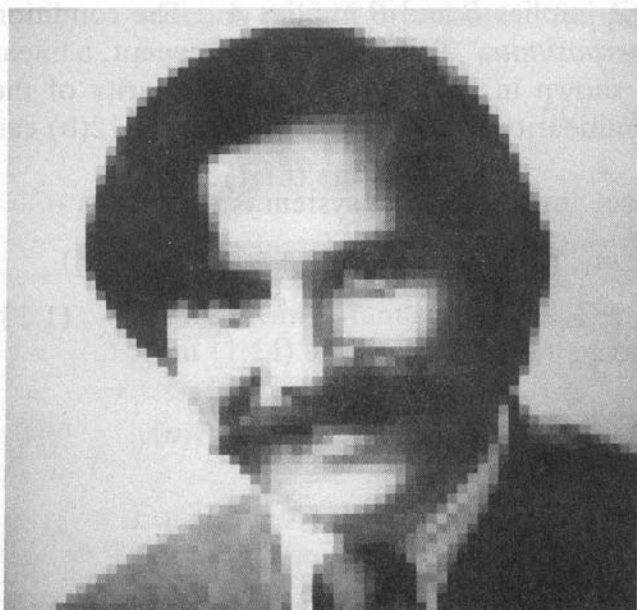
$N_1=N_2$	$(N_1 N_2)^2$ (DFT Directa)	$N_2(N_1)^2+N_1(N_2)^2$ (DFT, Des. Fila-Columna)	$N_1 N_2 \log_2(N_1 N_2)$ (FFT, Des. Fila-Columna)
8	4096	1024	35
32	1048576	65536	928
128	268435456	4194304	20786
256	4294967296	33554432	95021
512	68719476740	268435456	427595



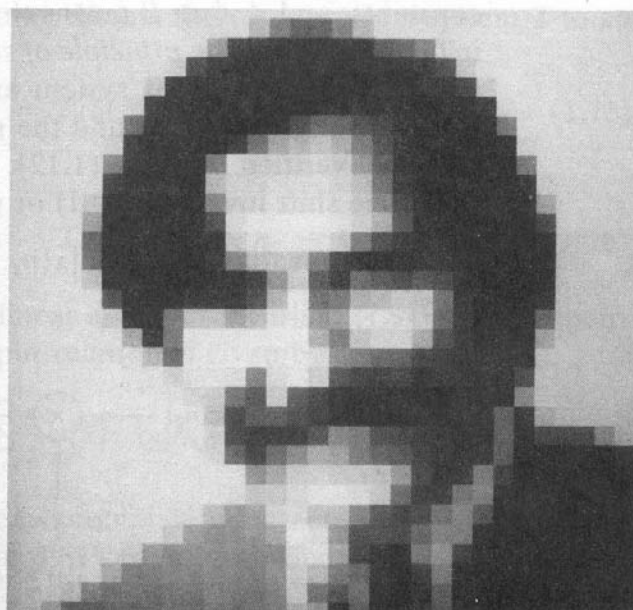
(a)



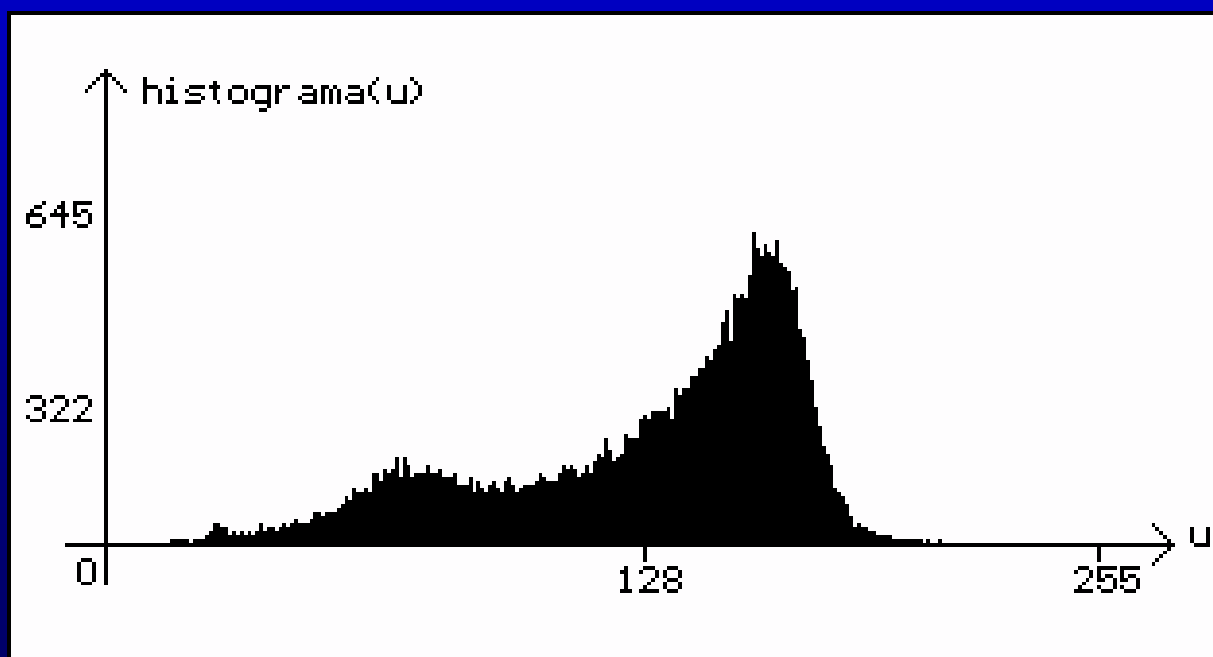
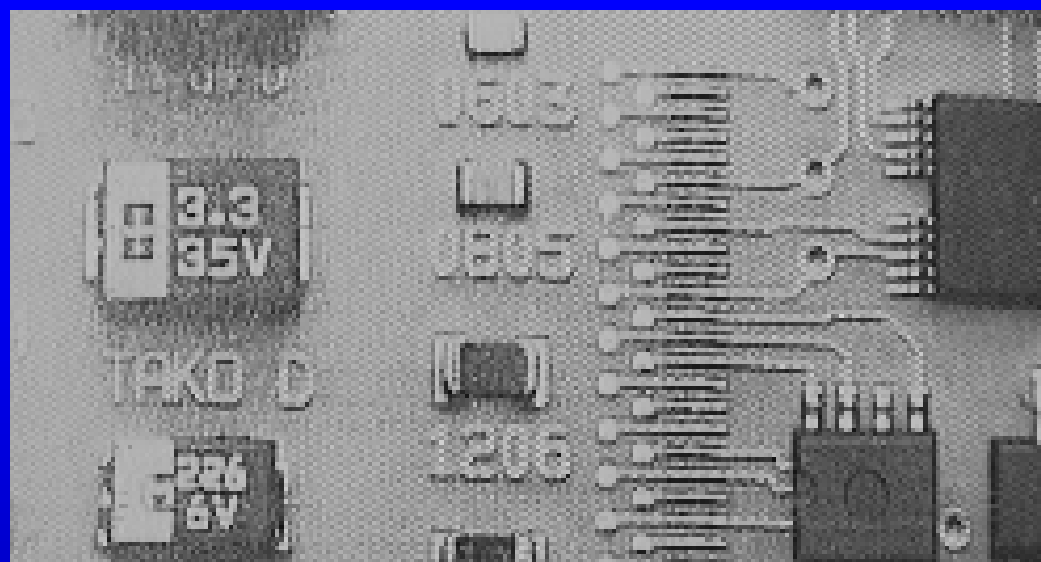
(b)

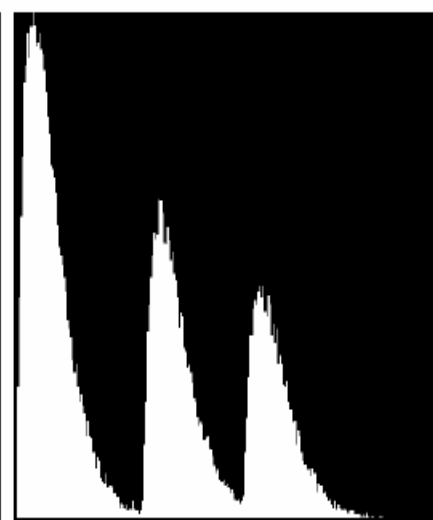
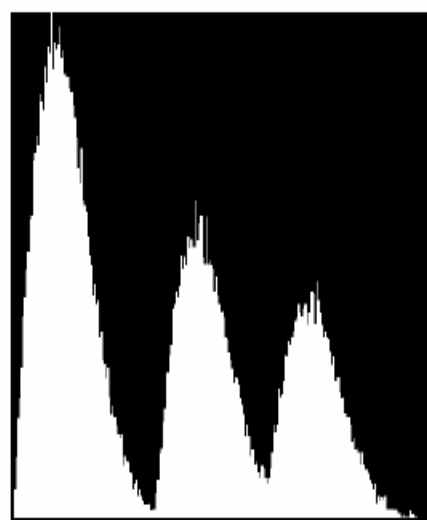
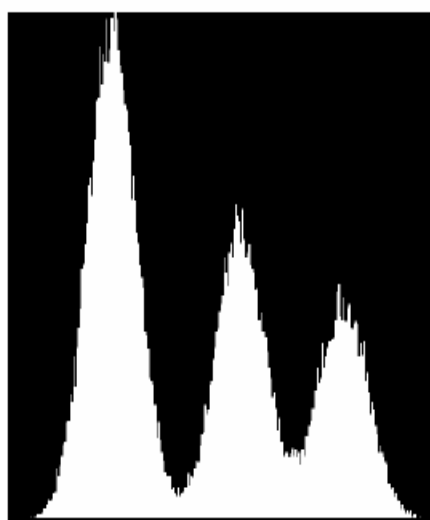
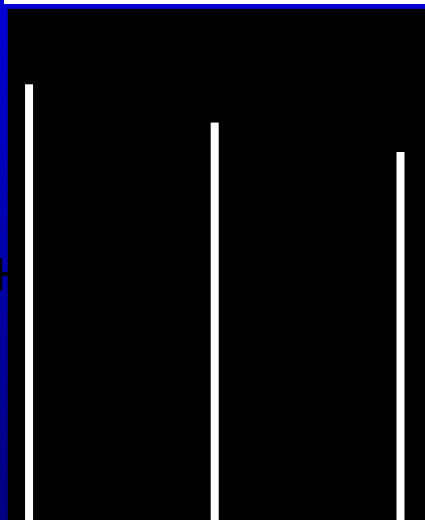
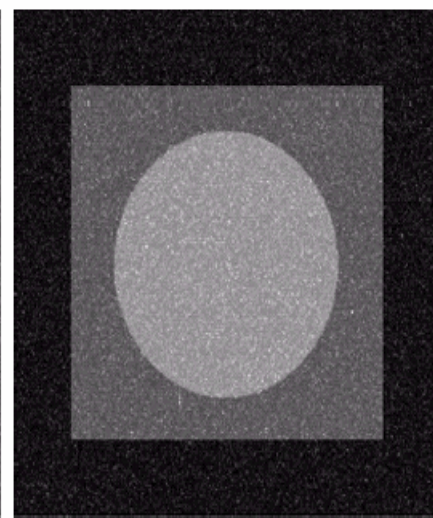
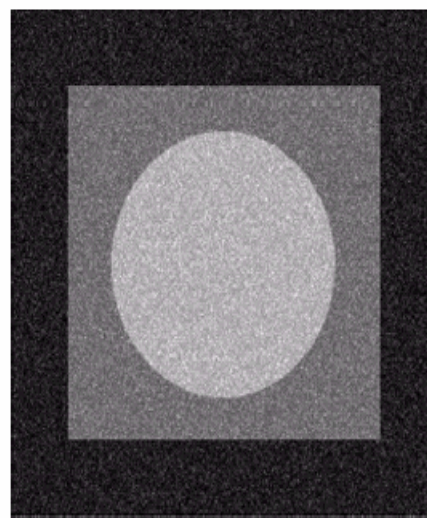
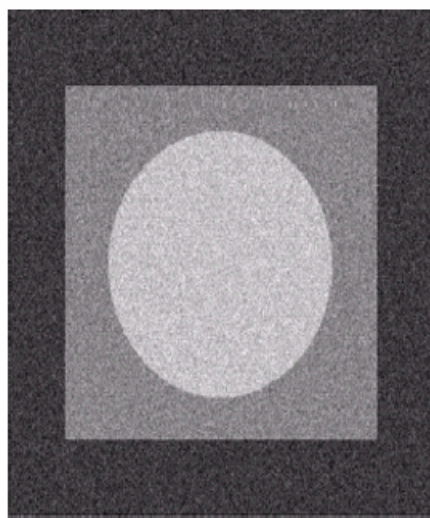
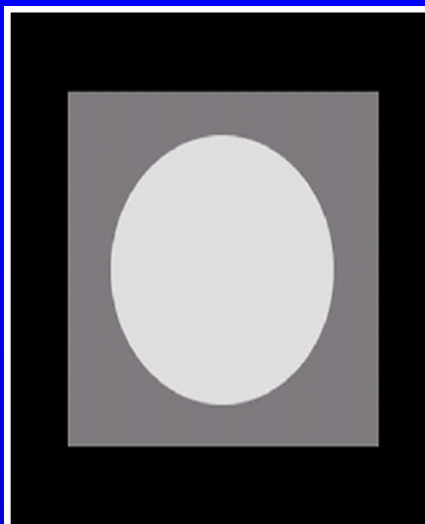


(c)



(d)





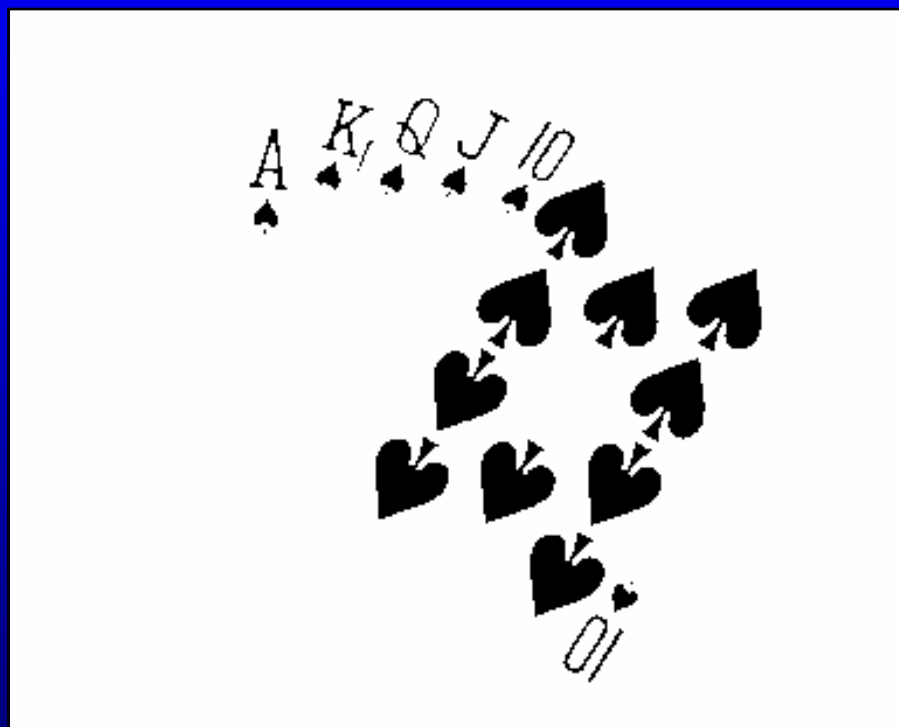
Gaussian

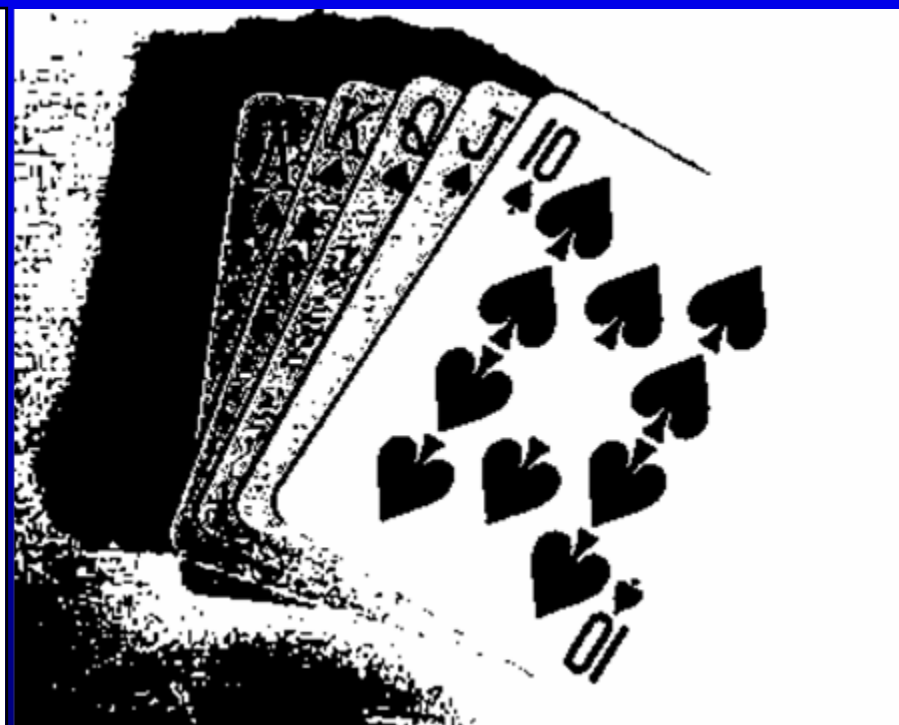
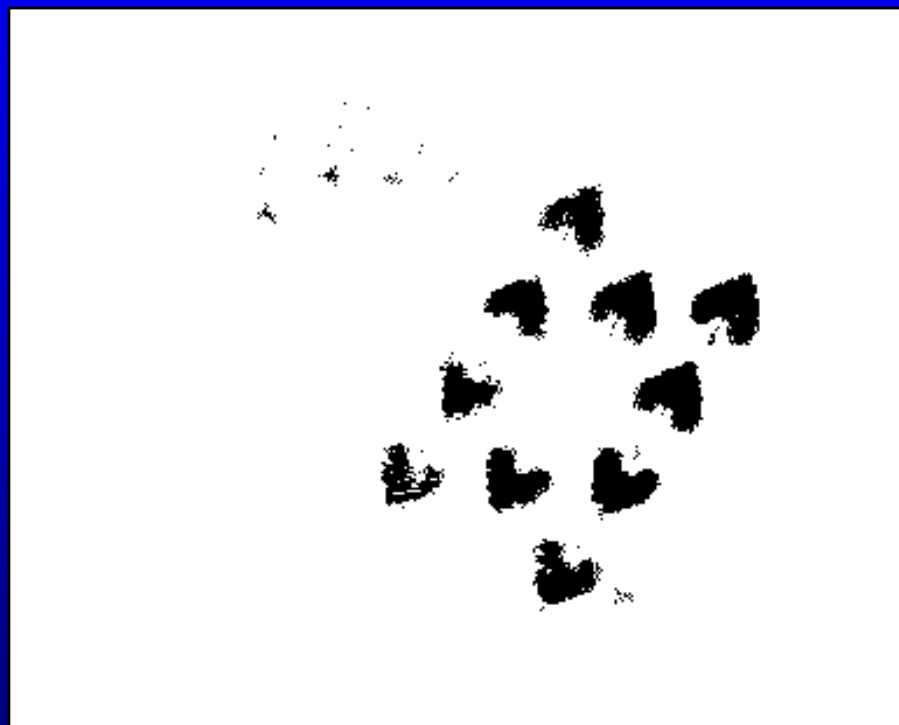
Rayleigh

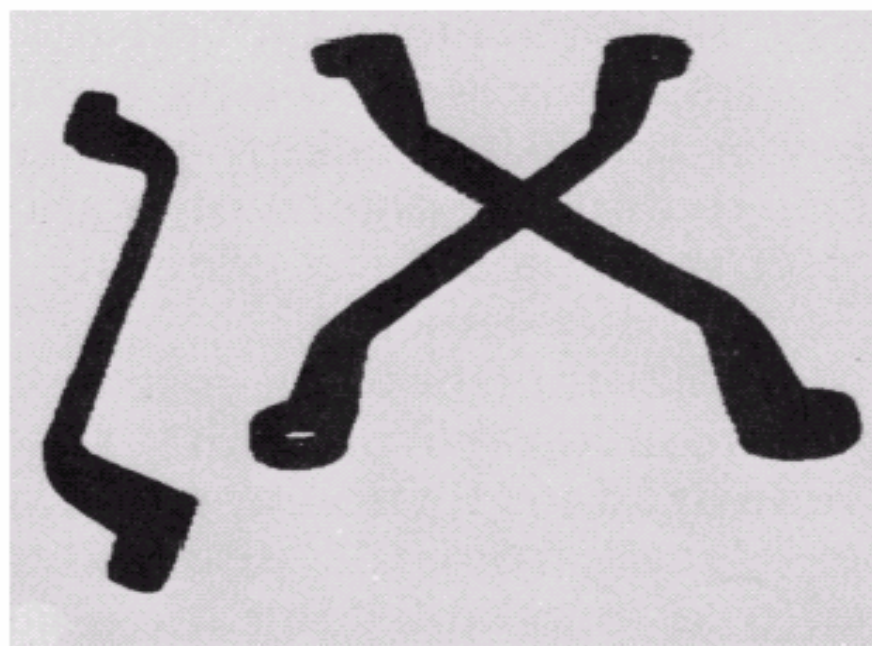
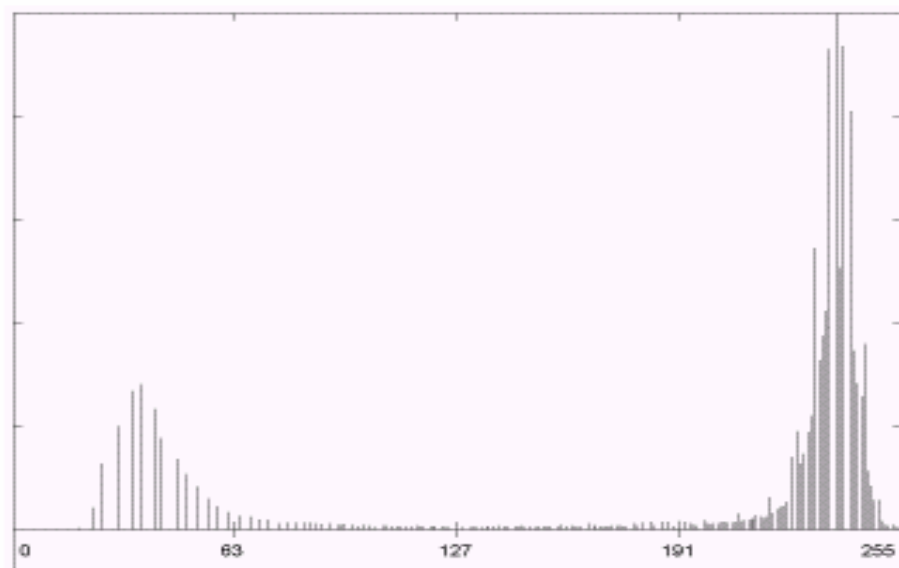
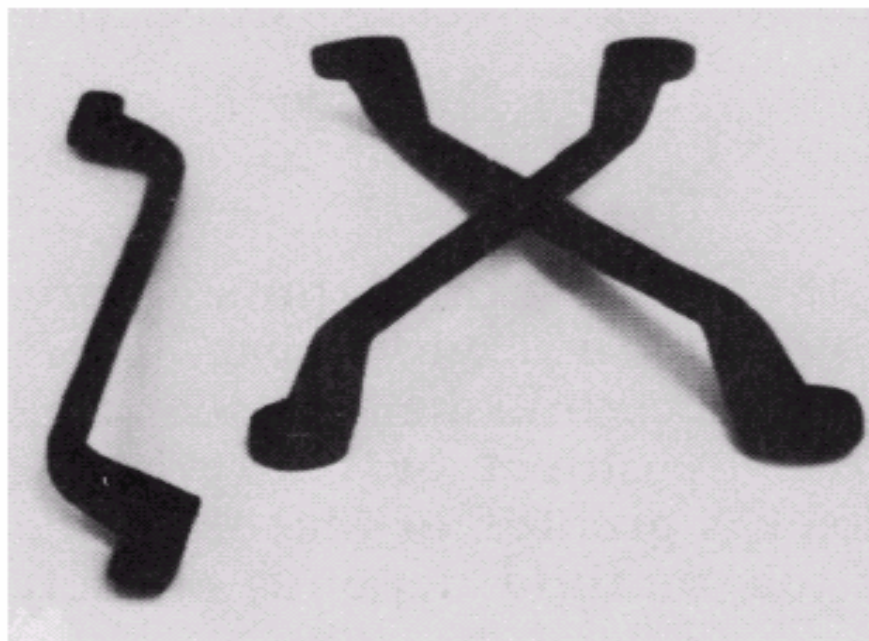
Gamma

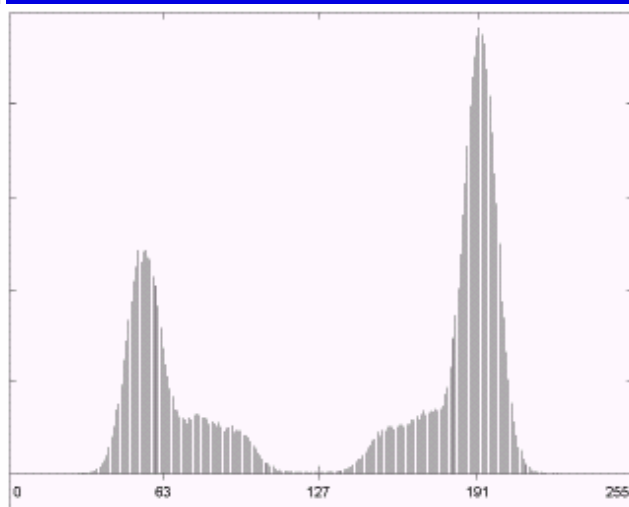
Uso de Umbrales

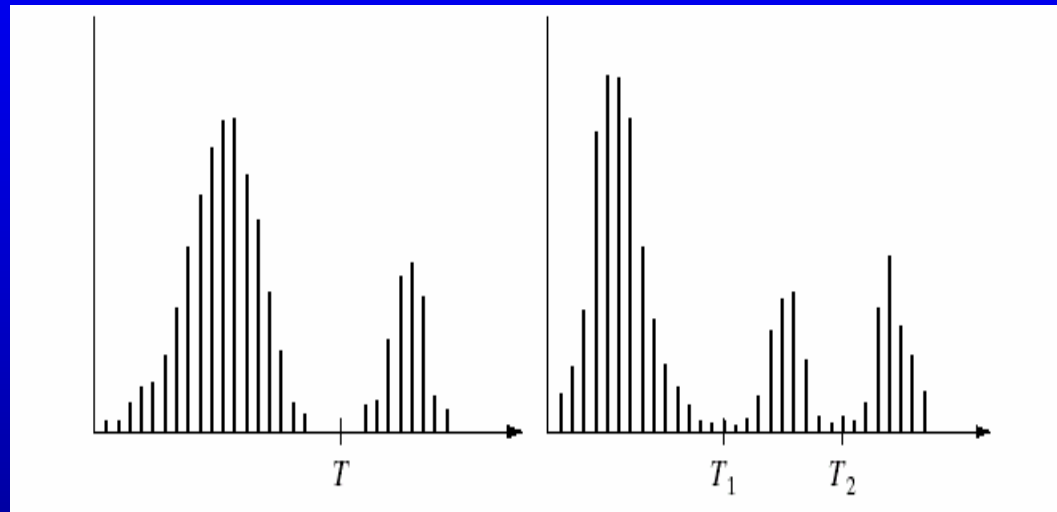
$$g(x, y) = \begin{cases} 1 & \text{if } f(x, y) > T \\ 0 & \text{if } f(x, y) \leq T \end{cases}$$





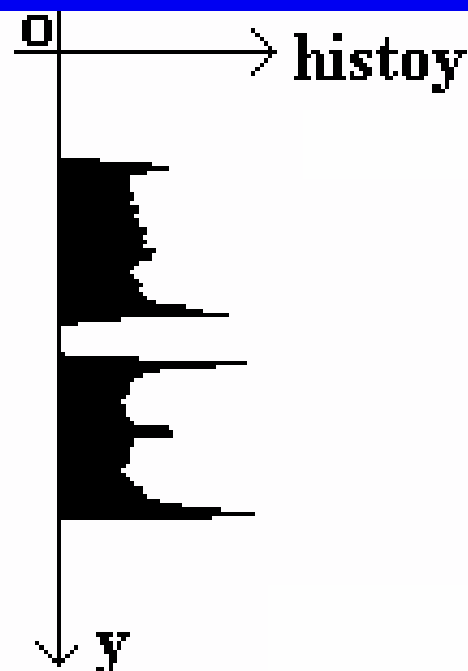






Varios umbrales

EL AMOR DE CHILE



EL AMOR

