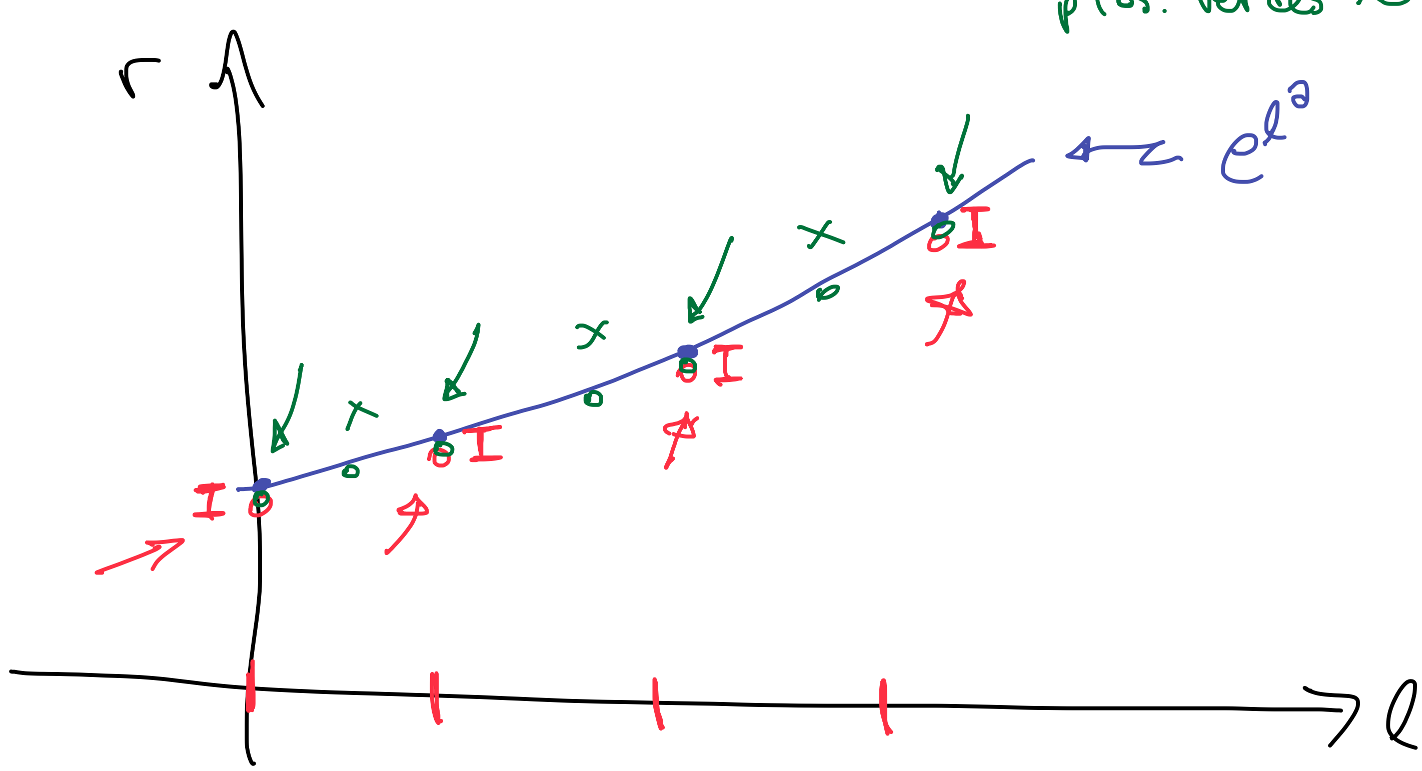
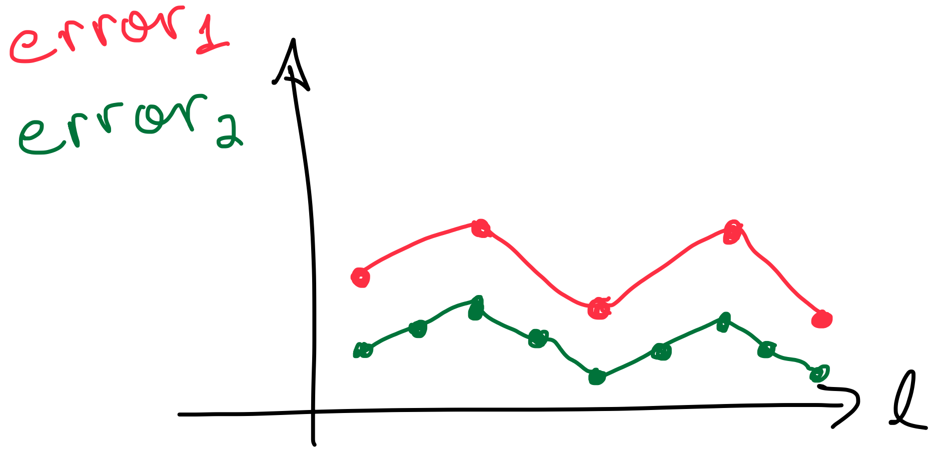
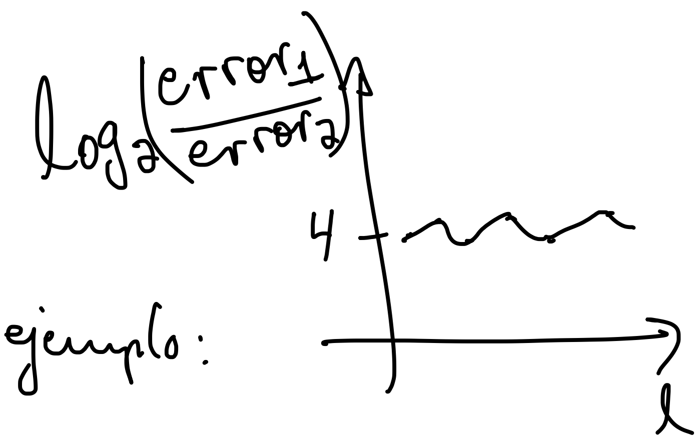
ptos. rojos ~ N=10.
ptos. verdes ~ N=20.





error.dat

l	Error 1	Error 2
l_0	#	#
$l_0 + dl$	#	#
$l_0 + 2dl$	#	#

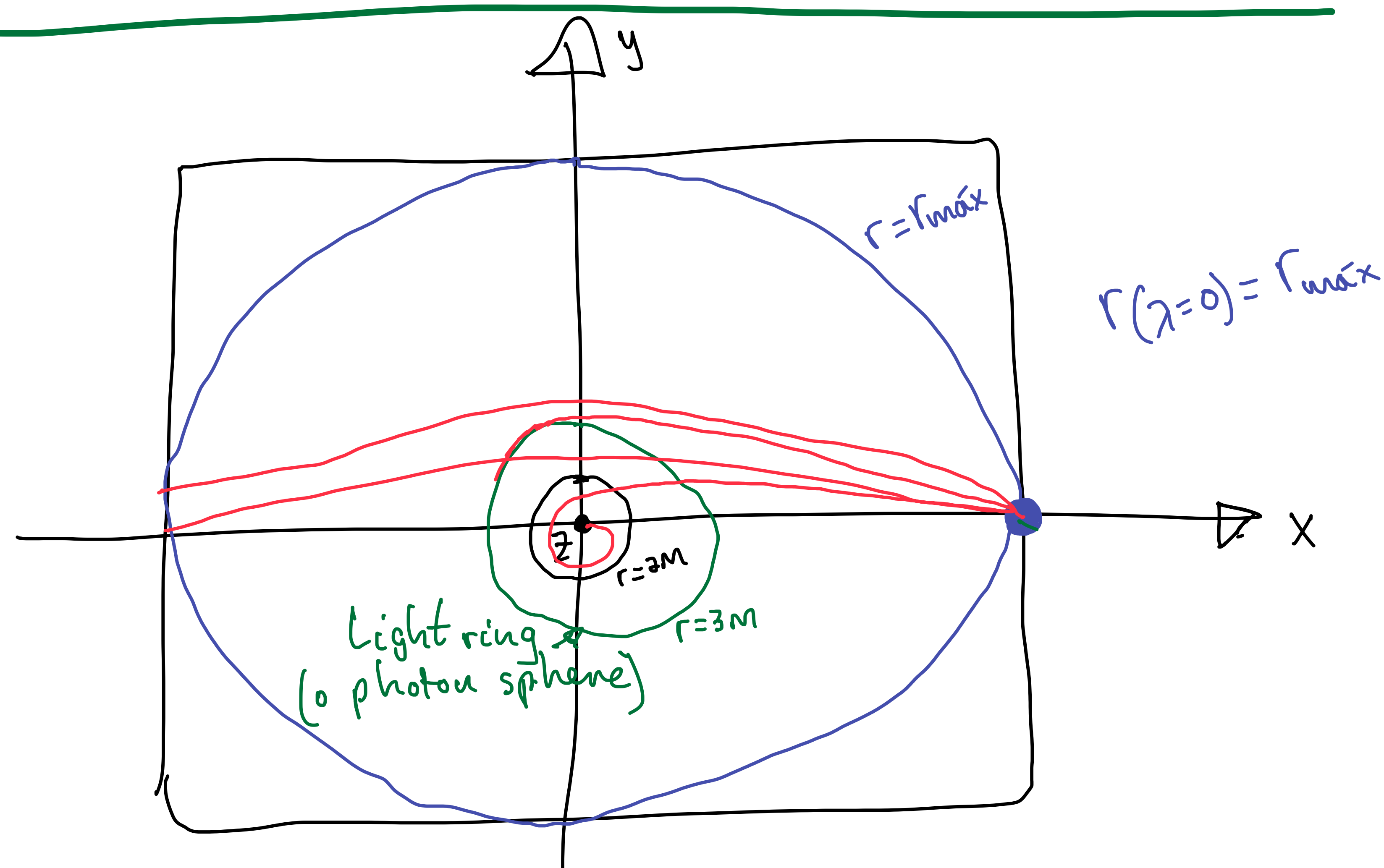


$$C.F. := \log_2\left(\frac{error_1}{error_2}\right)$$

por. ejemplo:

si $\frac{error_1}{error_2} = 16$

$$\Rightarrow \log_2(16) = 4$$



Queremos integrar.

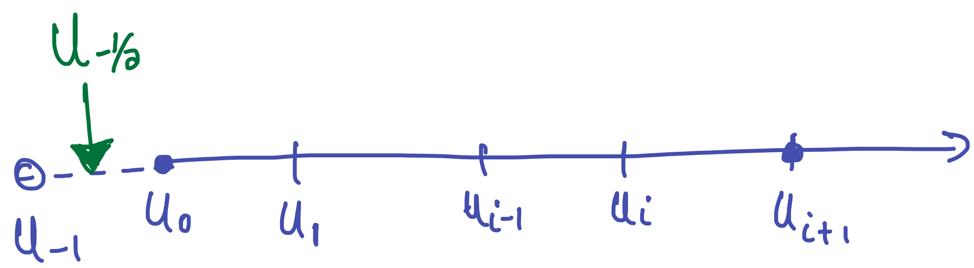
$$u'' = 3mu^2 - u \qquad (1)$$

Hay 2 estrategias:

(a) Discretizar directamente usando:

$$u'' \simeq \frac{u_{i-1} - 2u_i + u_{i+1}}{\Delta\varphi^2}$$

$$\boxed{u_{i+1} = \Delta\varphi^2\left[3mu_i^2 - u_i\right] + 2u_i - u_{i-1}}$$



Calculemos u_{-1}:

Partimos de la EDO de 1er orden para u:

$$(u')^2 = \frac{1}{b^2} - (1-2mu)u^2$$

Discreticemos

$$\boxed{\left.u'\right|_{u_{-1/2}} = \frac{u_0 - u_{-1}}{\left(\frac{\Delta\varphi}{2}\right)^2} = \frac{4}{\Delta\varphi^2}(u_0 - u_{-1})}$$

Luego $\frac{16}{(\Delta\varphi)^4}(u_0 - u_{-1})^2 = \frac{1}{b^2} - (1-2mu_0)u_0^2$

Donde aproximamos $u_{-\frac{1}{2}}$ por u_0.

$$(u_{-1}-u_0)^2 = \frac{(\Delta\varphi)^4}{16}[\cdots]$$

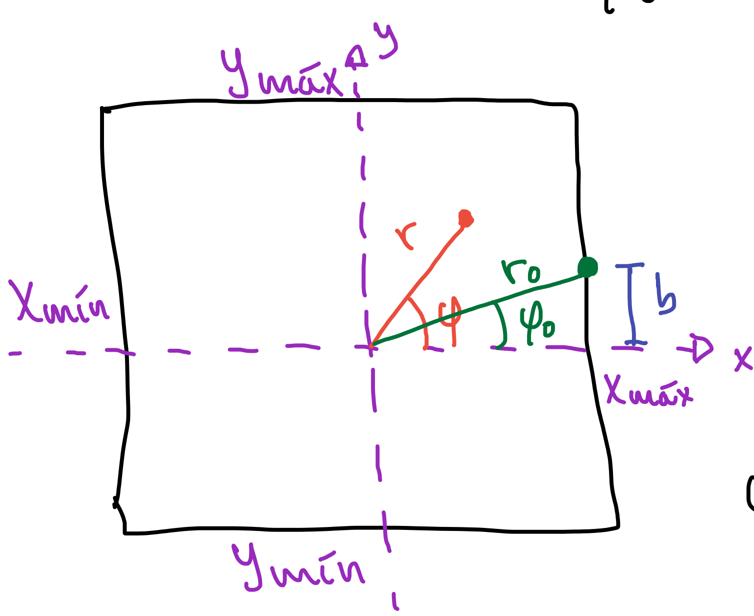
$$(u_{-1})^2 - 2u_0 u_{-1} + u_0^2 = \frac{(\Delta\varphi)^4}{16}[\cdots]$$

Falta determinar el dato inicial u_0.

$$u_0 = \frac{1}{r_0}$$

El usuario da los datos inicales: m y (x_0, y_0)

Falta calcular φ_0:

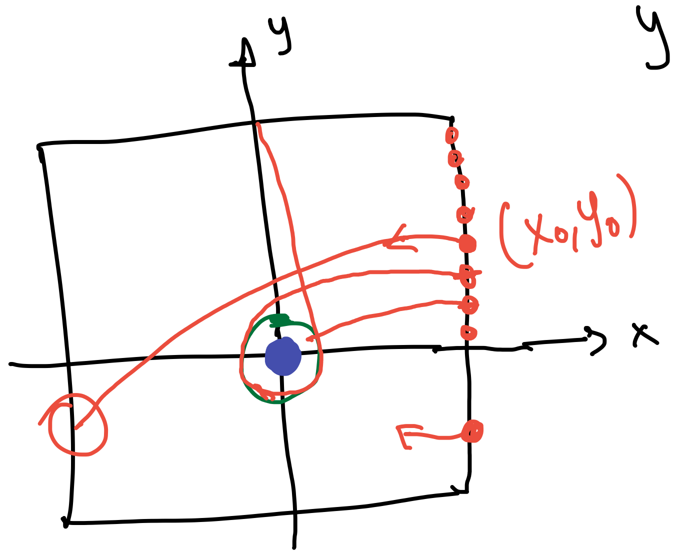


Tenemos $\operatorname{sen}\varphi_0 = \frac{b}{r_0}$

$$\Rightarrow \varphi_0 = \arcsin\left(\frac{b}{r_0}\right)$$

con $r_0 = \sqrt{x_0^2 + y_0^2}$

y $b = y_0$

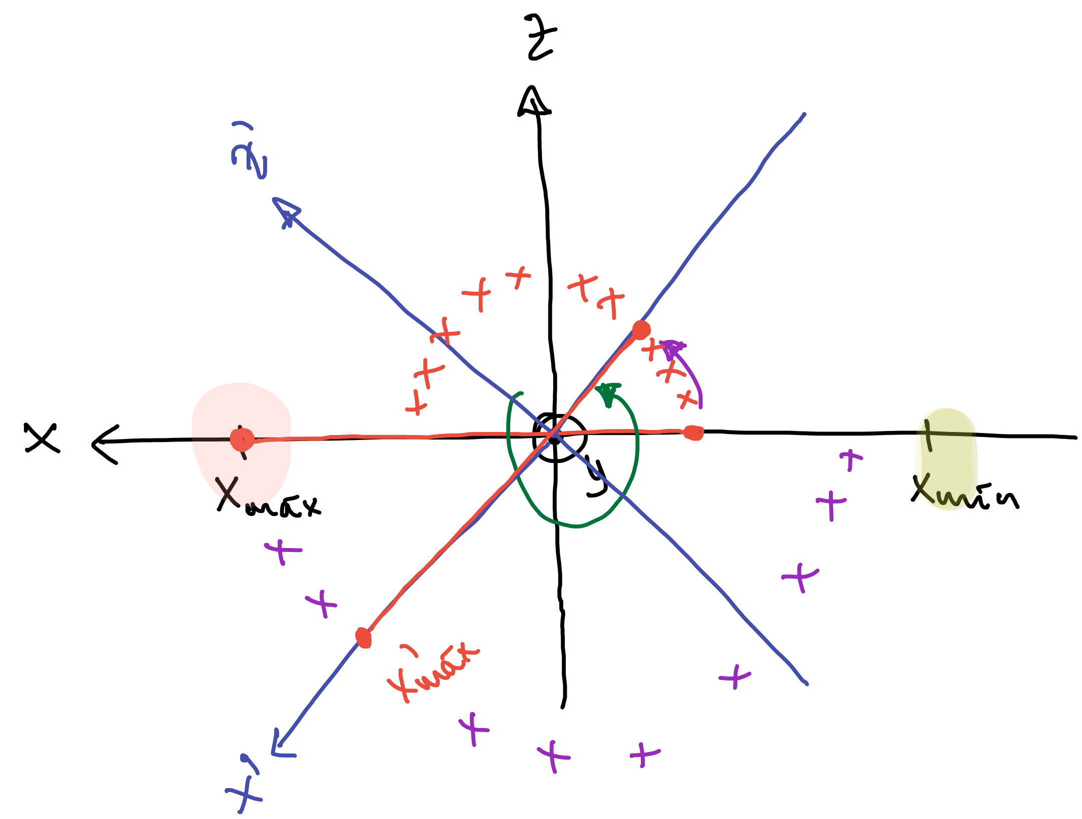


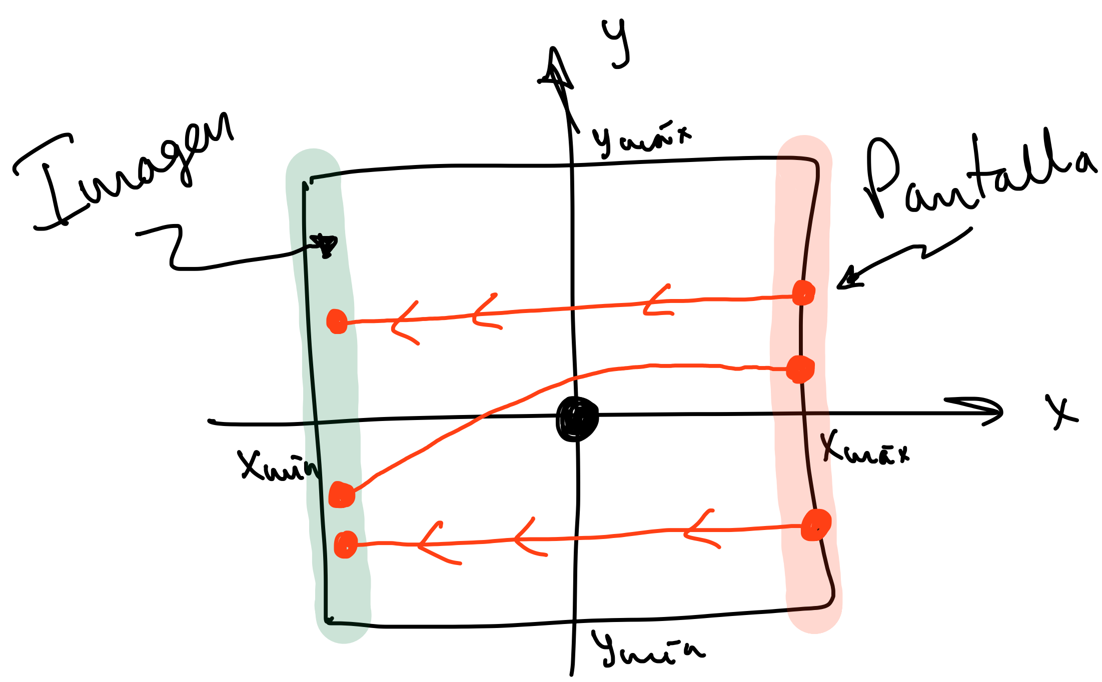
$(x_0, y_0) \longrightarrow r_0 \longrightarrow \varphi_0$

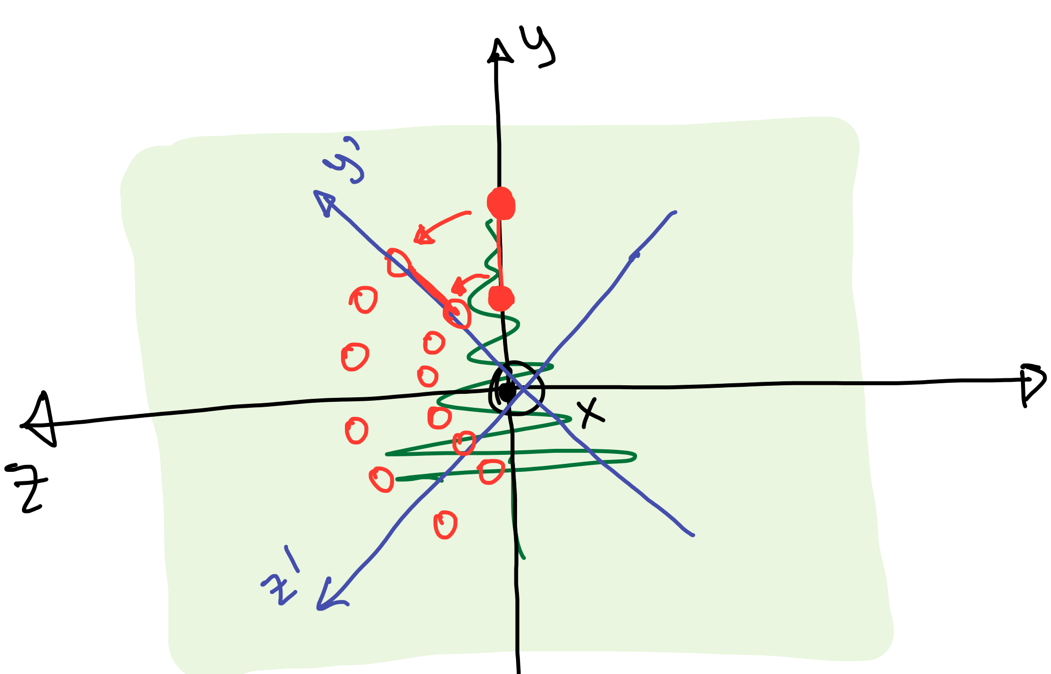
Checar que si $b \leq \sqrt{27}\,m$ entonces las trayectorias van $r = 2m$.

$x_0 = x_{máx}$

$y_0 = \sqrt{27}\,m$


z
z'
x
y
$X_{máx}$
$X_{mín}$
$X'_{máx}$
x'


y
$y_{máx}$
Imagen
Pantalla
x
$X_{mín}$
$X_{máx}$
$y_{mín}$


y
y'
x
z
z'