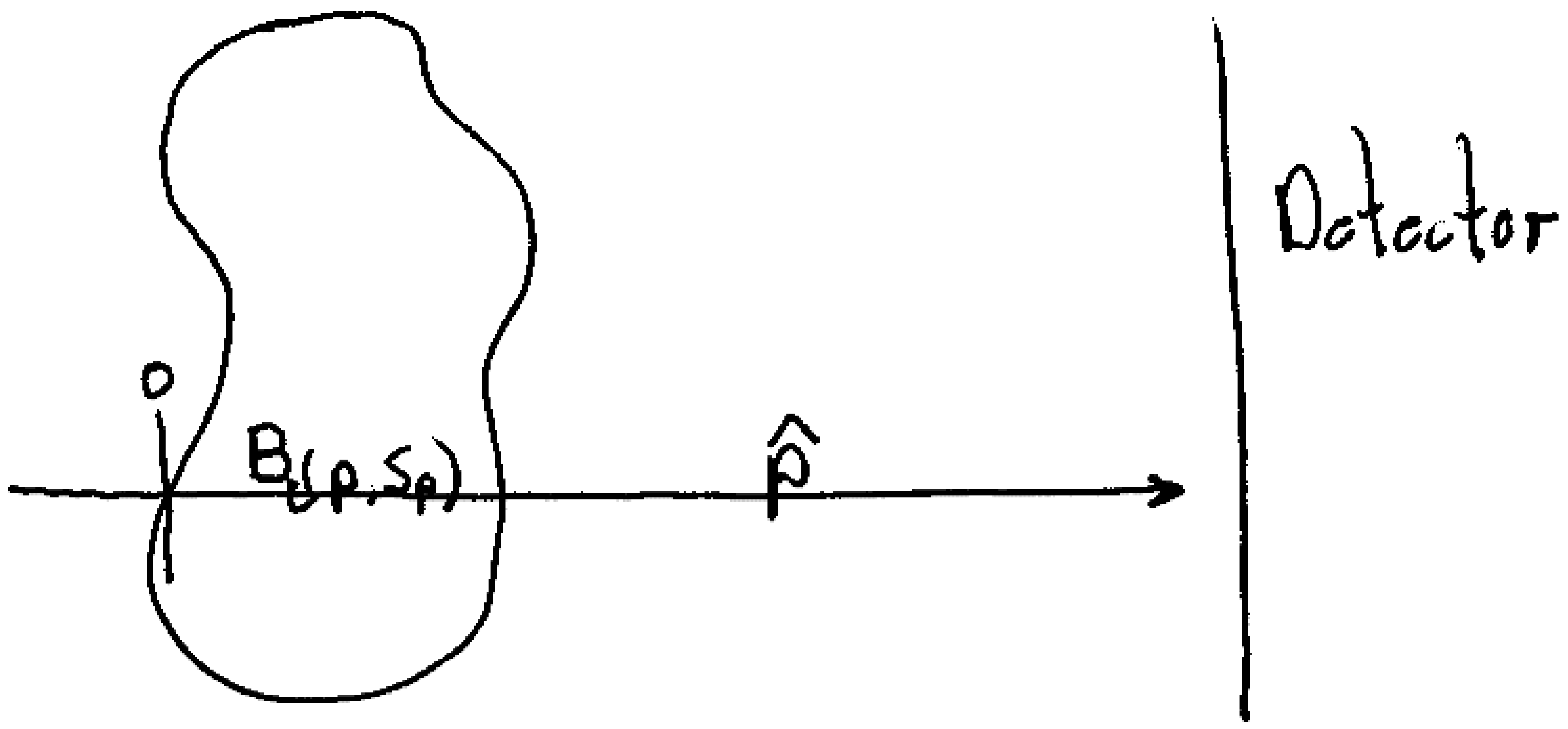
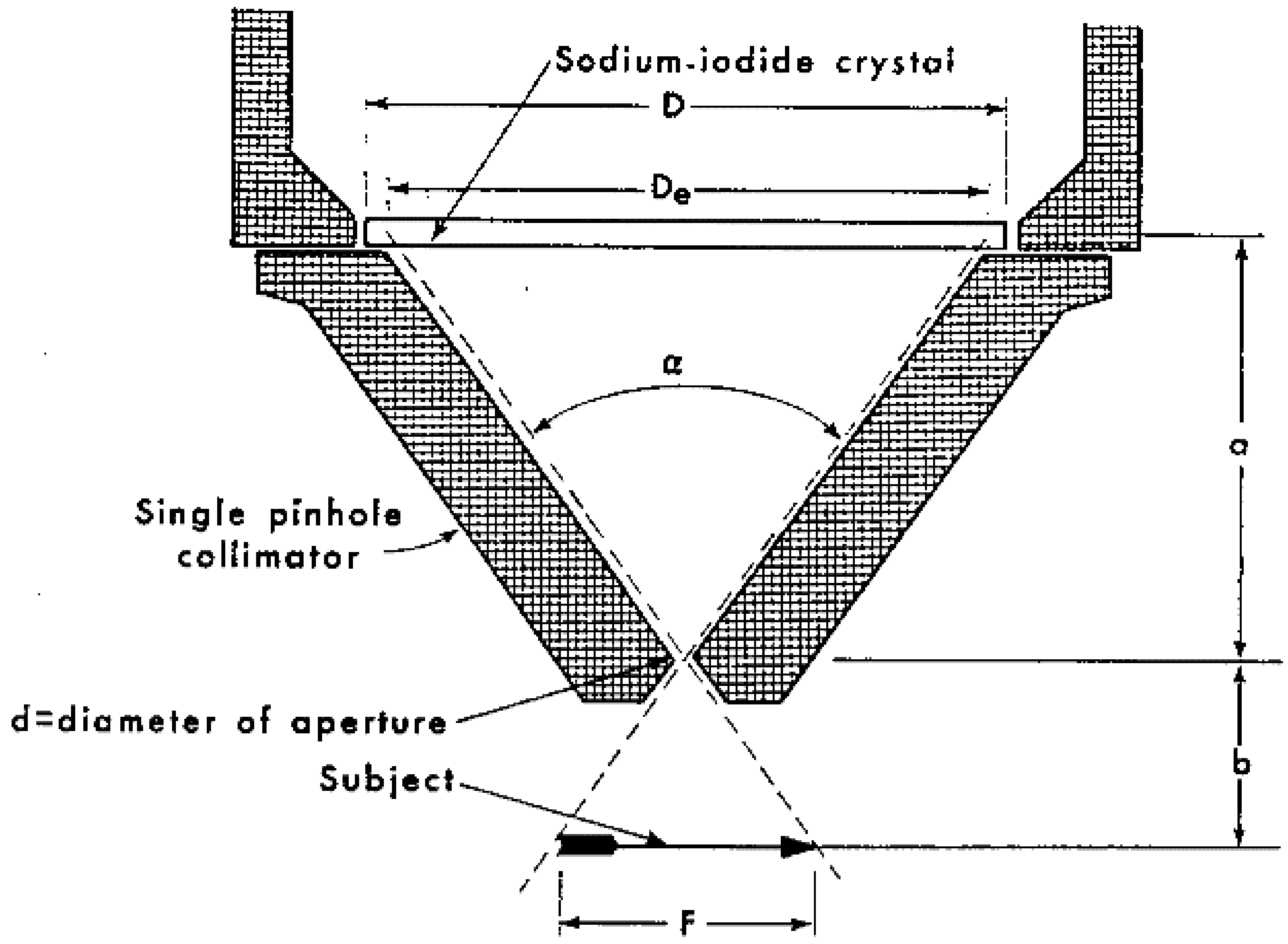
Activity Projection



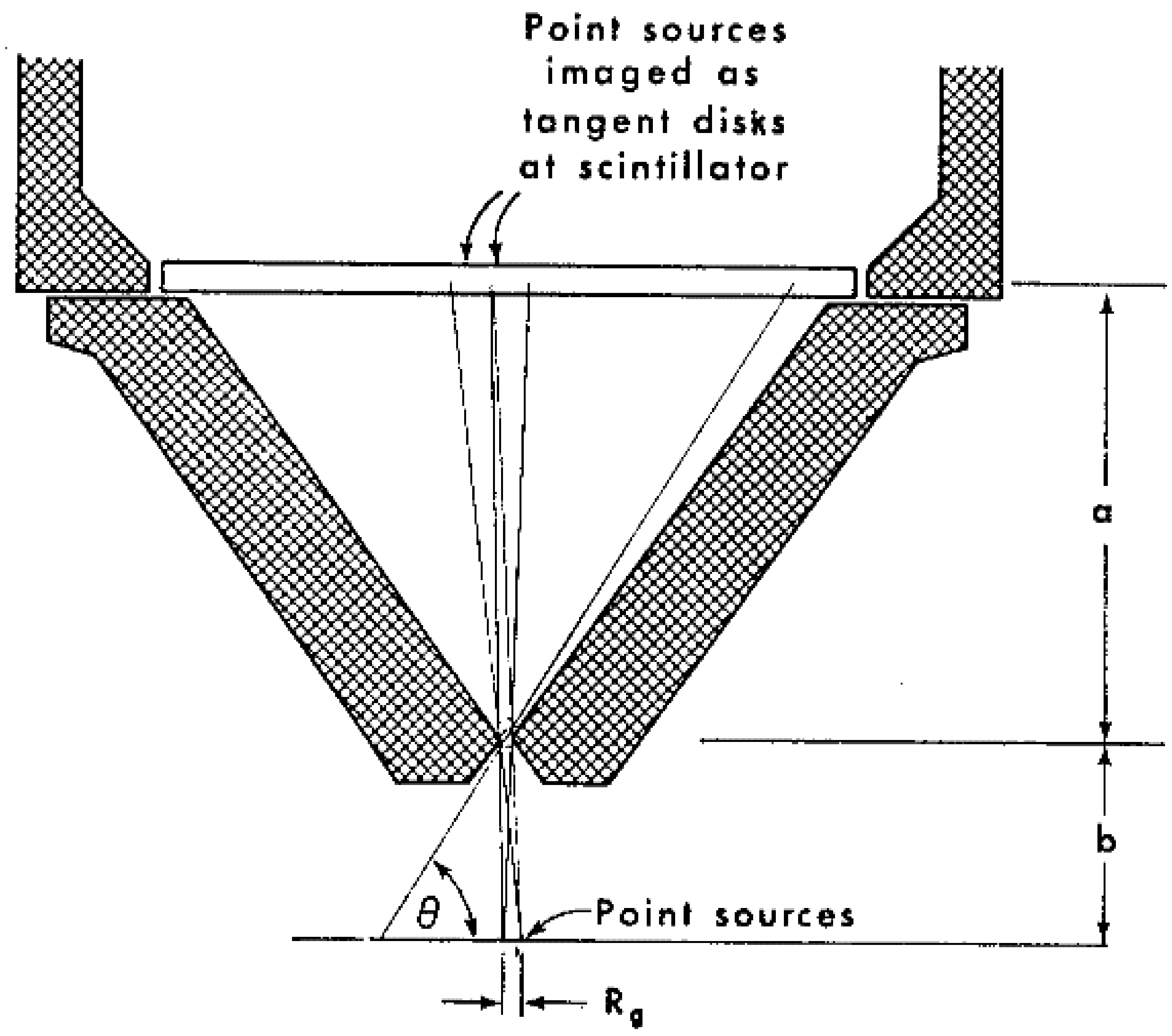
$$S_i \propto \int_0^{S_p} B_i(p, s)\, ds$$

Self Absorbtion

$$S_i = \int_0^{S_p} B_i(p, s)\, e^{-\mu (S_p - s)}\, ds$$



(A)



(B)

FIG. 15. (A) Single pinhole parameters relating to subject size and magnification. (B) Single pinhole parameters relating to resolution when resolution distance is defined as the distance between two point sources imaged as tangent disks at scintillator.

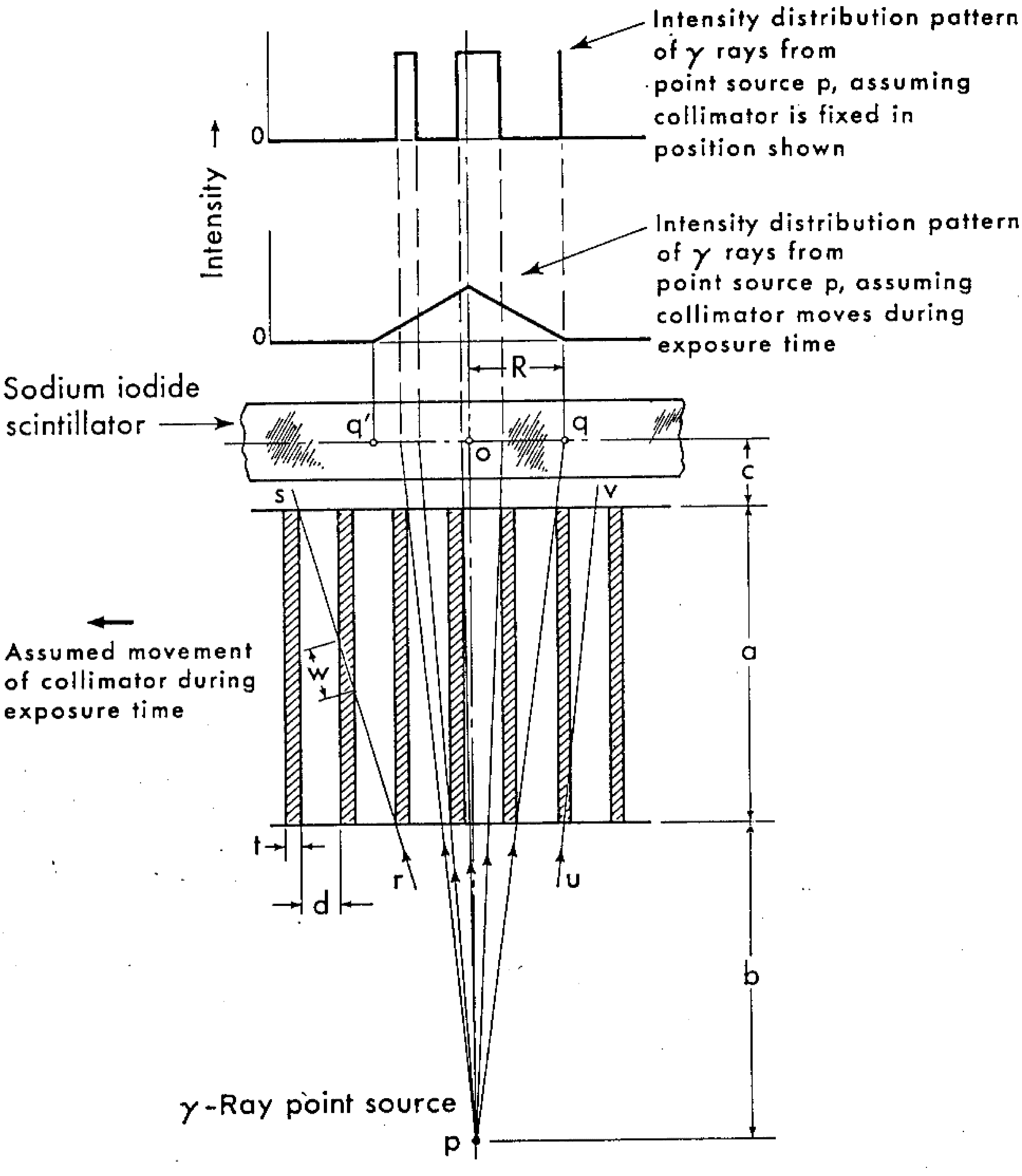
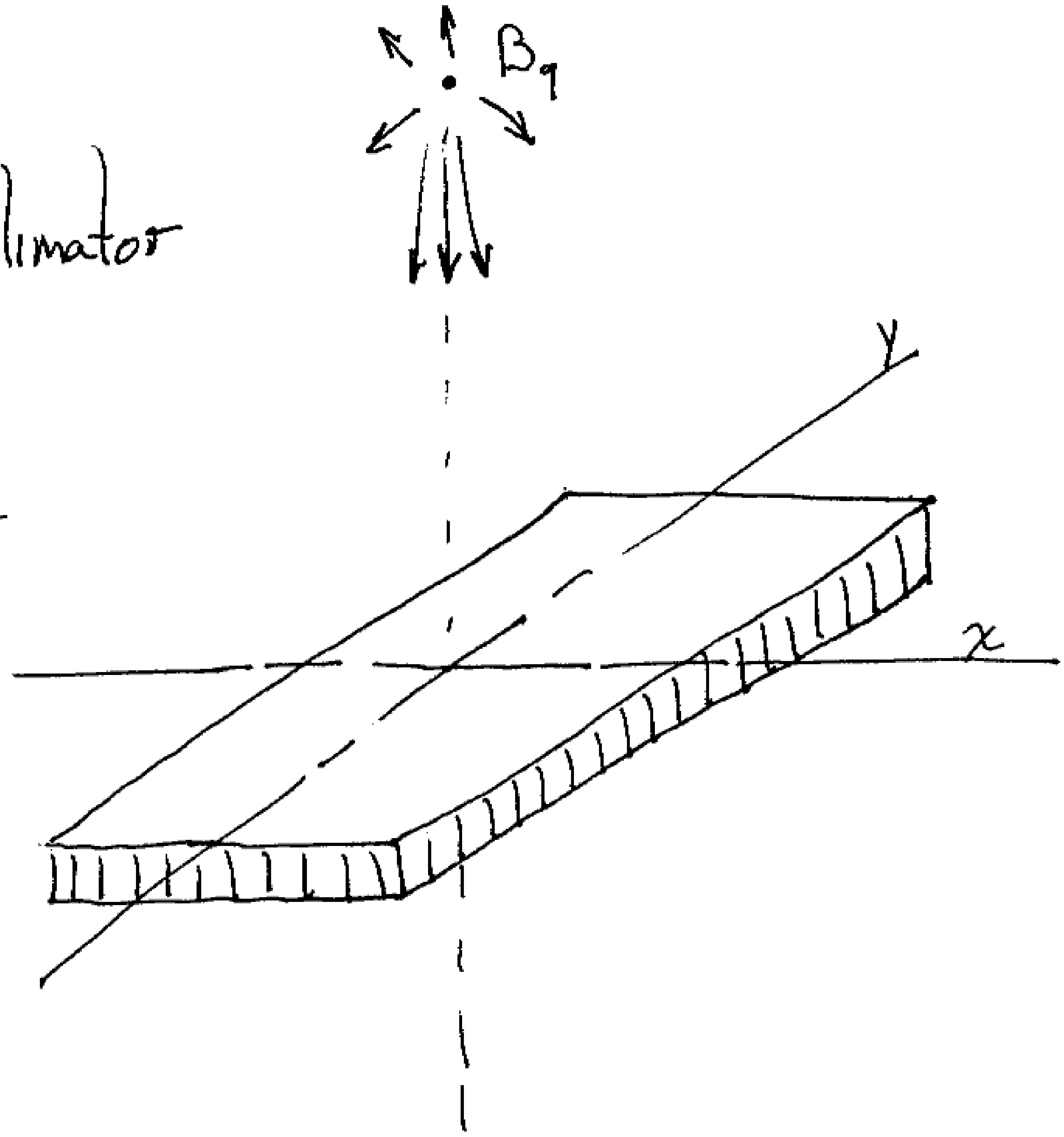


FIG. 17. Section view of multichannel collimator. γ-Ray pathways are show bottom, irradiated areas of scintillator when collimator is stationary are show top, and irradiated area if collimator moves during exposure time is indicate center (*11*).

Collimator Spatial Response

Point Source



At the ~~detector~~ collimator surface:

$$\phi_c(x,y) = \frac{B_q f}{4\pi D_{so}^2}$$

for $x \ll D_{so}$

$y \ll D_{so}$

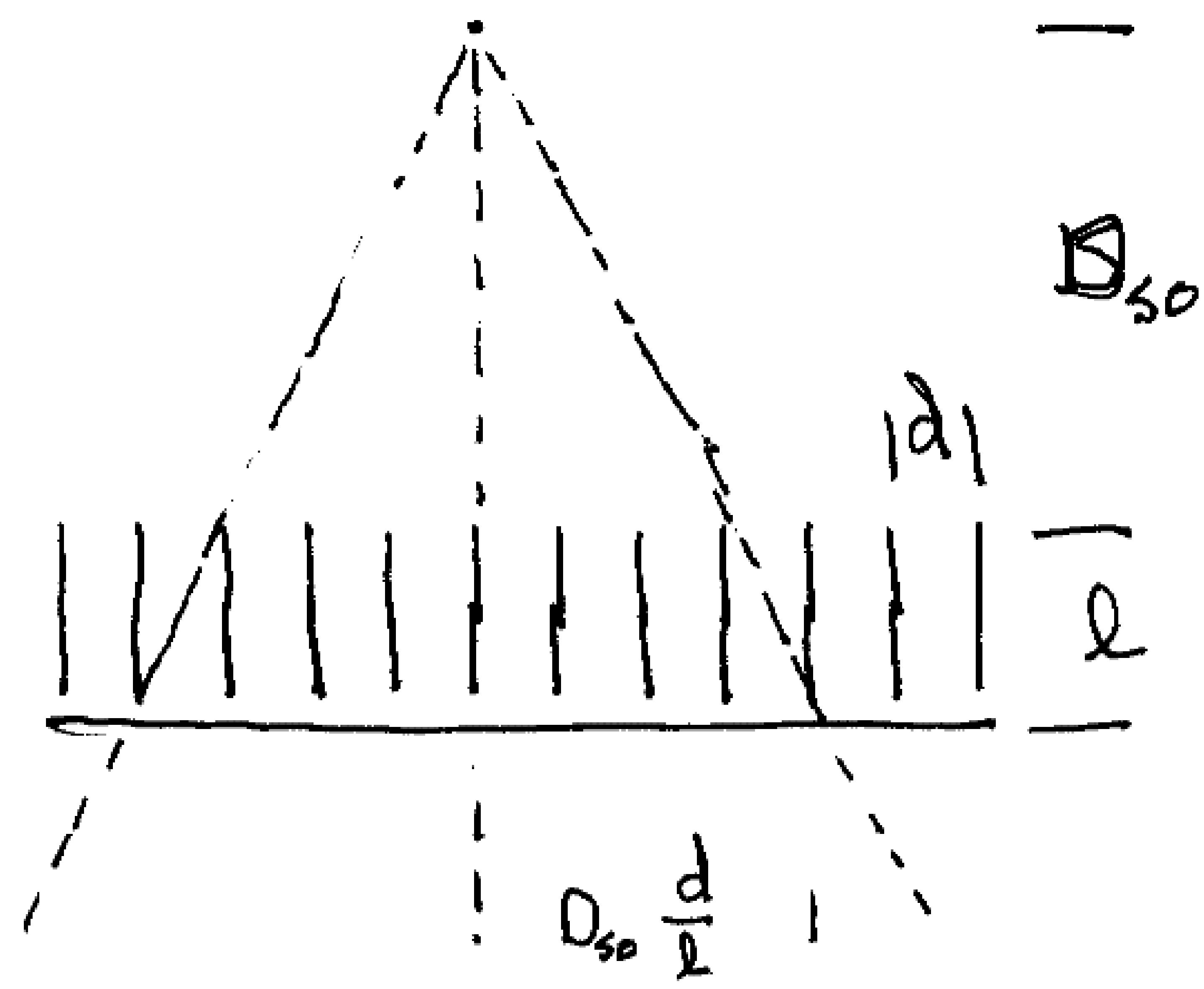
Define: $$g(x,y) = \frac{\phi_D(x,y)}{\phi_C(x,y)}$$

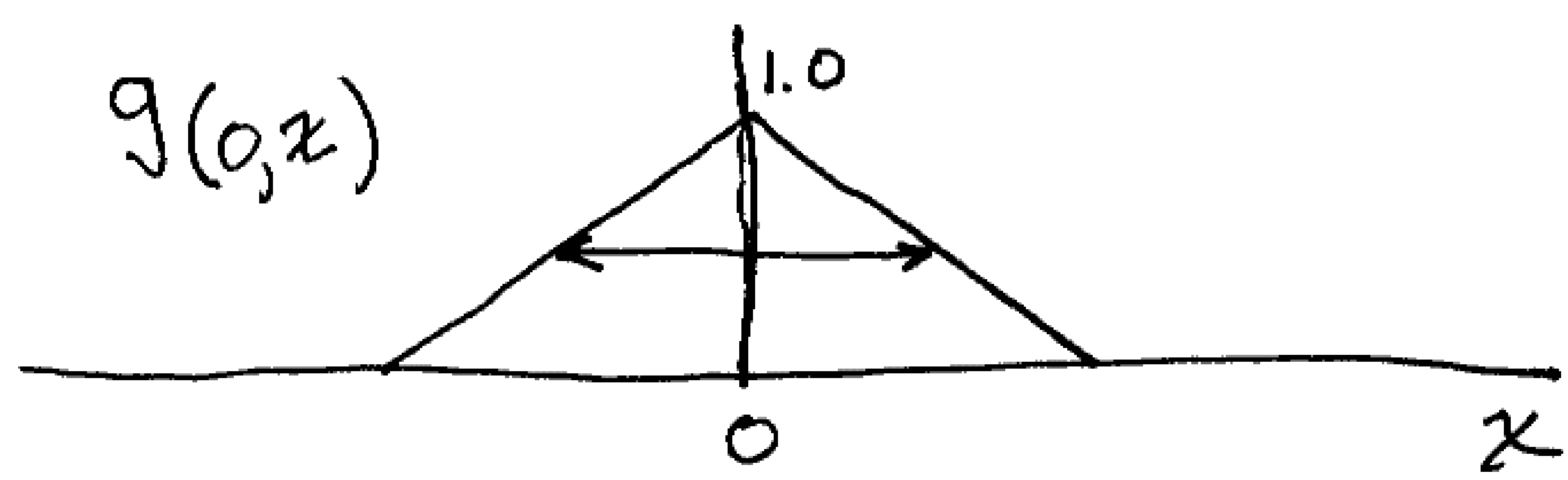
Collimator Spatial Response

$$g(x, y)$$

$$R_c \approx D_{so} \frac{d}{l}$$

where R_c is the full width at half maximum of $g(x,y)$





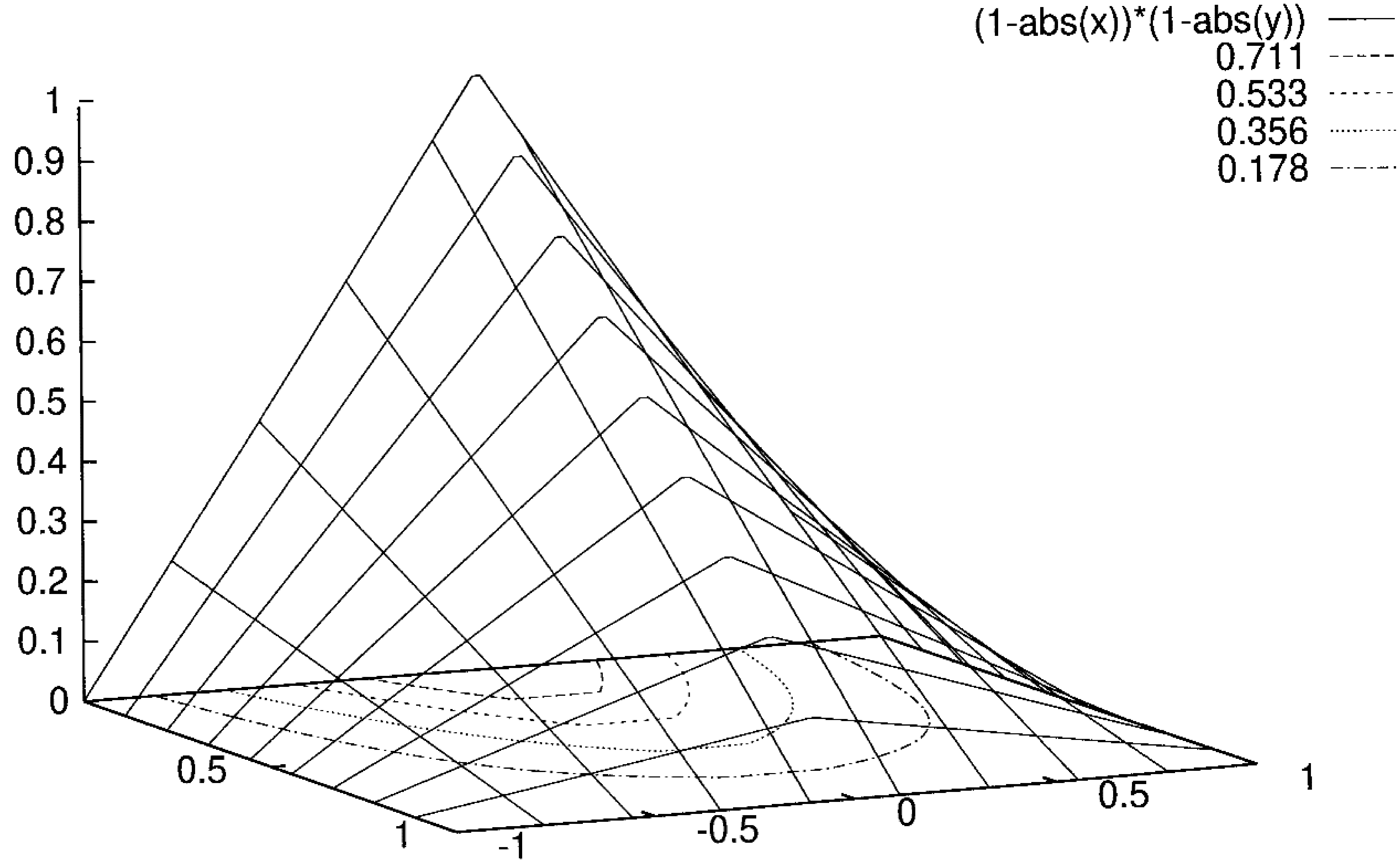
Accounting for the "effective" length of the collimator holes

$$R_c \approx (D_{so} + l_e) \frac{d}{l_e}$$

$$g(x,y) = \left(1 - \left|\frac{x}{R_c}\right|\right)\left(1 - \left|\frac{y}{R_c}\right|\right) \qquad x, y \leq R_c$$

$$= 0 \qquad x, y \geq R_c$$

Collimator Response to A Point Source



Collimator Response

efficiency

~~For square~~

The count rate in response to a point soure is:

$$\Phi_D(x,y) = g(x,y)\,\frac{B_q f}{4\pi D_{so}^2}$$

The collimator efficiency is defined as:

$$G = \frac{\iint \Phi_D(x,y)\,dx\,dy}{B_q f}$$

G is thus the total number of photons striking the detector per second relative to the photon emission rate in photon per second

Collimator Response

efficiency: square holes

$$G = \frac{1}{4\pi D_{50}^2} \int_{-R_c}^{+R_c}\int_{-R_c}^{+R_c} g(x,y)\, dx\, dy$$

let $x' = \frac{x}{R_c} \quad \frac{dx'}{dx} = \frac{1}{R_c}$

$y' = \frac{y}{R_c} \quad \frac{dy'}{dx} = \frac{1}{R_c}$

$$G = \frac{R_c^2}{4\pi R_{50}^2} \int_{-1}^{1}\int_{-1}^{1} (1-|x'|)(1-|y'|)\, dx'dy'$$

$$= \frac{1}{4\pi}\left(\frac{d}{l}\right)^2 4 \int_0^1\int_0^1 (1-x')(1-\cancel{y'})\, dx'dy'$$

$$= \frac{1}{4\pi}\left(\frac{d}{l}\right)^2 4 \int_0^1 (1-x')\,dx' \int_0^1 (1-y')\, dy'$$

$$= \frac{1}{4\pi}\left(\frac{d}{l}\right)^2 4 \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$$

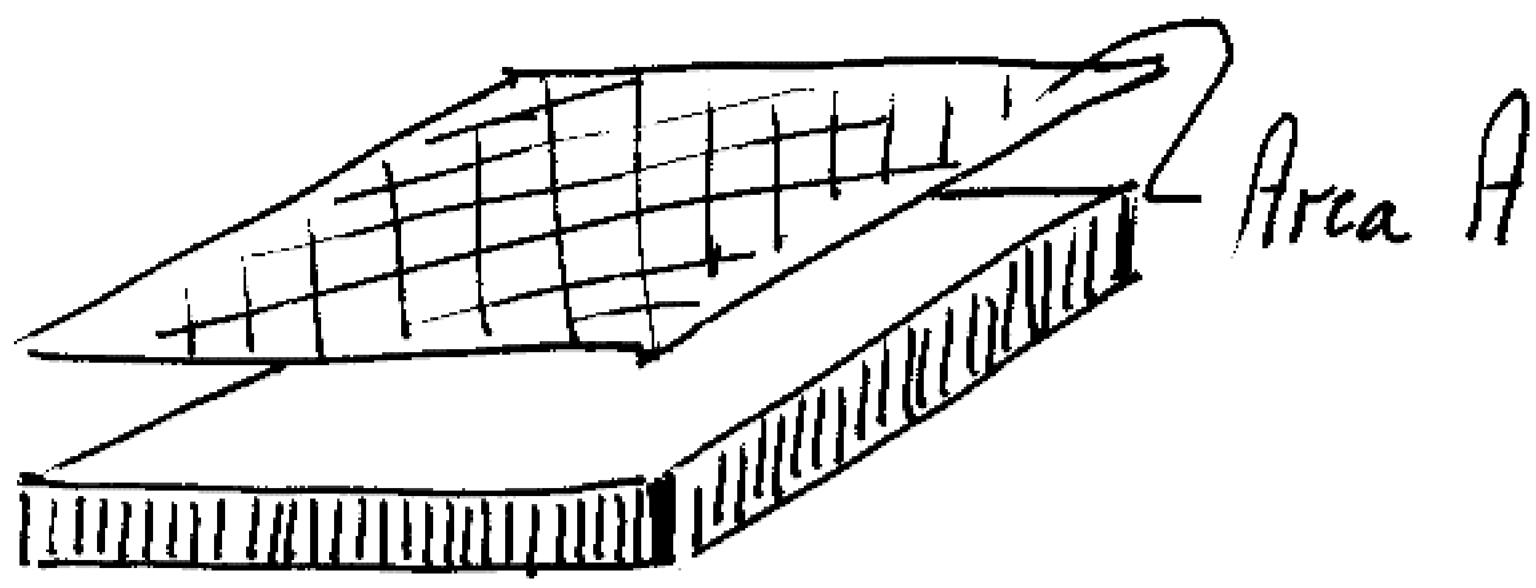
$$= \frac{1}{4\pi}\left(\frac{d}{l}\right)^2$$

Collimator Response

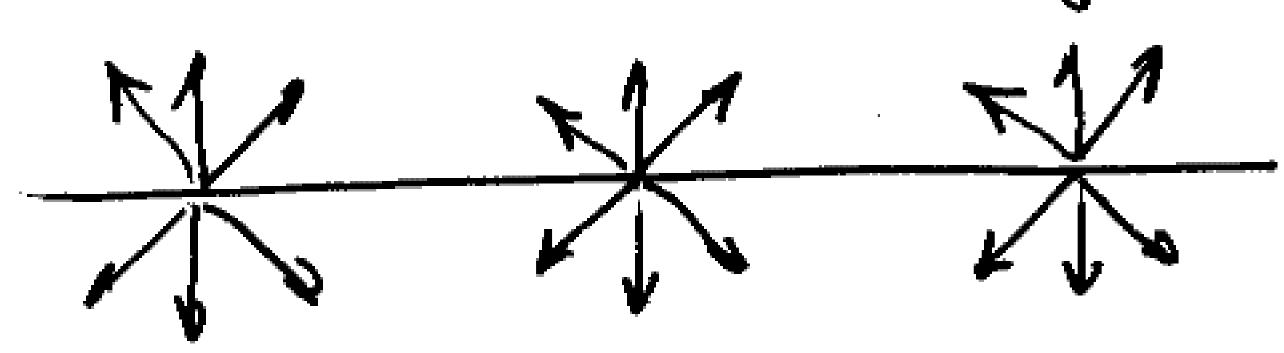
Source Distributed on a Plane

Source: distribution

$\frac{B_a}{A}$, $\frac{dis/sec}{cm^2}$



Emission per solid angle (radiance

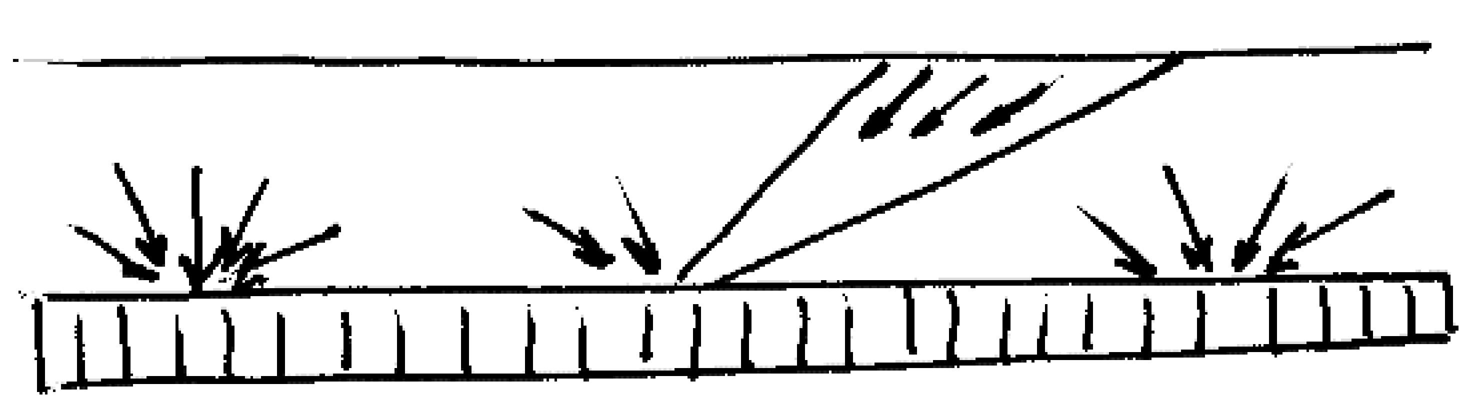


Source emission

$$\frac{1}{4\pi}\frac{B_a f}{A}, \quad \#/sec/sr/cm^2$$

When the distance from the collimator to the plane source is small relative to the length and width, the irradiance of the surface is also:

$$\frac{1}{4\pi}\frac{B_a f}{A}, \quad \#/sec/sr/cm^2$$



Collimator Response

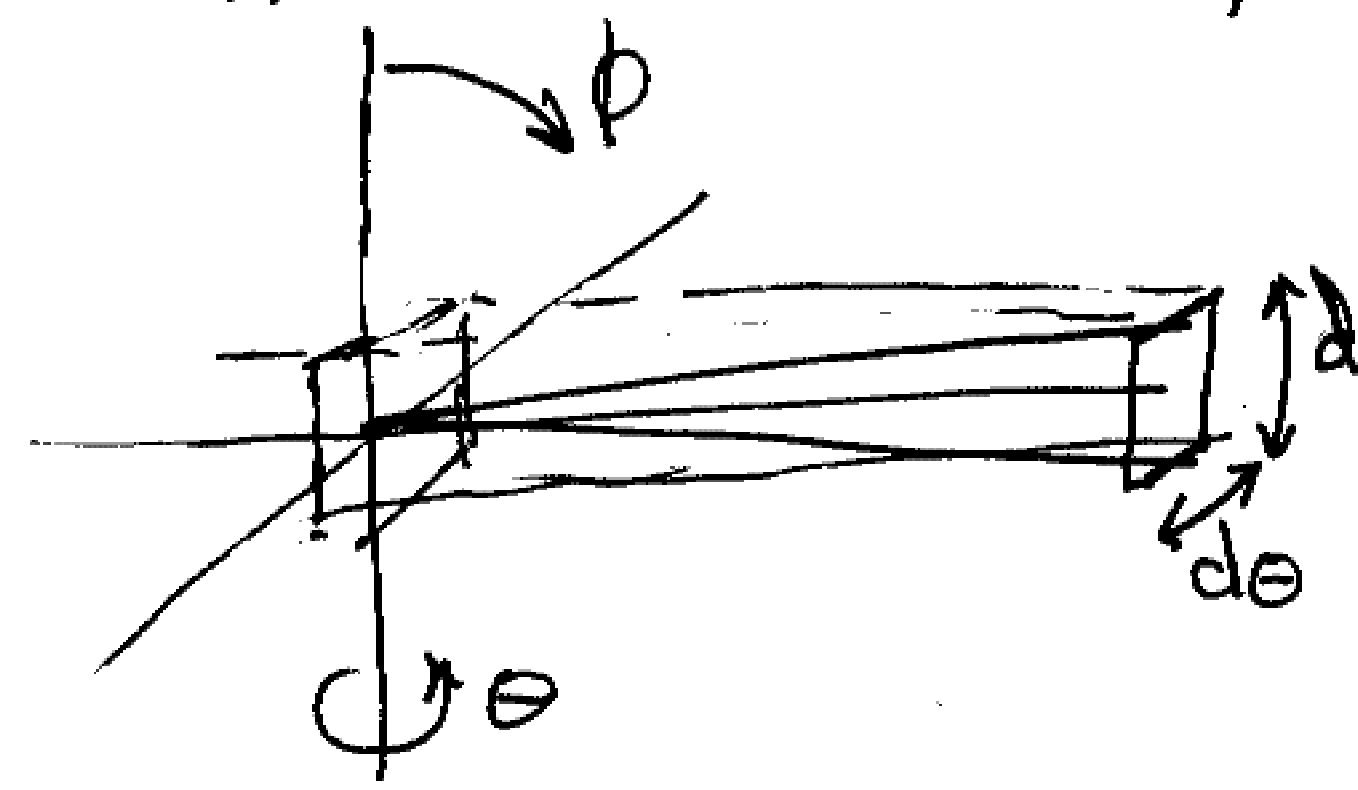
Plane source efficiency

The collimator efficiency to a plane source is given by the #/cm²/sec passing through the collimator, divided by the source strength dis/cm²/sec:

$$G = \frac{\left[\frac{1}{4\pi}\,\frac{B_q f}{A}\right]\Omega_c}{B_q f/A} = \frac{1}{4\pi}\,\Omega_c$$

where Ω_c is the solid angle for which the collimator holes can transmit radiation;

$$d\Omega = \sin\phi \, d\theta \, d\phi$$
$$\simeq d\theta \, d\phi$$



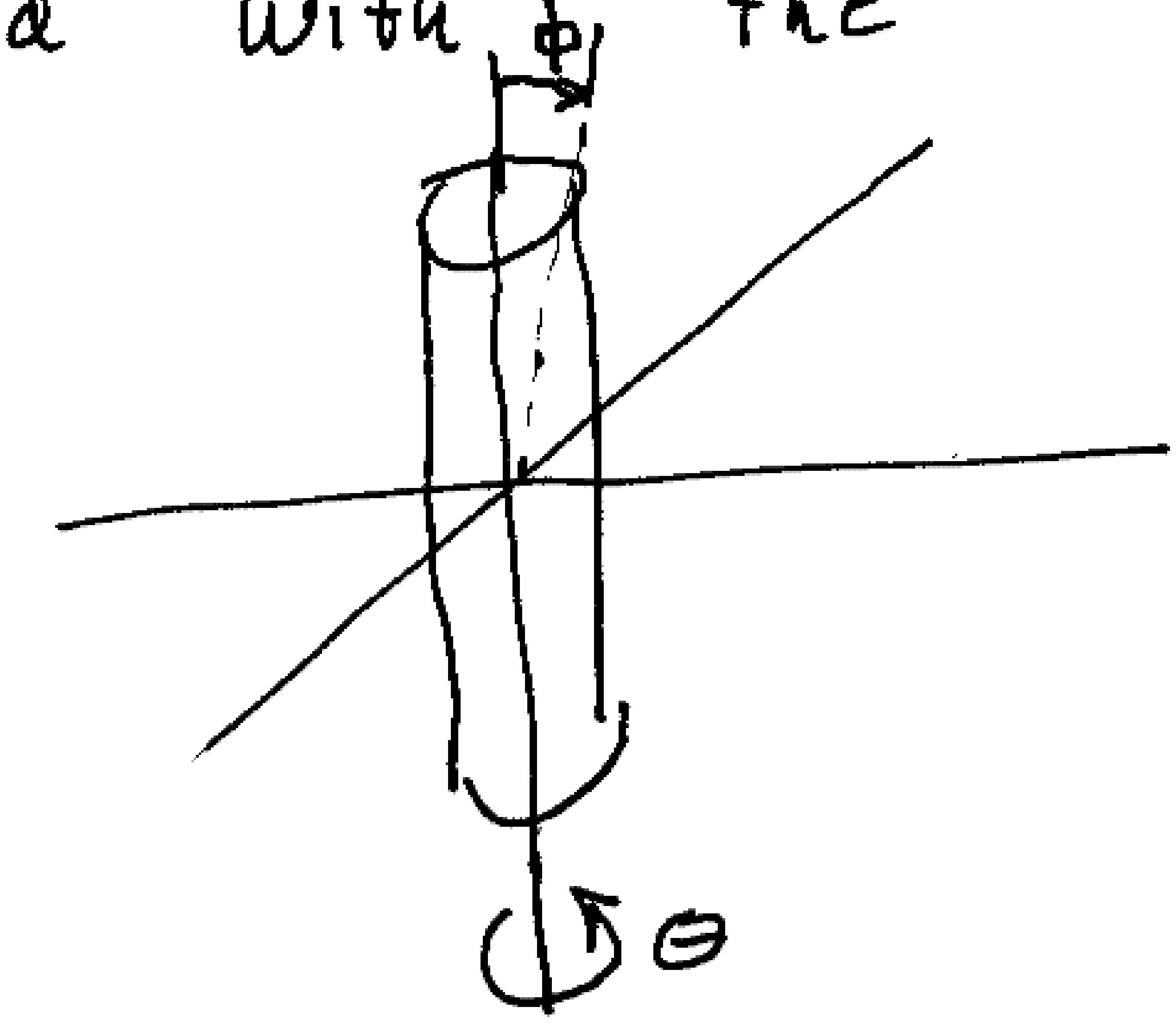
$$\Omega_c = \int_{-\frac{d/2}{\ell}}^{+\frac{d/2}{\ell}} \int_{-\frac{d/2}{\ell}}^{+\frac{d/2}{\ell}} d\theta \, d\phi = \left(\frac{d}{\ell}\right)^2$$

$$G = \frac{1}{4\pi}\left(\frac{d}{\ell}\right)^2$$ ~~for f = 1~~

The efficiency for a plane source is, as expected equal to the efficiency of a point source

G and Solid Angle for cylinder

derivation of the acceptance solid angle of a cylinder. Consider a cylinder aligned with the ϕ axis



$$d\Omega = \sin\phi \, d\theta \, d\phi$$

$$\Omega_c = \int_0^{2\pi} d\theta \int_0^{\frac{1}{2}d/\ell} \sin\phi \, d\phi$$

where d is now the diameter.

since $\sin\phi \approx \phi$

$$\Omega_c = 2\pi \int_0^{\frac{1}{2}\frac{d}{\ell}} \phi \, d\phi = 2\pi\left[\frac{1}{2}\left(\frac{1}{2}\frac{d}{\ell}\right)^2\right]$$

$$\Omega_c = \frac{\pi}{4}\left(\frac{d}{\ell}\right)^2$$

The solid angle is seen to be the area of the hole $(\pi d^2/4)$ divided by the length squared.

$$\therefore \quad G = \frac{1}{4\pi}\Omega_c = \left(\frac{1}{4}\right)^2\left(\frac{d}{\ell}\right)^2$$

Collimator Response
efficiency

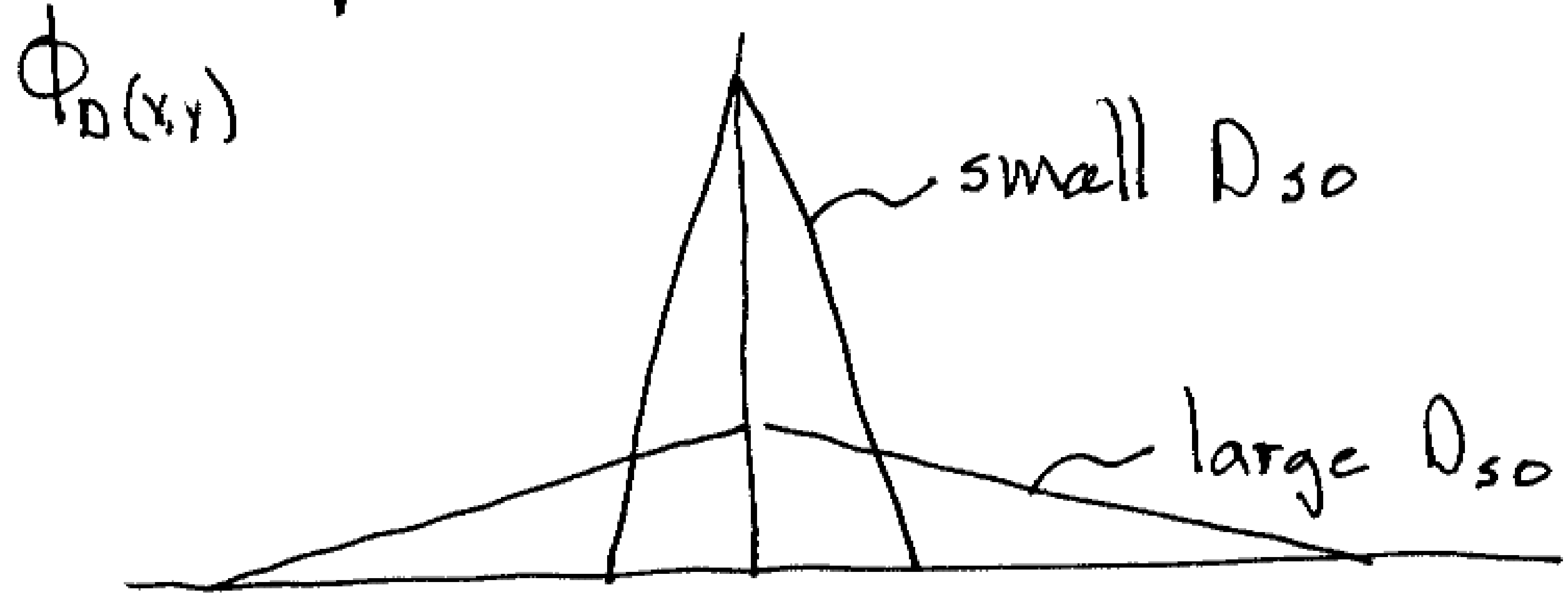
$$G = K^2 \left(\frac{d}{l}\right)^2 \left(\frac{d}{d+t}\right)^2$$

$K = .28$ square holes

$.26$ hexagonal holes

$.24$ round holes

G is independant of D_{50}



large $\frac{d}{l} \Rightarrow G$ high

$\Rightarrow R_c$ large $\Rightarrow$ resolution is poor