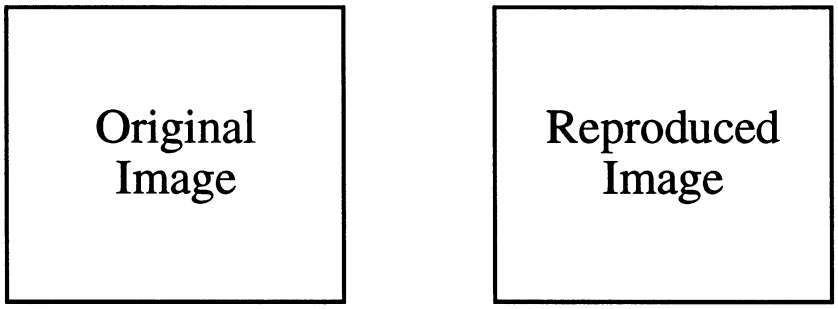
2.3.3 HUMAN VISUAL SYSTEM

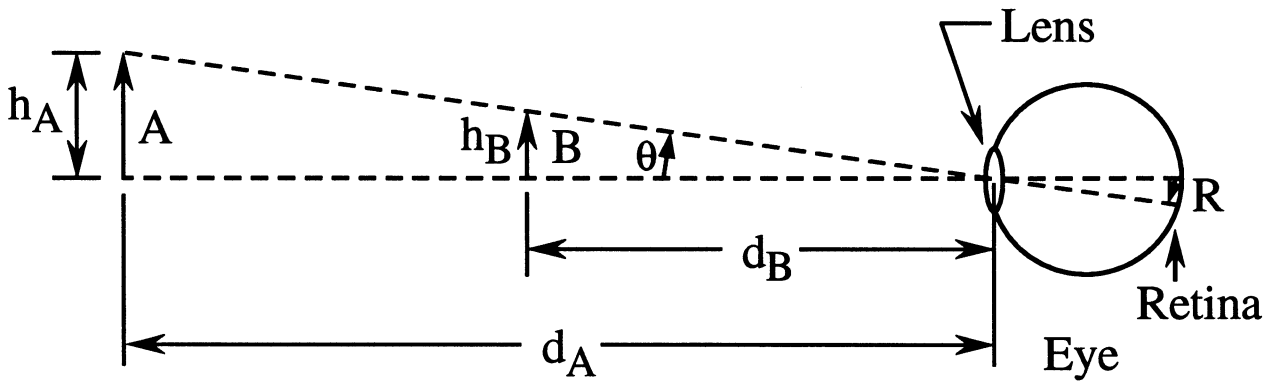
Image Quality Paradigm



- How good does reproduction need to be in order to appear identical to the original?

- If image quality is high, it may be argued that threshold phenomena will govern the perceived difference between the two images.

Viewing Geometry



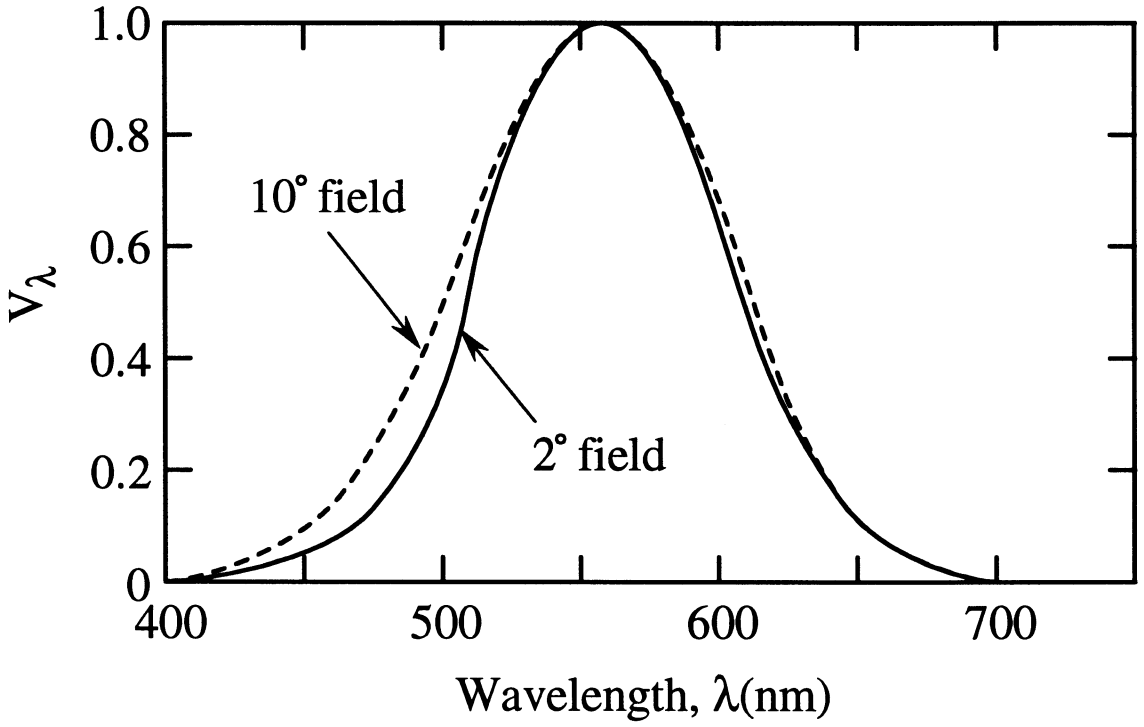
- Both arrows A and B generate the same retinal image R.

- It is convenient to measure the size of the retinal image in terms of the subtended angle θ

$$\theta = \arctan\left[\frac{h_A}{d_A}\right] = \arctan\left[\frac{h_B}{d_B}\right]$$

Relative Luminous Efficiency

- The human viewer is not equally sensitive to light at all wavelengths



- Luminance

$$L = k_m \int_0^\infty V(\lambda)S(\lambda)d\lambda \quad (cd/m^2)$$

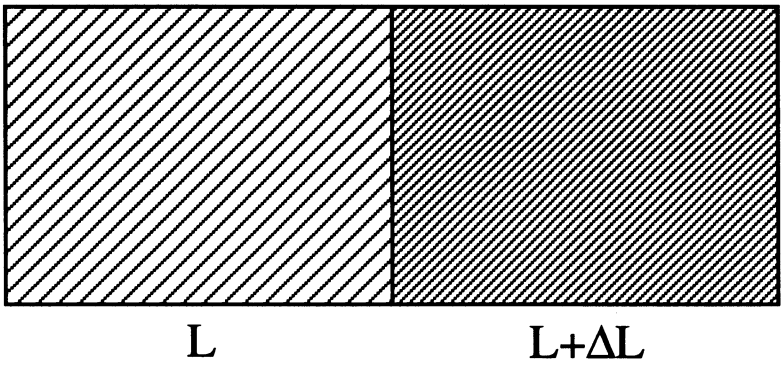
k_m - 680 lm/W

$S(\lambda)$ - spectral radiance density of stimulus

- Luminance is a measure of the perceived brightness of the stimulus.
- Luminances of 0.1 to 1000 cd/m^2 are typically encountered in displays.

Weber's Law

- Dependence of detectability of a change in stimulus on the magnitude of the stimulus



- The minimum value of ΔL for which the two subfields are distinguished 50% of the time satisfies

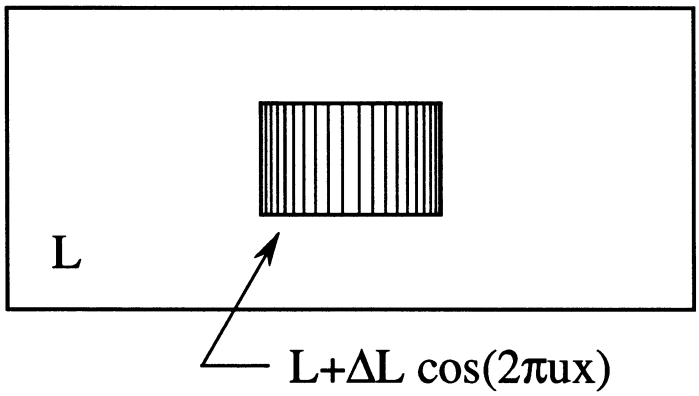
$$\frac{\Delta L}{L} = k$$

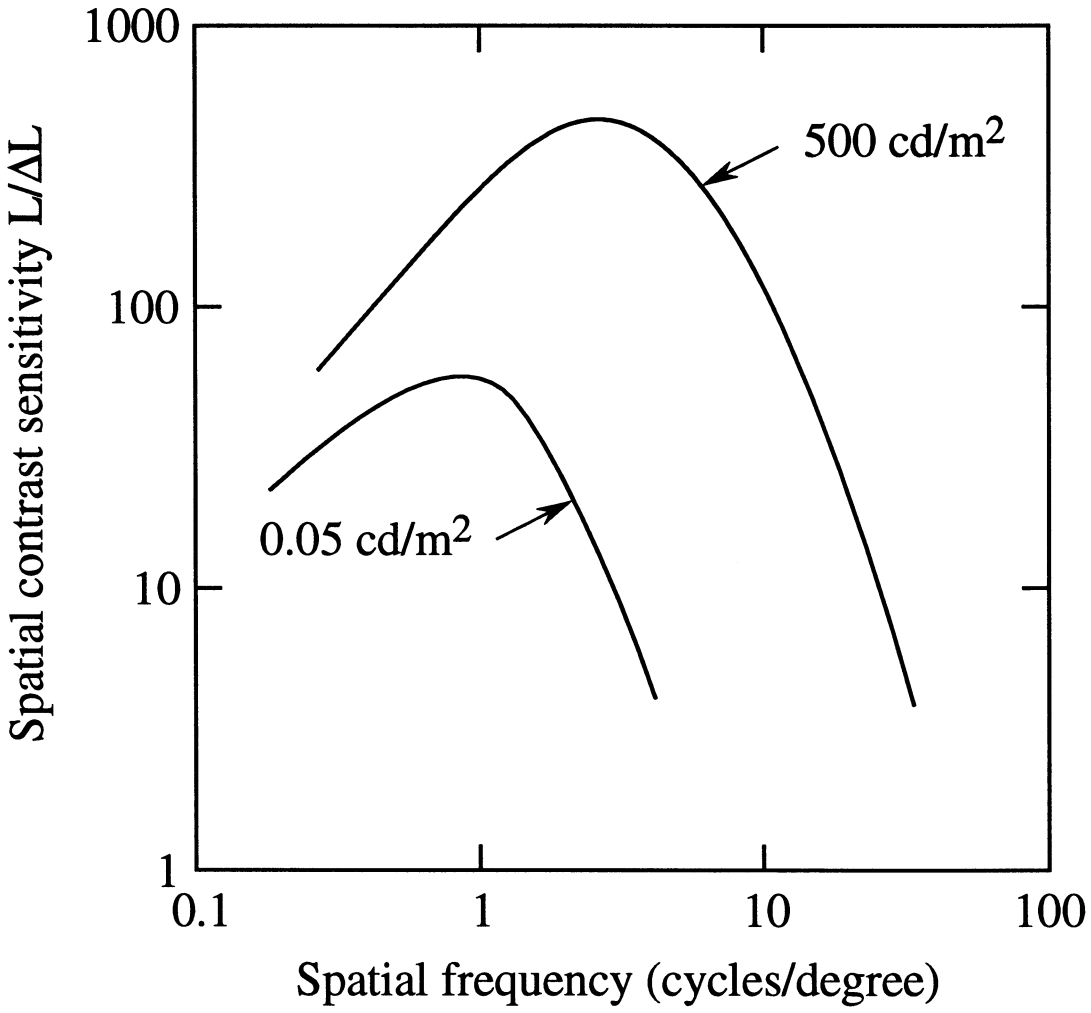
k - constant (Weber fraction) ≈0.01 to 0.02

- Define *contrast* as $\Delta L/L$

Response to Spatially Varying Stimulus

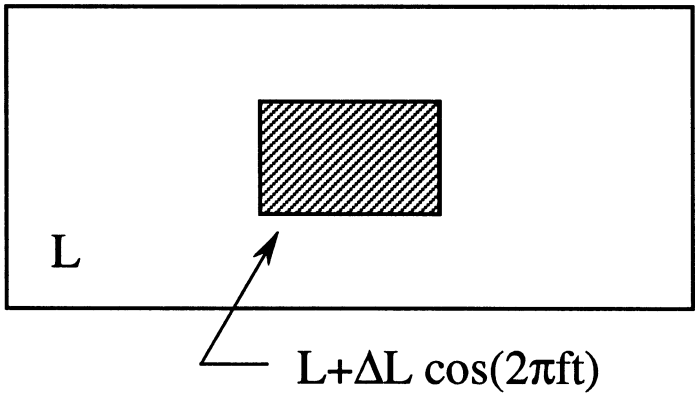
- Dependence of contrast sensitivity on spatial frequency

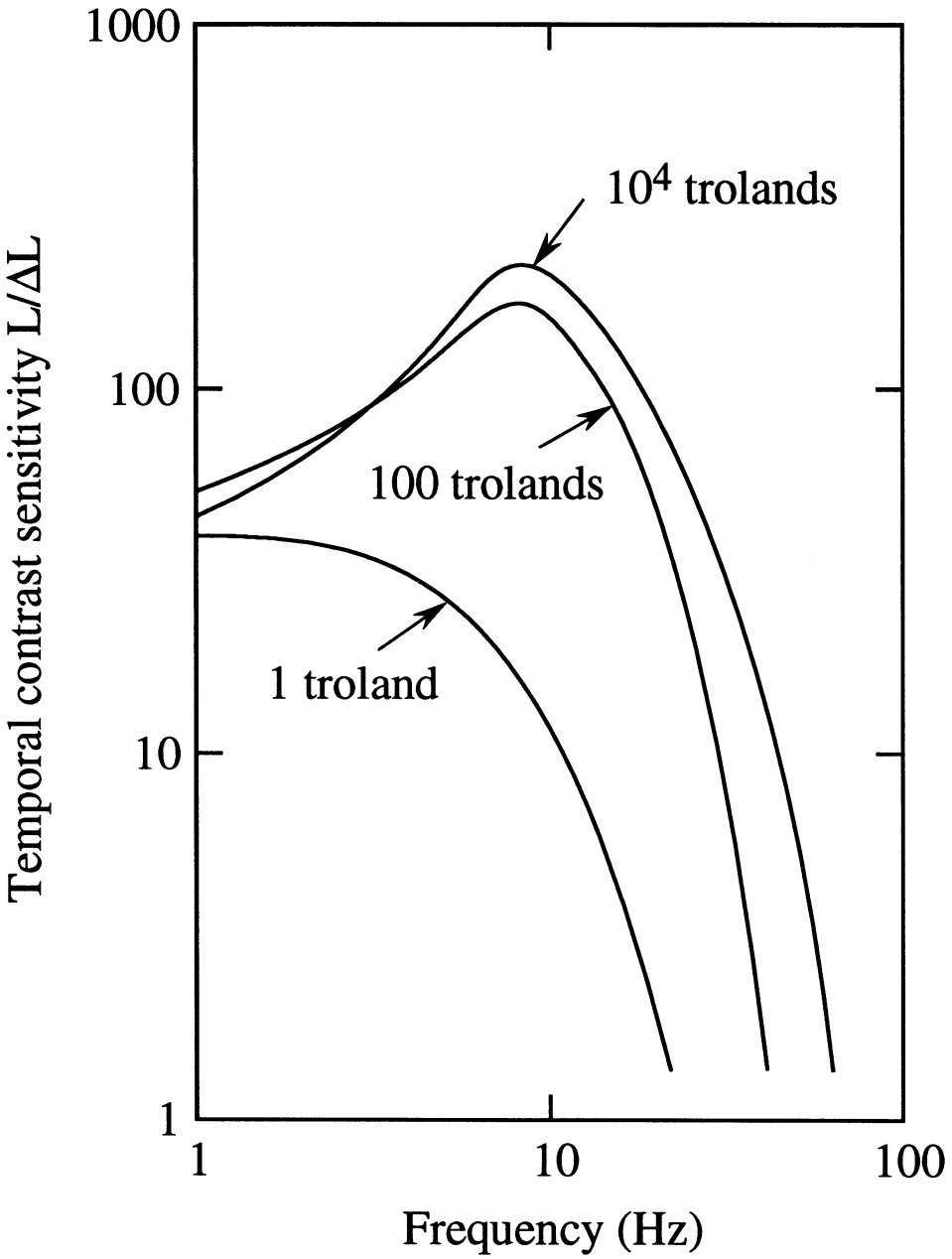



1000
100
10
1
Spatial contrast sensitivity L/ΔL
500 cd/m2
0.05 cd/m2
0.1
1
10
100
Spatial frequency (cycles/degree)

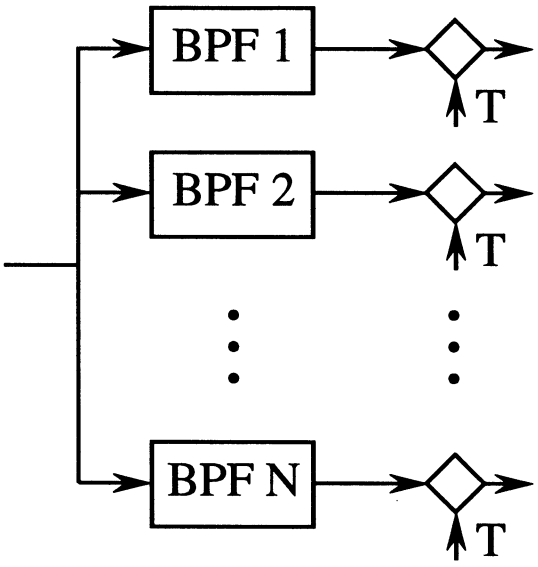
Response to Temporally Varying Stimulus

- Dependence of flicker sensitivity on temporal frequency

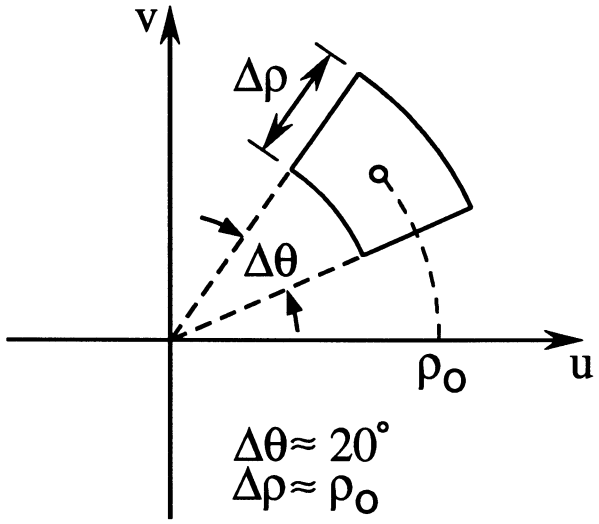



1000
100
10
1
1
10
100
Temporal contrast sensitivity L/ΔL
Frequency (Hz)
10^4 trolands
100 trolands
1 troland

Spatial Frequency Channels



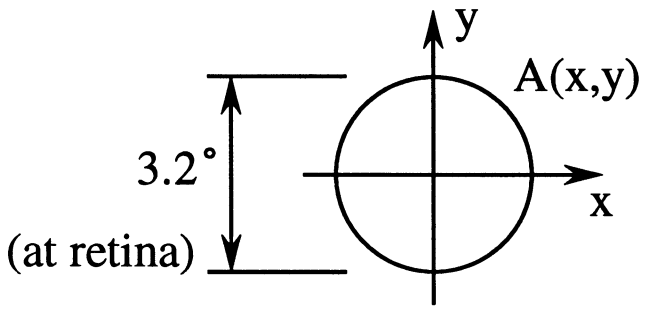
Bandpass Filters Thresholds



Channel gain depends on ρ_o in accordance with spatial frequency contrast sensitivity

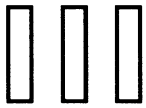
Spatial Summation

Perceptibility of  vs. 



spatial sensitivity
weighting function

Spatial Masking

Perceptibility of  vs.