

實驗3. 投影顯示技術實驗

實驗負責助教：卓奕辰

Display Optics Lab (電二351a)

E-mail: r08941044@ntu.edu.tw

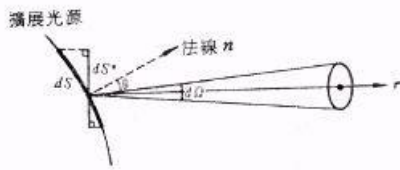
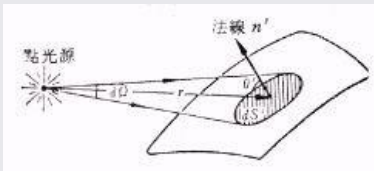
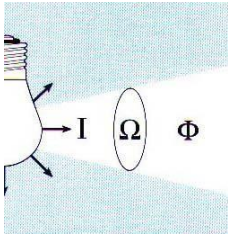
手機:0920982219

Experimental Objectives

- To study the basic performance parameters of a display system.
 - Luminance (brightness, 輝度; 亮度)
 - Contrast Ratio (對比)
 - Chromaticity (color, 色度)
 - Uniformity (均勻度)
 - Viewing angles (視角)

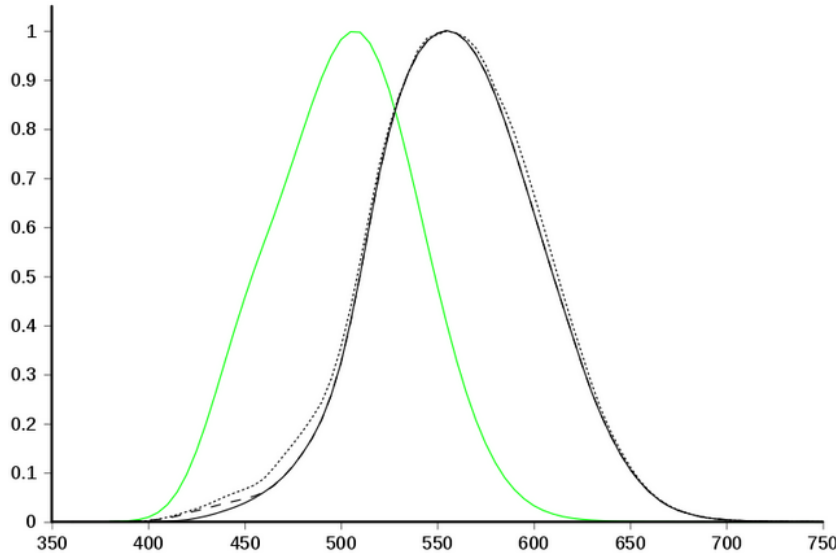
1. Photometry 光度學

Photometry	Definition	Unit
光通量 (Luminous flux, Φ)	由一光源所發射並被人眼感知之所有輻射能稱之為光通量。	lumen, lm, 流明
光強度 (luminous intensity, I)	<p>光源在某一方向立體角內之光通量大小。</p> <p>一般而言，光源會向不同方向以不同之強度放射出其光通量。在特定方向所放出之可見光輻射強度稱為光強度。</p>	candela, cd, lm/sr, 燭光
照度 (Illuminance, E)	<p>照度是光通量與被照面積之比值。</p> <p>1 lux之照度為1 lumen之光通量均勻分佈在面積為一平方米之區域。</p>	lux, lx, lm/m ²
亮度, 輝度 (Luminance, L)	一光源或一被照面之輝度指其單位表面在某一方向上的光強度密度，也可說是人眼所感知此光源或被照面之明亮程度。	cd/m ² , nit



Luminous efficiency function

$V(\lambda)$



Luminous flux (Unit: lm)

$$\Phi_{\text{lum}} = 683 \frac{\text{lm}}{\text{W}} \int_{\lambda} V(\lambda) P(\lambda) d\lambda$$

$V(\lambda)$ - 人眼相對光譜敏感度曲線，是總結眾多針對人眼的測試經驗而得到的，它描述人眼對不同波長的光的反應強弱

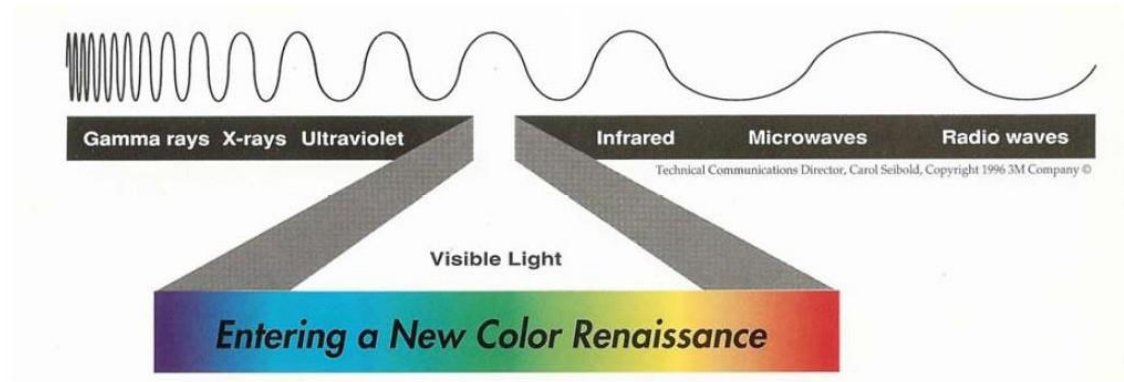
$P(\lambda)$ - 該波長的輻射功率

- (黑線)波長為**555nm**的單色光發光效率定為**1**，此光每**1W** 輻射通量具有**683**流明的光通量

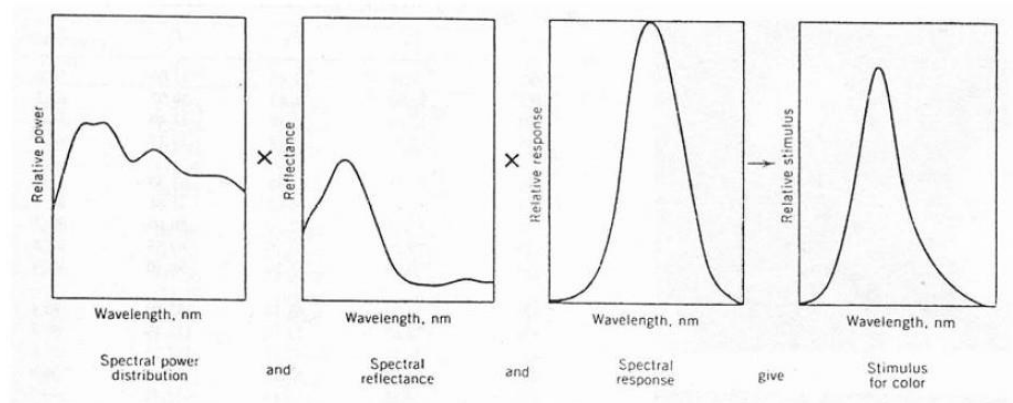
2. Contrast Ratio

$$\text{CR} = \frac{\text{Luminance at the brightest white}}{\text{Luminance at the darkest black}}$$

3. Color Measuring



Wavelength between 380nm to 780nm



Luminance

Contrast Ratio

Chromaticity

Uniformity

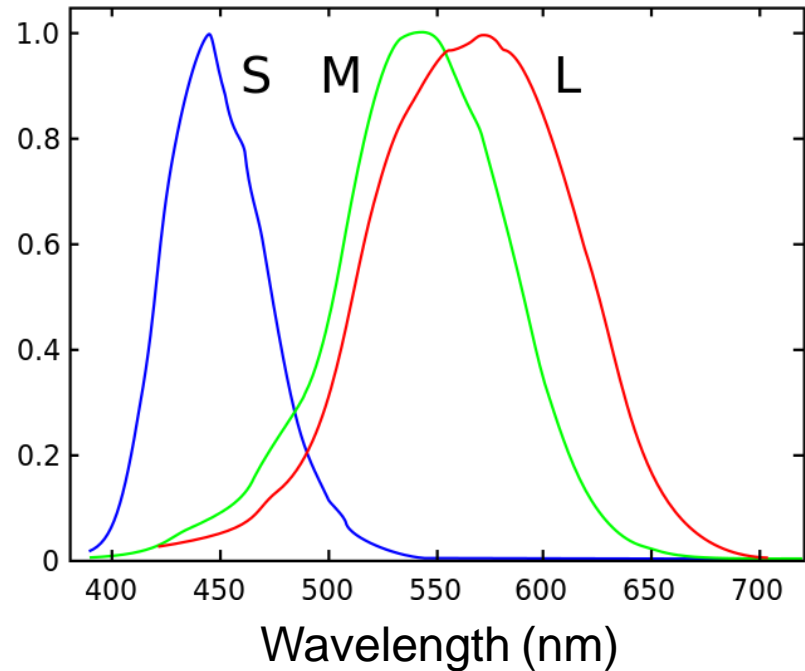
Viewing angle

Human Eye

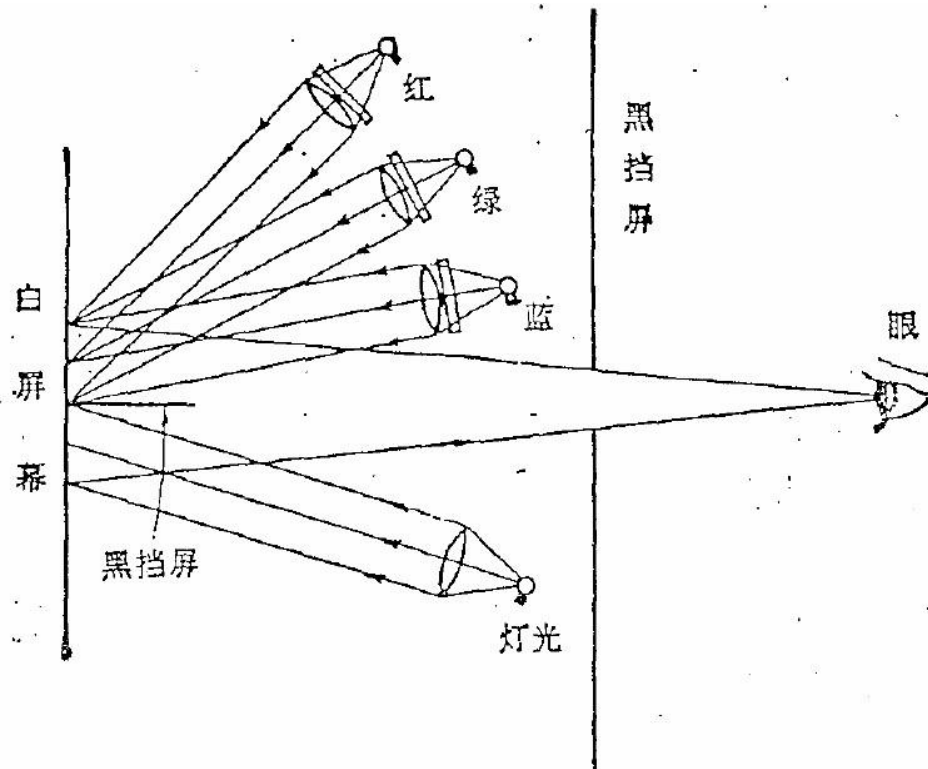
Humans normally have three kinds of cone cells.

The three types have peak response near 564–580 nm (L), 534–545 nm (M), and 420–440 nm (S).

The difference in the signals received from the three cone types allows the brain to perceive a continuous range of colors.



Color Matching



$$Q = R_Q \mathbf{R} + G_Q \mathbf{G} + B_Q \mathbf{B}$$

$$Q + R'_Q \mathbf{R} = G_Q \mathbf{G} + B_Q \mathbf{B}$$

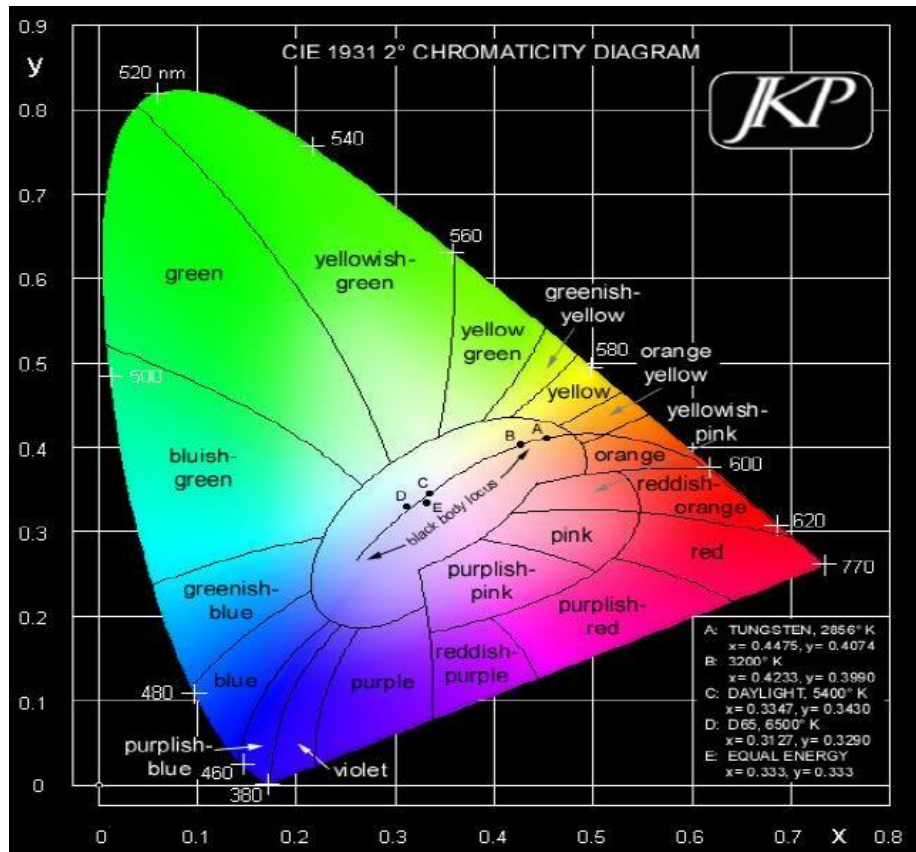
$$Q = -R'_Q \mathbf{R} + G_Q \mathbf{G} + B_Q \mathbf{B}$$

$$R_Q \equiv -R'_Q$$

CIE 1931 Chromaticity Diagram(色度圖)

CIE : **C**ommission **I**nternationale de l'**É**clairage

國際照明委員會, International Commission on Illumination



$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$z = \frac{Z}{X + Y + Z}$$

Luminance

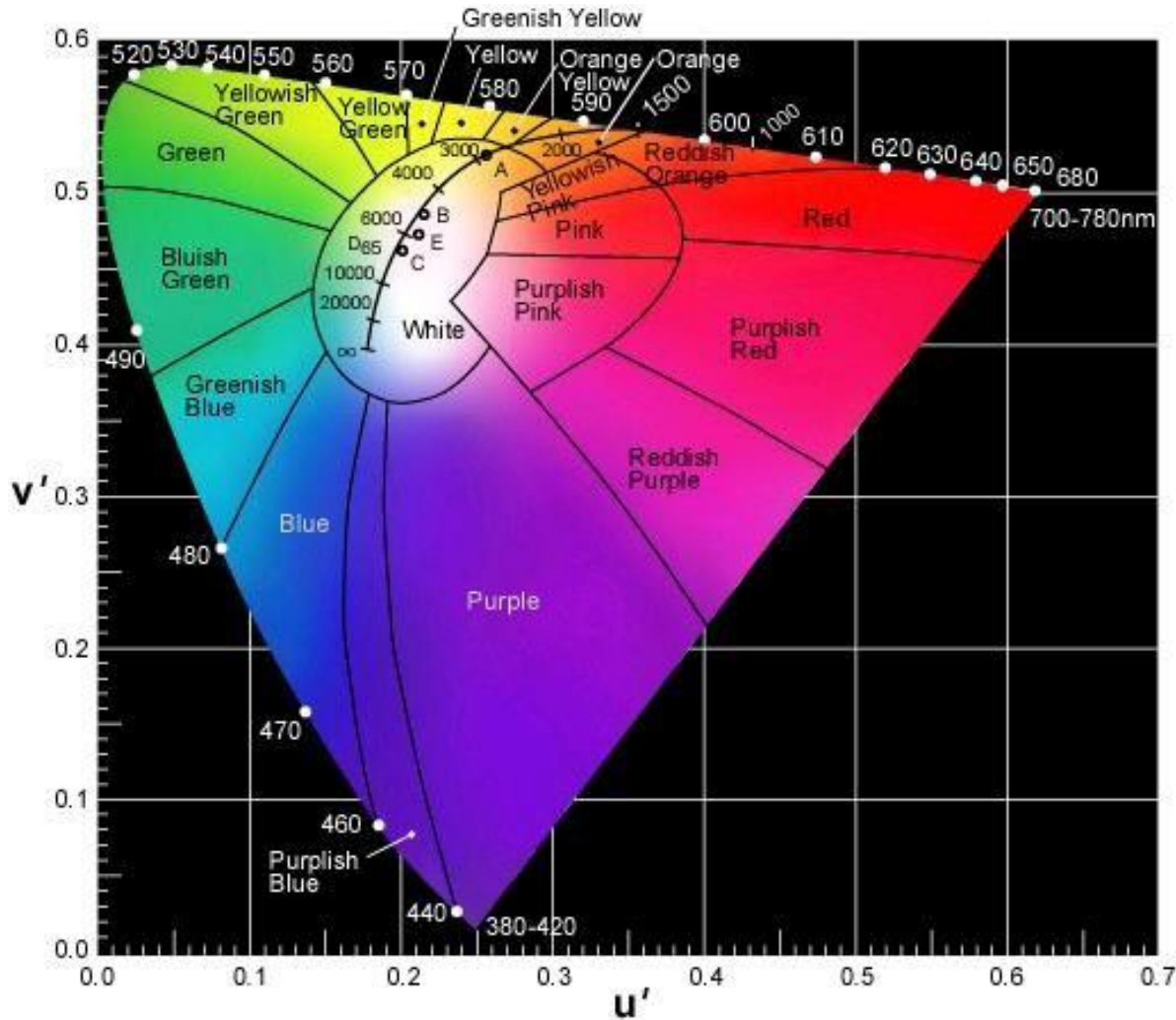
Contrast Ratio

Chromaticity

Uniformity

Viewing angle

CIE 1976 U.C.S. (Uniform Chromatic Scale) Diagram



$$\begin{aligned}u' &= 4x/(3+12y-2x) \\ v' &= 9y/(3+12y-2x)\end{aligned}$$

Luminance

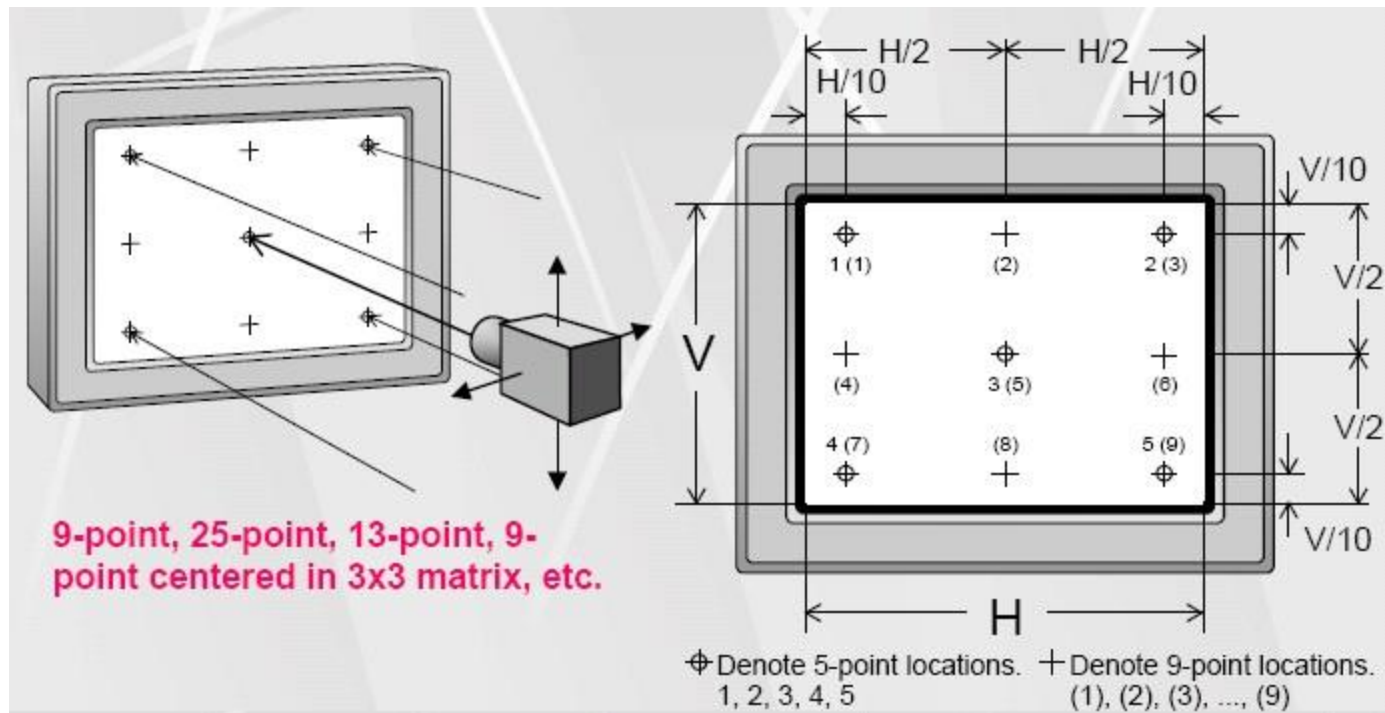
Contrast Ratio

Chromaticity

Uniformity

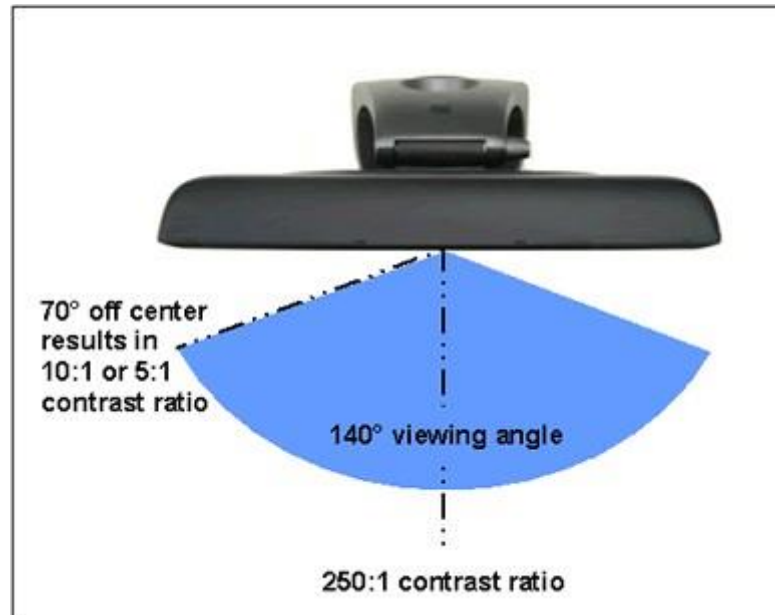
Viewing angle

4.Uniformity



5. Viewing Angle

- Viewing angle is the maximum angle at which a display can be viewed with acceptable contrast ratio.



預報問題

- 輻射學(Radiometry)與光度學(Photometry)相關資料(如色溫、光通量、發光強度、照度或輝度的定義和單位。)
- 100流明的綠光與100流明的藍光，哪個輻射功率較高？請解釋。
- 請描述DLP型投影機的基本工作原理。
- (Bonus) DLP型投影機如何調整某一畫素的亮度？

