No.2

Seminar I on Agricultural Process Engineering
農産加工学演習　I

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農学研究科　地域環境科学専攻

近藤　直・清水　浩

An energy flow from light source to output of TV camera

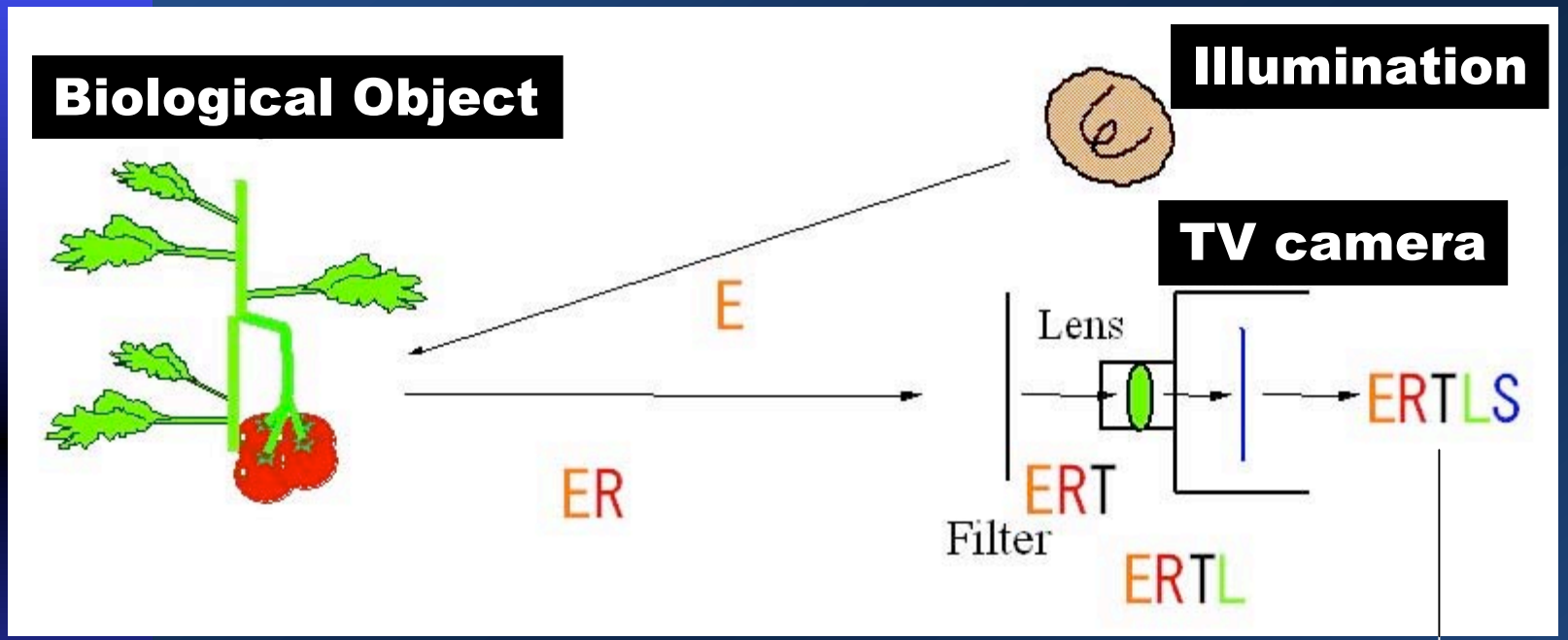
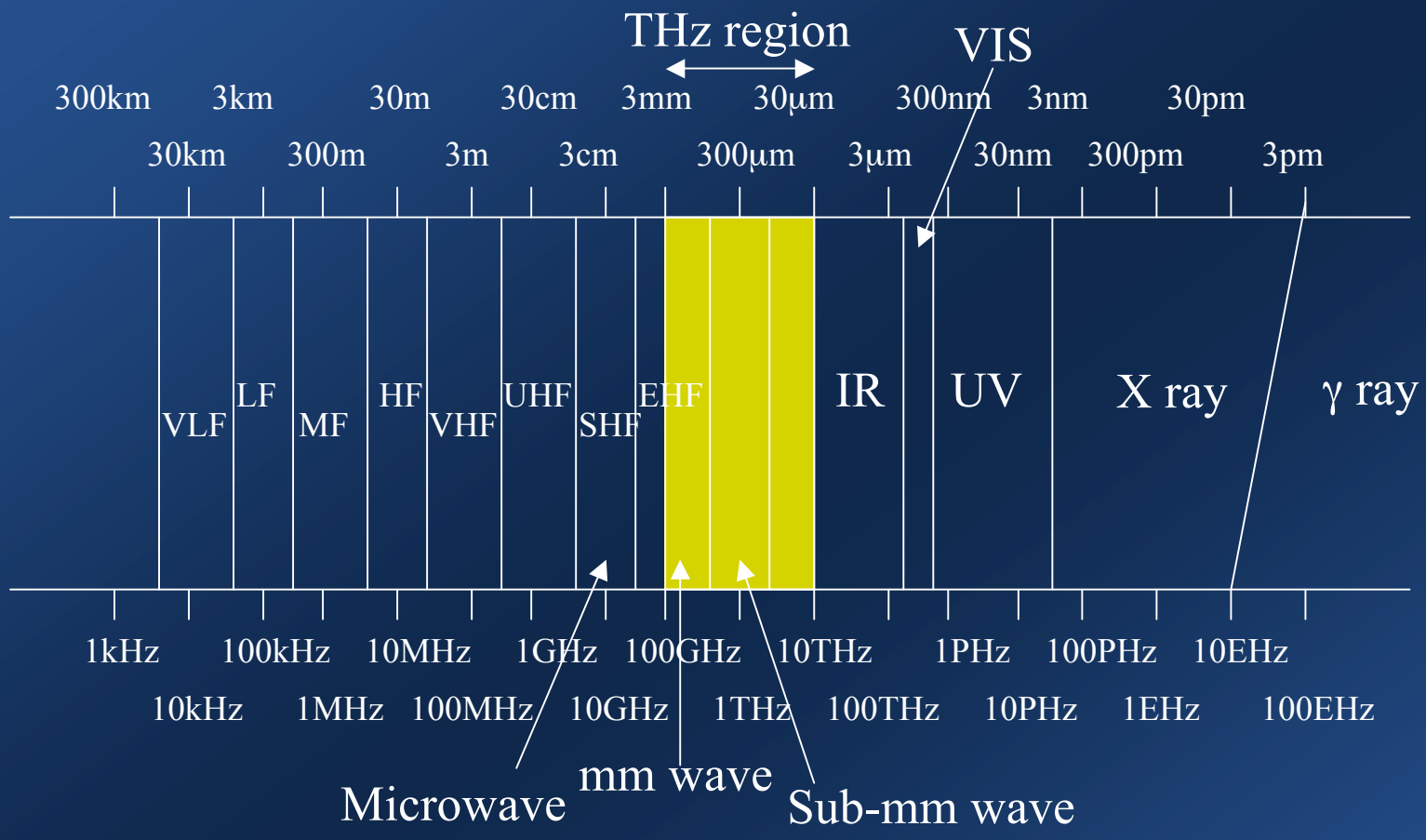
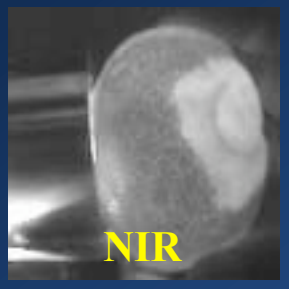


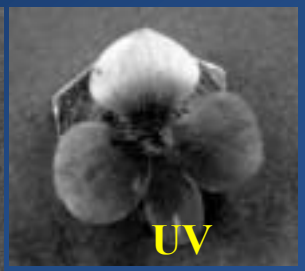
Image grabber and/or PC

Illumination

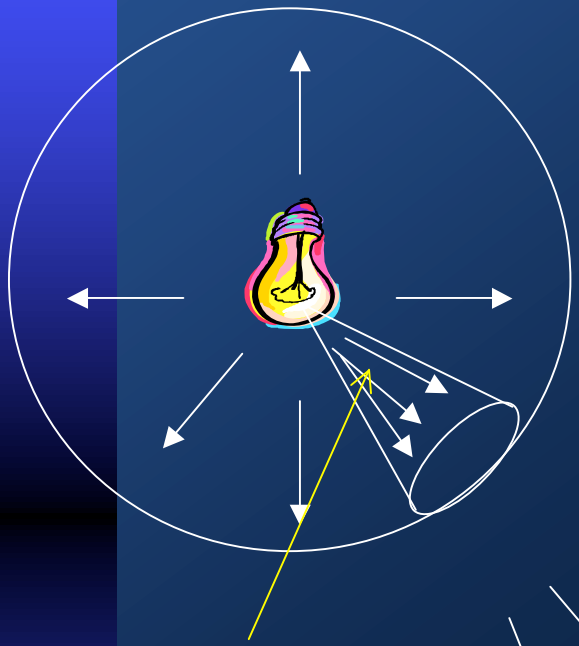
Frequency map for electromagnetic waves





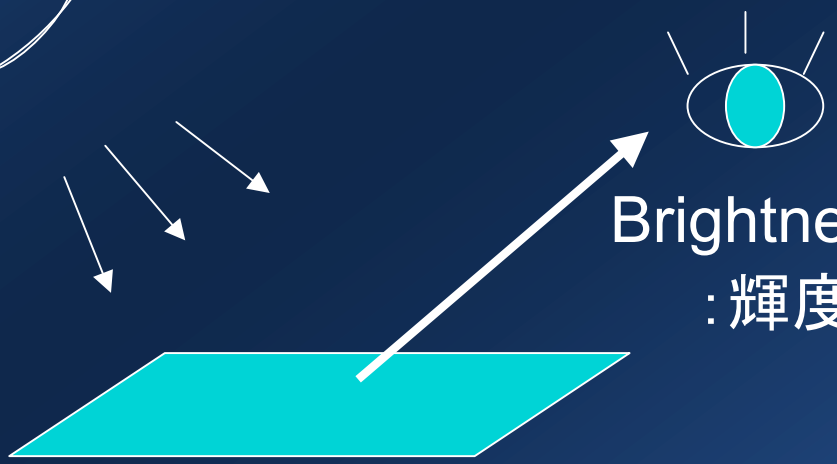


Fundamentals of light



Quantity of light(lm)：光束

Luminous intensity(cd, lm/sr)：光度



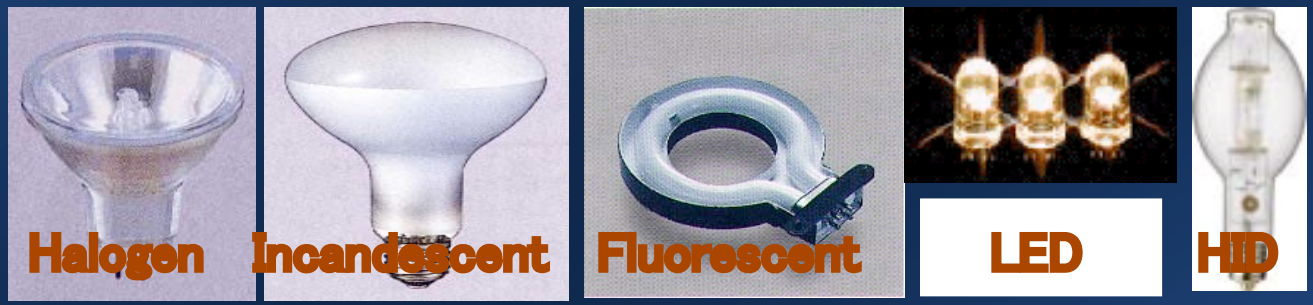
Solid angle
立体角

Brightness(cd/m^2)
：輝度

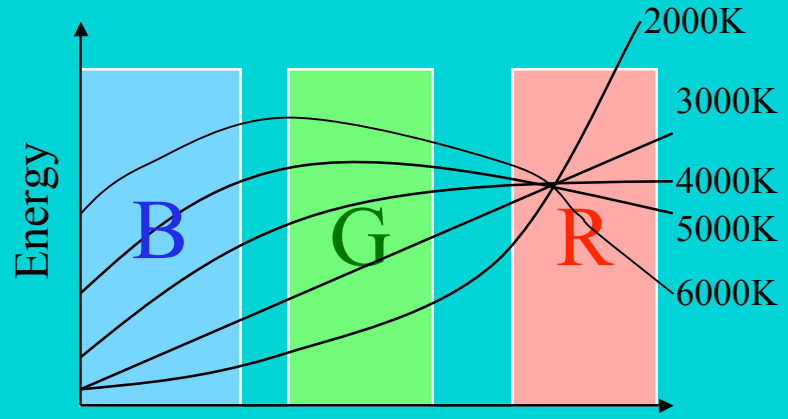
Intensity of illumination (lx)：照度

1cd = 4 πlm

Various lamps

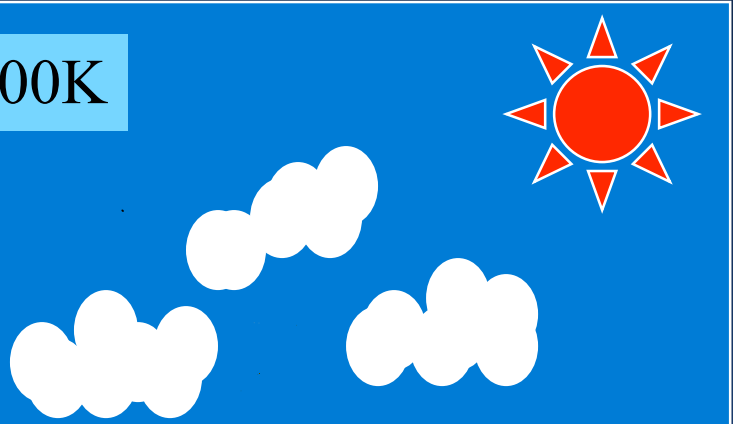


Color temperature



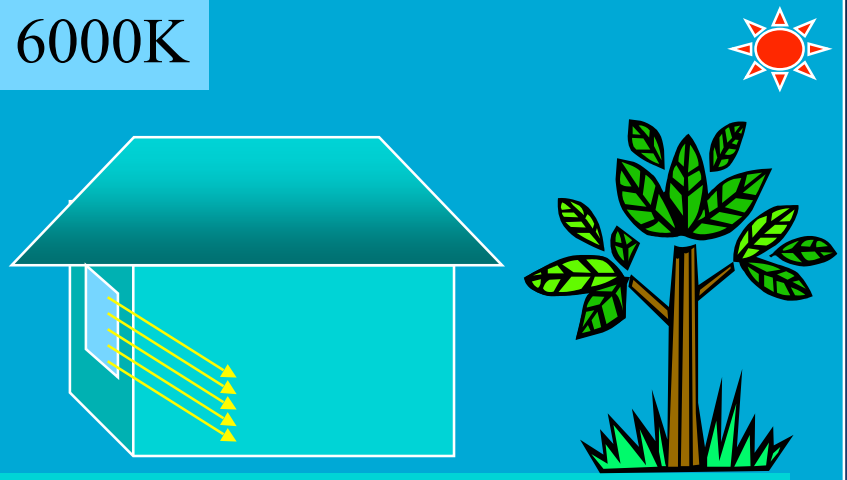
Radiation from black body

5000K



Direct sun light

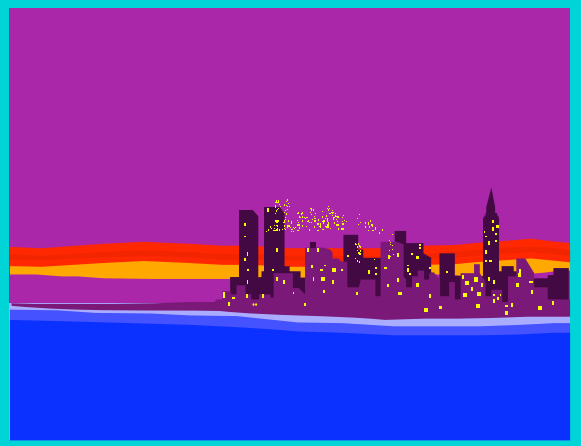
6000K

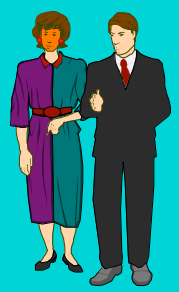


Light from north side window

Sky at sunset

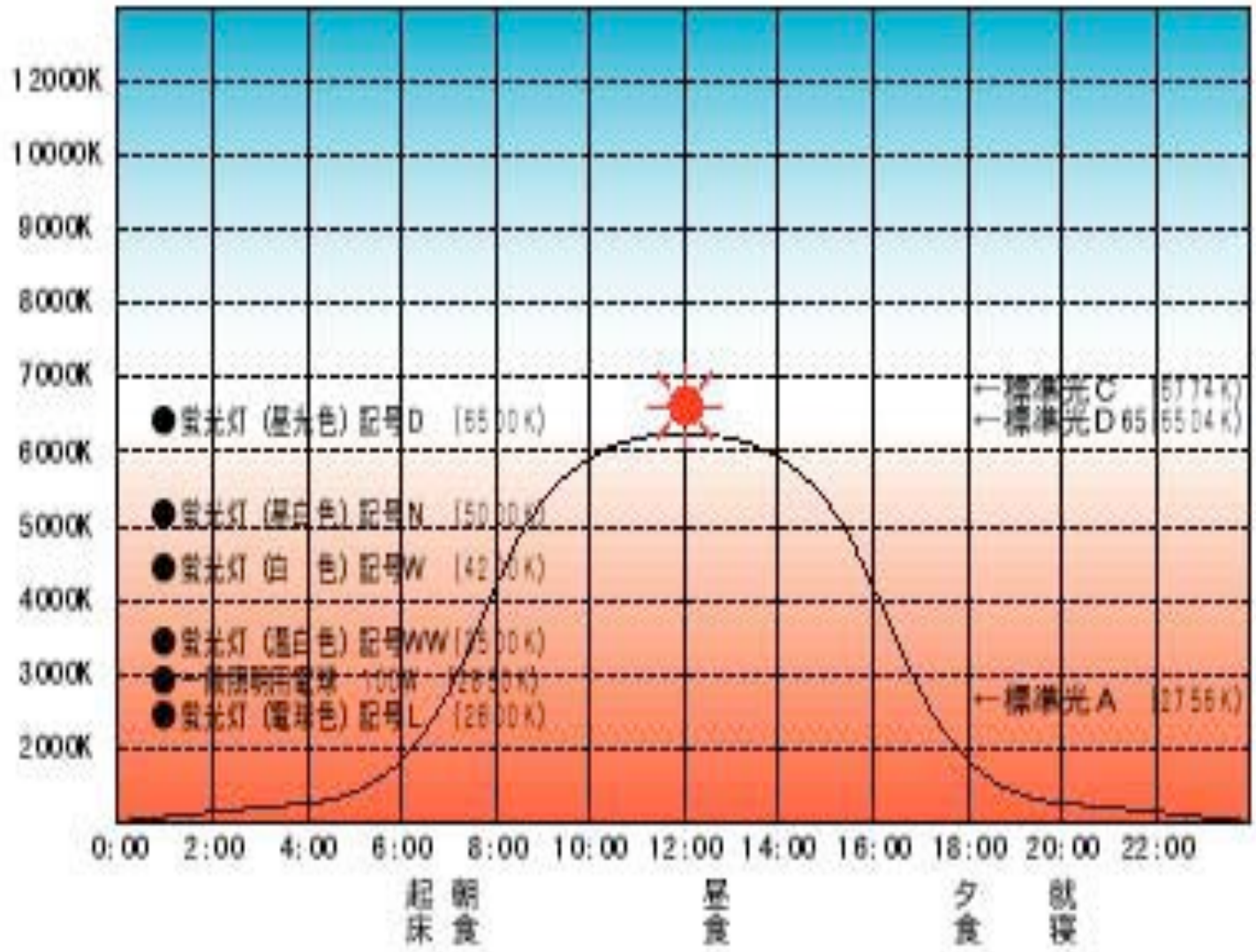
2000K

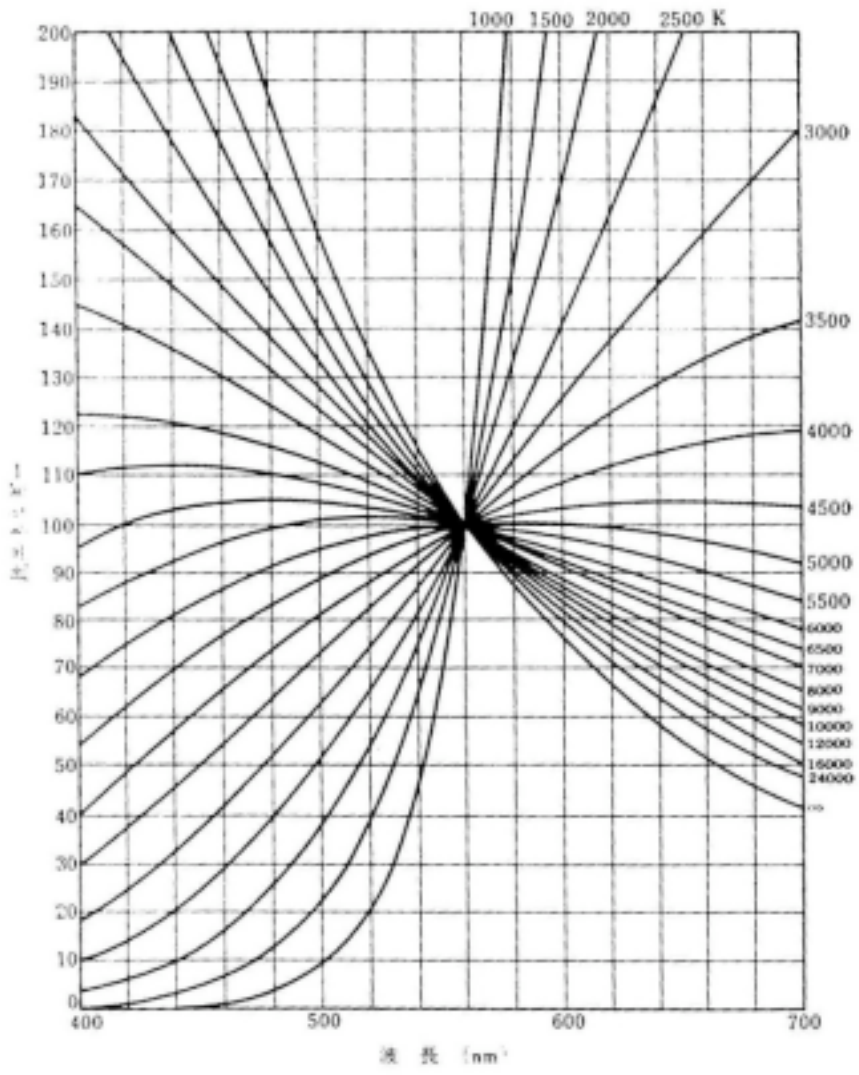




色温度

Color temperature of sunlight





Spectral radiation of blackbody

$$E_\lambda = \frac{C_1}{\lambda^5(e^{C_2/\lambda T} - 1)}$$

T: Color temperature (K)

$C_1 = 3.740\times10^{20}$ ($W\cdot m^{-2}\cdot nm^4$)

$C_2 = 1.438\times10^{7}$ ($nm\cdot deg$)

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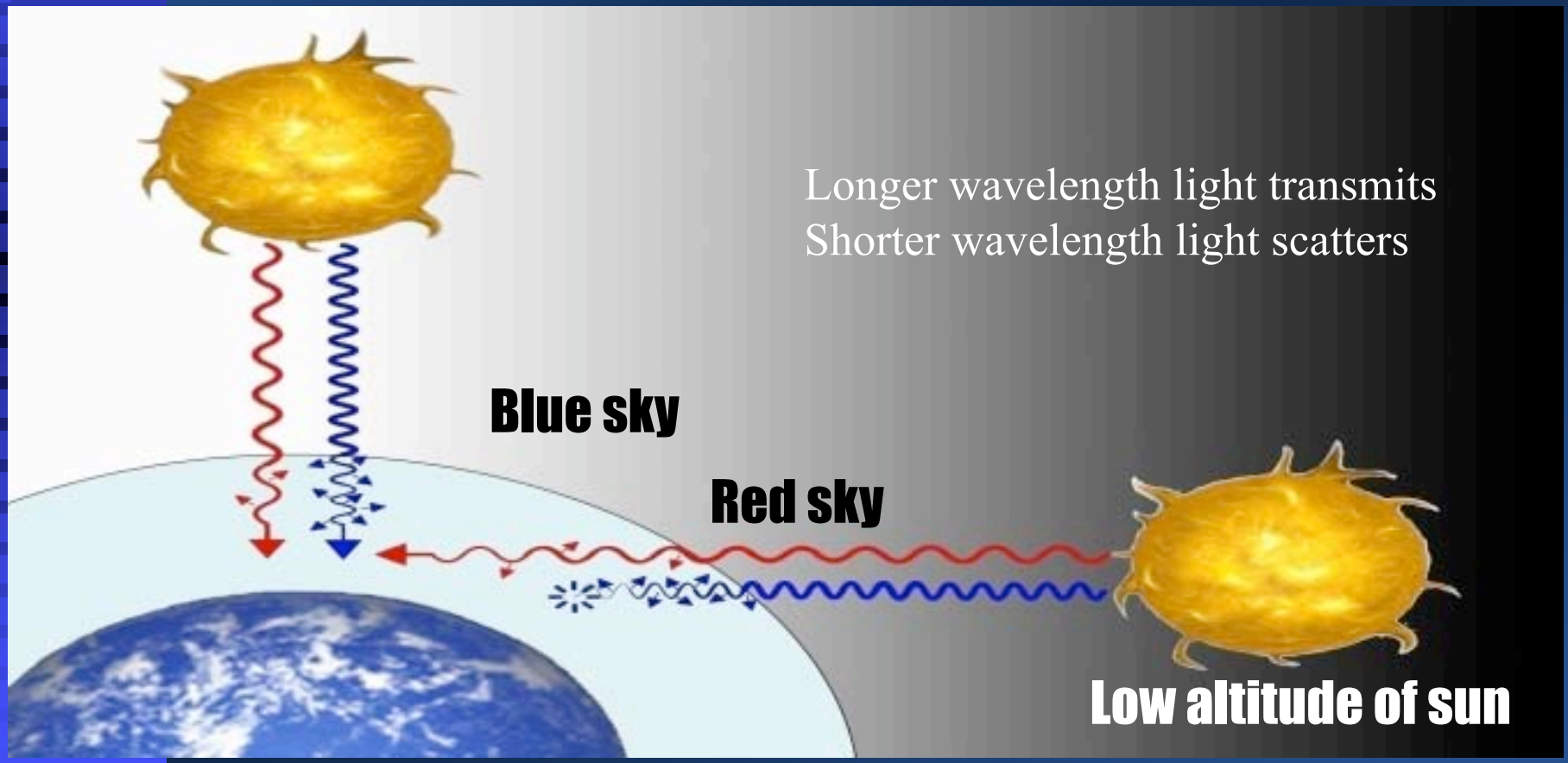
Why is the sunset color red?

Why is the sky blue in day time?

Rayleigh's Scattering theory

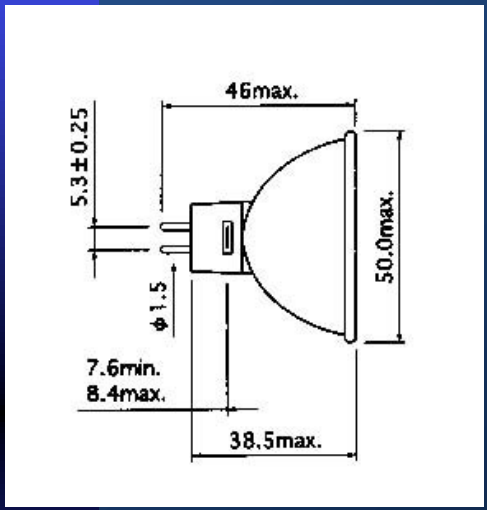
$$I(\theta)=\frac{I_0\pi^4 d^6}{8R^2\lambda^4}\left(\frac{m^2-1}{m^2+1}\right)(1+\cos^2\theta)$$

High altitude of sun



Why are leaves green?

Higher color rendering lights



Halogen lamp
With mirror

Halogen lamp
with no mirror

Incandescent lamp

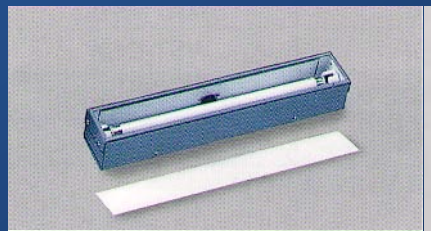
(Halogen cycle)

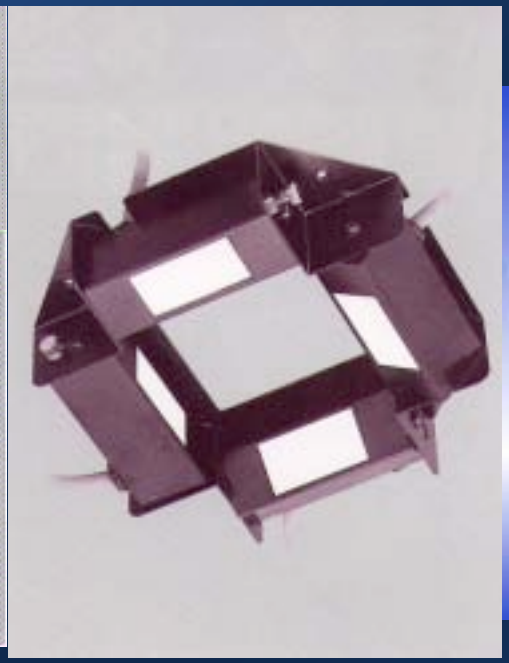
(Only electric power)

Halogen cycle

Longer life
Higher efficiency

Fluorescent lamps

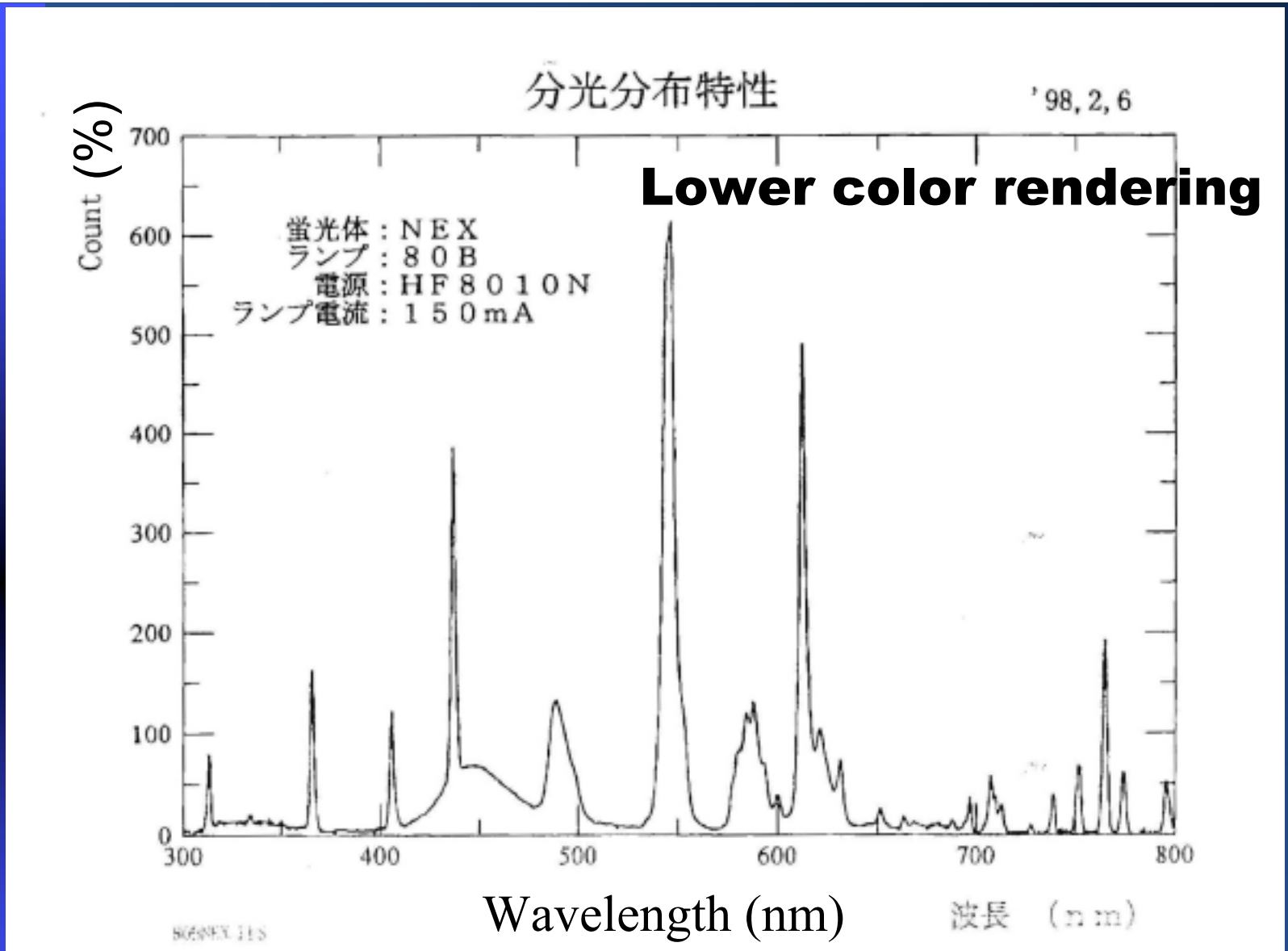




250nm UV light causes fluorescence reaction

Some AC fluorescent lamps fluctuate luminous intensity in low frequency (50Hz or 60Hz)

Higher frequency by an inverter (20-60 kHz) for machine vision



Lower color rendering

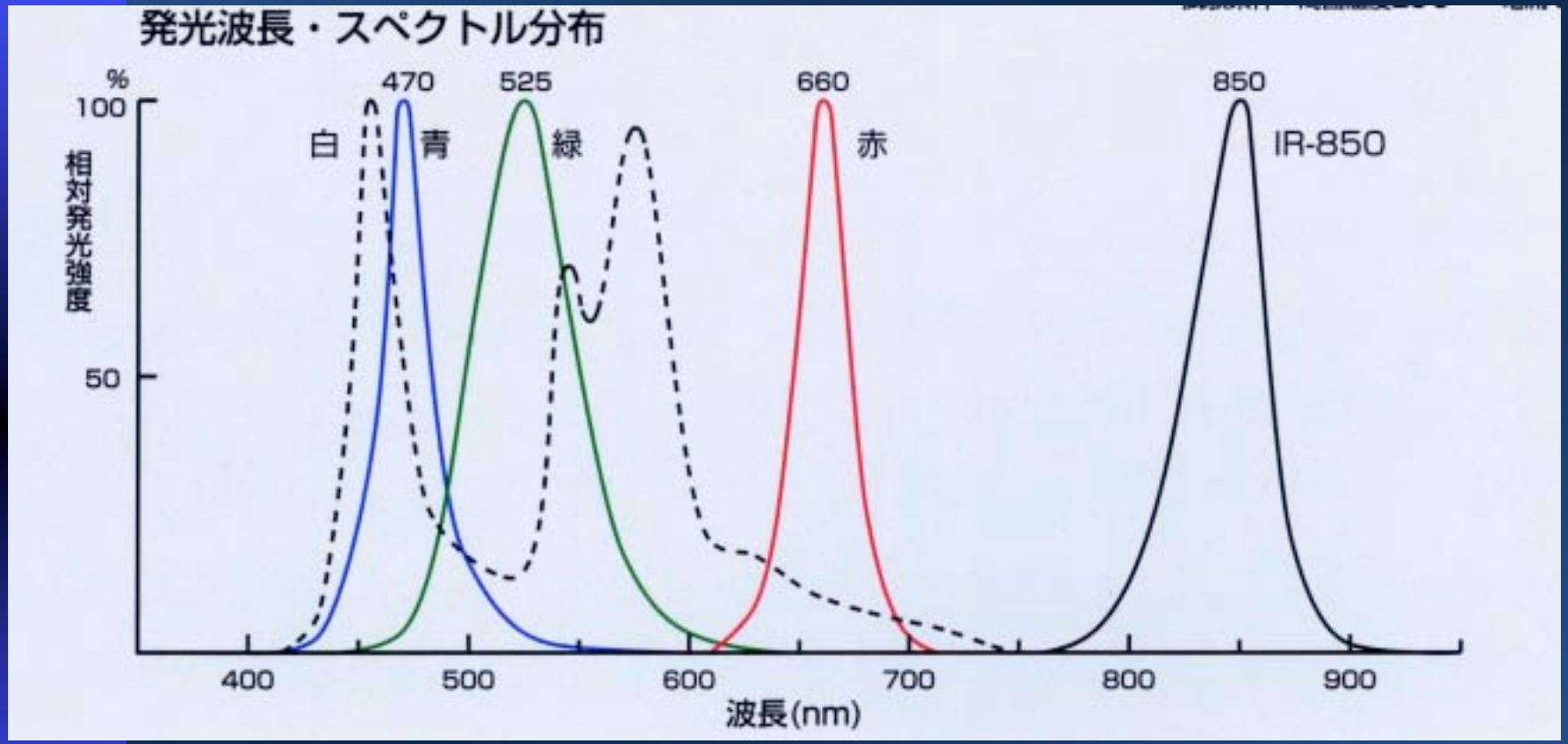
Spectral radiation of Fluorescent lamp

LEDs (Light Emitting Diodes)

Luminous intensity has been improved

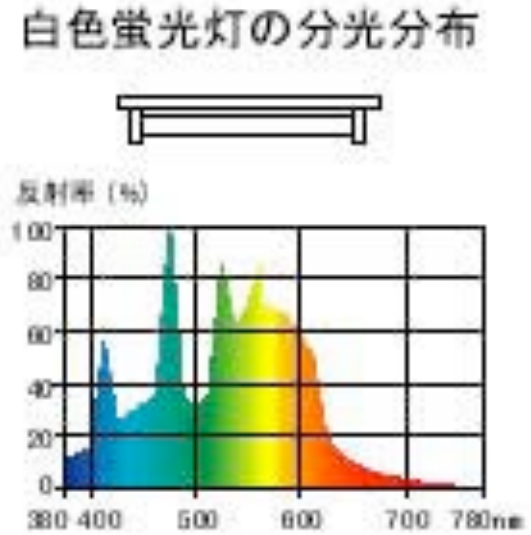
Easy arranging adapting object shape and color

Spectral radiation of LEDs

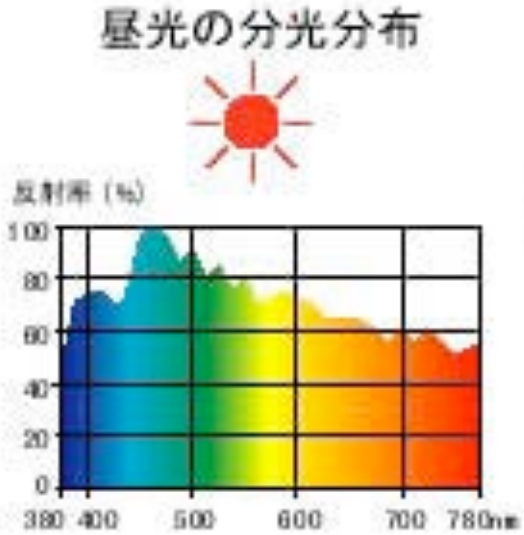


Spectral energy of lighting devices and sunlight

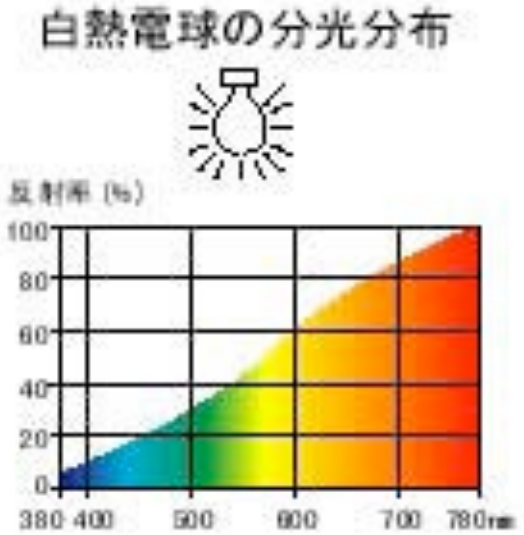
Fluorescent lamp



Sunlight



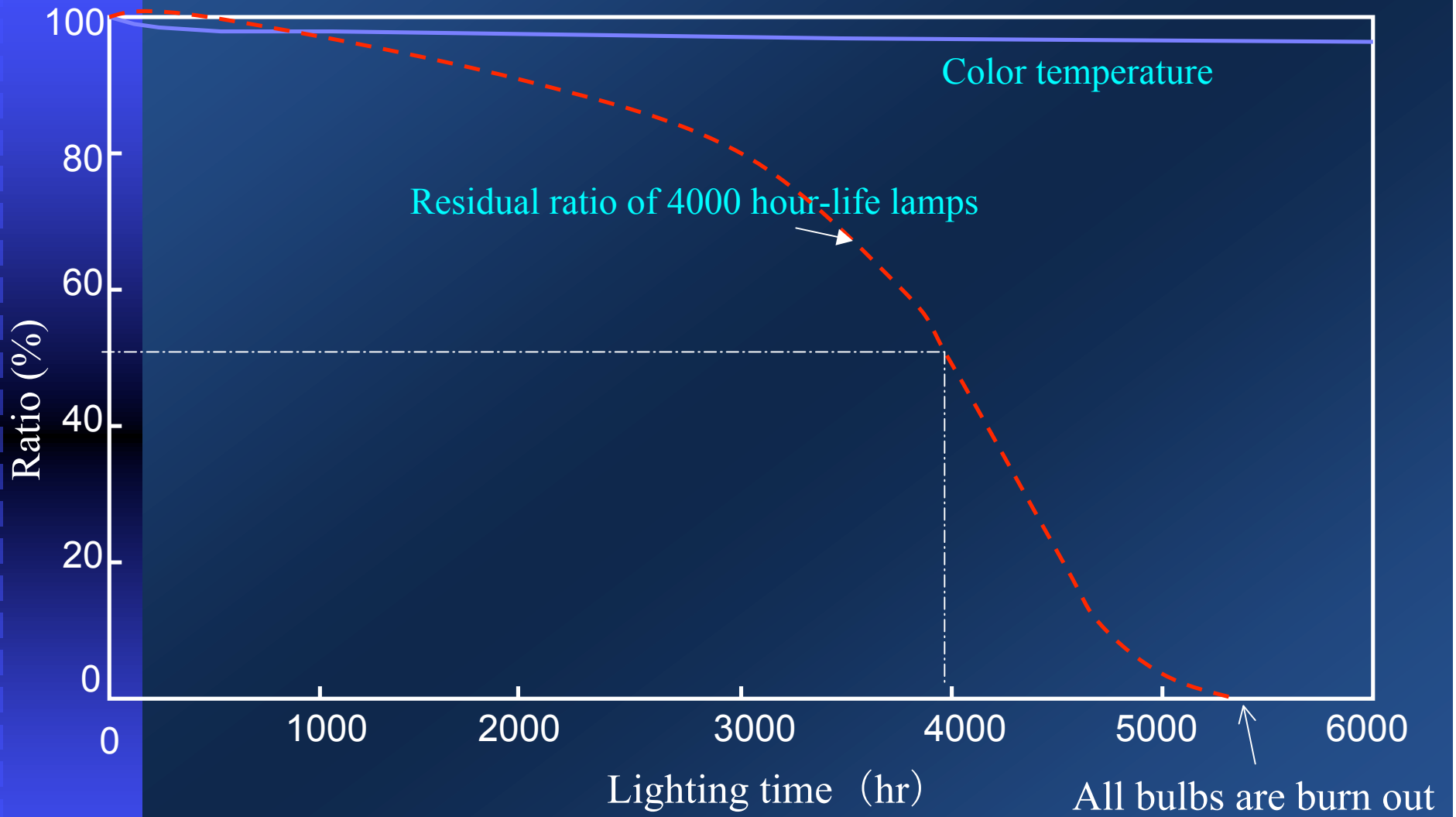
Incandescent lamp



HID lamps (High Intensity Discharge lamps)
(Metal halide lamp, Hg lamp, Na lamp)

Higher voltage by an inverter
Constant electric current

What is lamp life?



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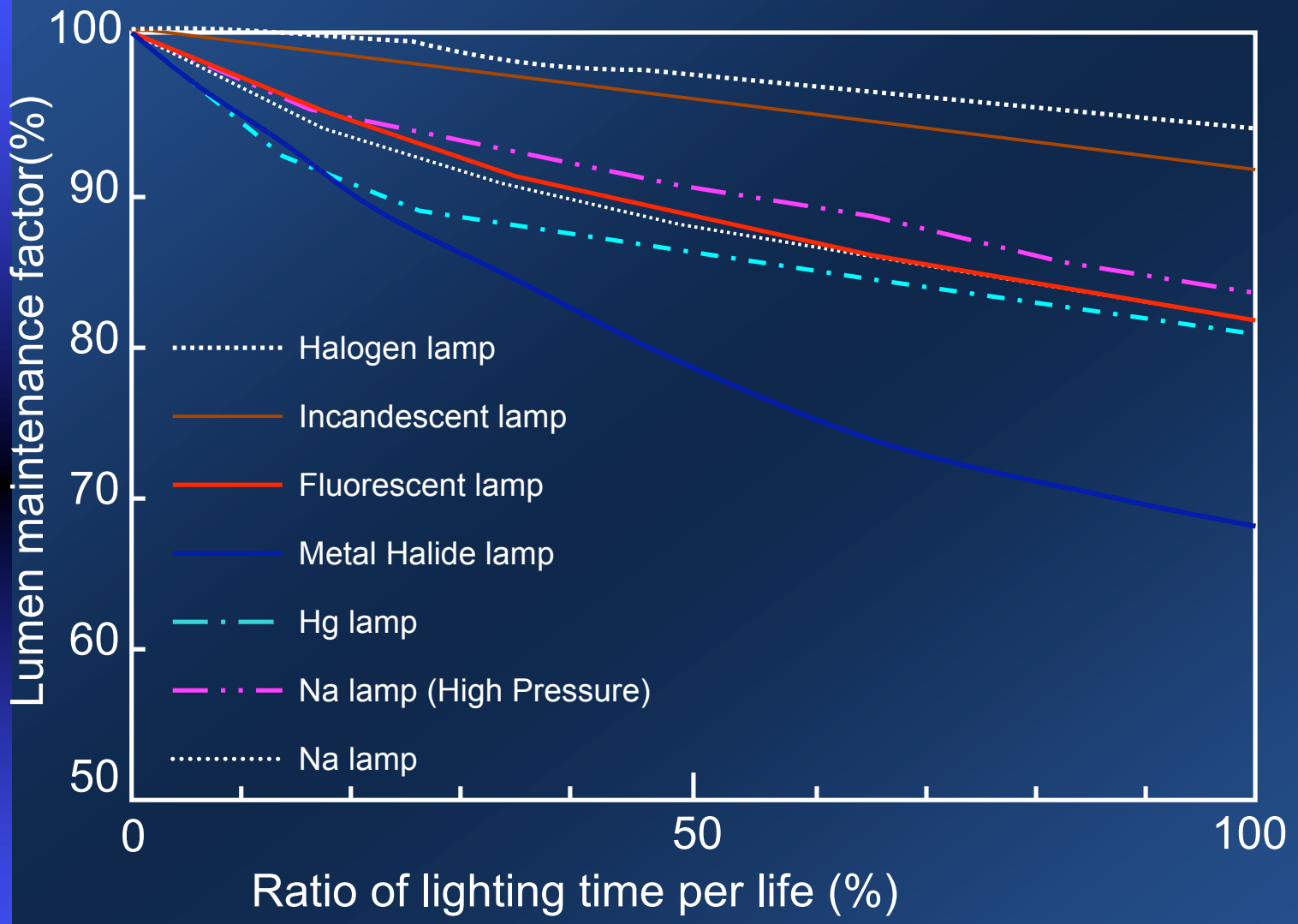
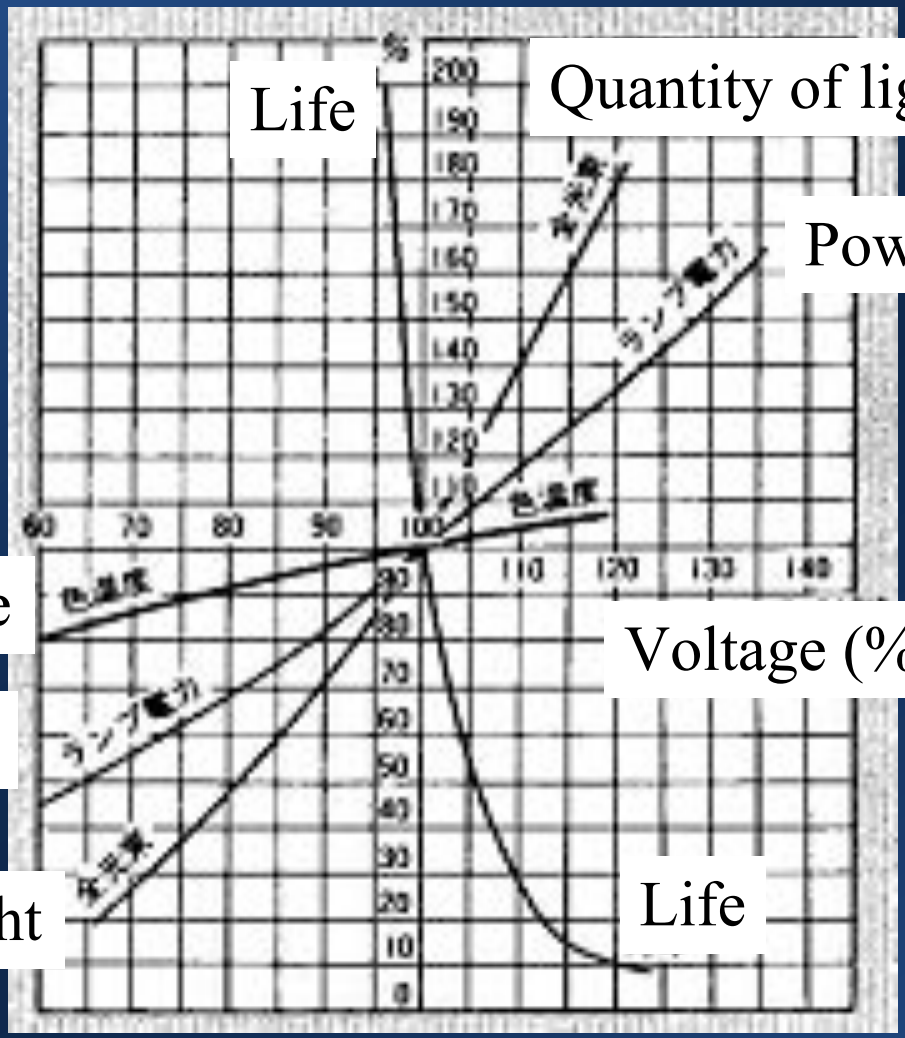
Variation of lumen maintenance with time





Halogen lamp properties

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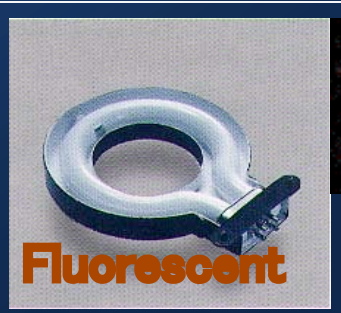
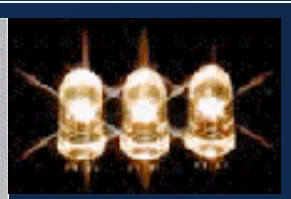
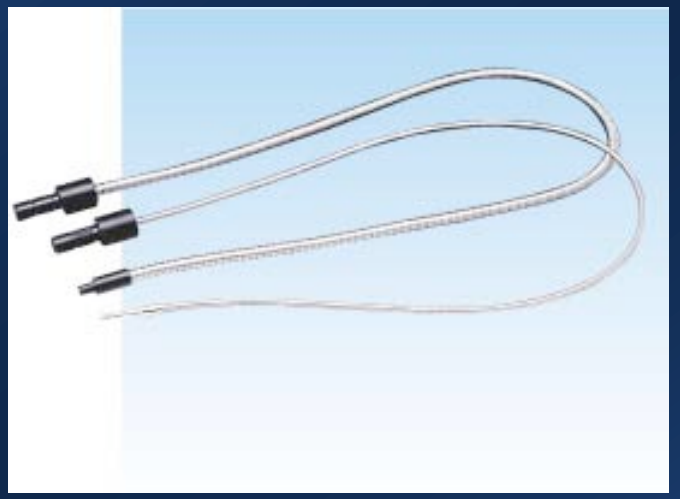
Comparison of lamps

	 Halogen	 Incandescent	 Fluorescent	 LED	 HID
Brightness	High	Mid	Low	Low	High
Color rendering	High	High	Low	Mid	Mid
Lumen Maintenance	High	High	Mid	High	Low
Life	Mid	Short	Mid	Long	Long
Price	Low	Low	Mid	High	High

Devices of Optical fiber



Easy replacement of fiber end adapting object shape

Assignment

1. Explain why sky is blue and why plant leaf is green in a couple of sentences.
2. Describe characteristics of halogen lamp, fluorescent lamp, and LED