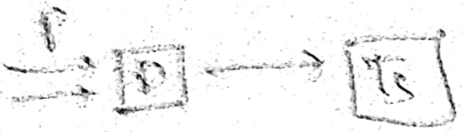
Date - 1.08.2025

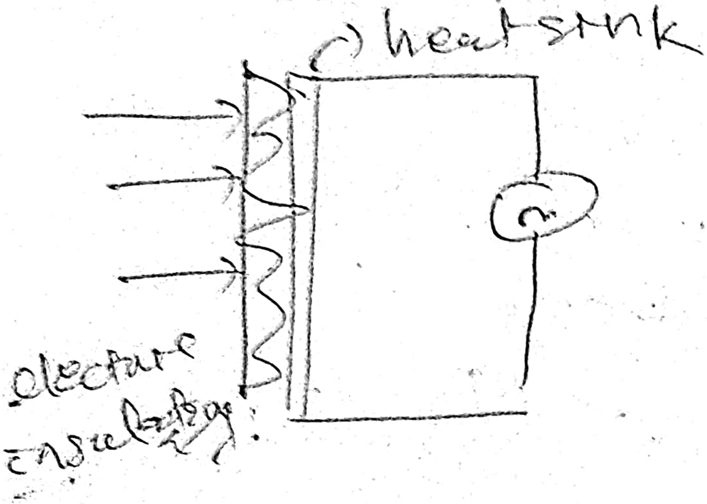
Thermal detectorr



Bolometerr

Thermal imageny.

Infrared ~~astronomy~~ astronomy



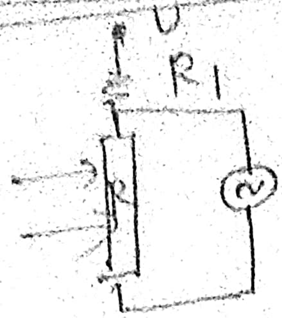
change in voltage.

$$\Delta V = N \frac{dV}{dT} \Delta T$$

N: no. of thermocouple.

$\frac{dV}{dT}$: sensitivity of each thermocouple

Thermistor



temp. coeff. of resistance

$$\alpha = \frac{\frac{dR}{dT}}{R}$$

$$\delta U = i\,\delta R = i\,\alpha \cdot R\,\Delta T$$

$$= \frac{V_0 R}{R+R_1}\,\alpha\,\Delta T$$

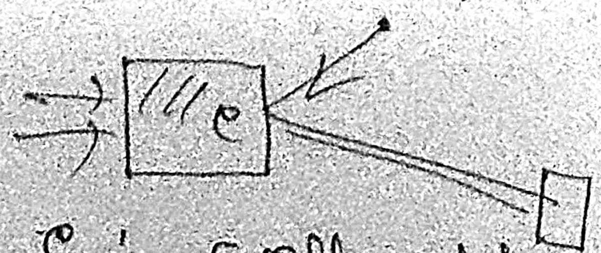
for semiconductor

$$\frac{n_e(T)}{n_e(T+\Delta T)} = e^{\left(-\frac{\Delta E_g T}{k T^2}\right)}$$

Golay cell

→ use for . photoacoustic spectroscopy

Photodiode



light detector

e : cell with membrane

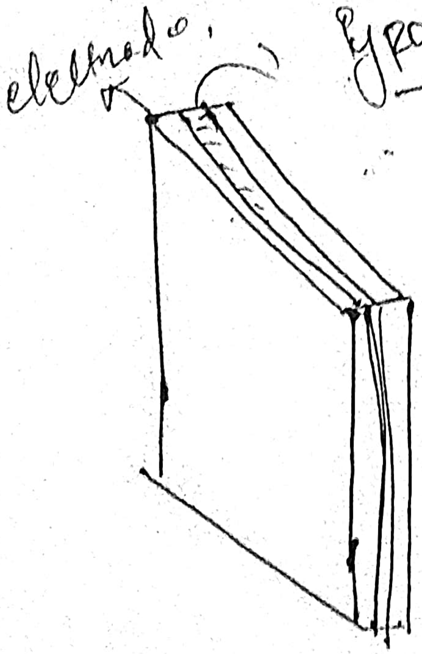
filled with gase.

$$PV = NRT$$

$$\delta V = \frac{nR\delta T}{P}$$

→ change in reflected position of light ∝ change in capacitance

Pyroelectric detector.



It has intrinsic dipolemoment.

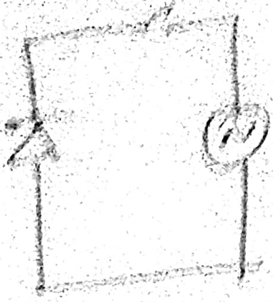
which arrange with temp.

C,

to measure → change in surface charge.

Junction

Photodetector

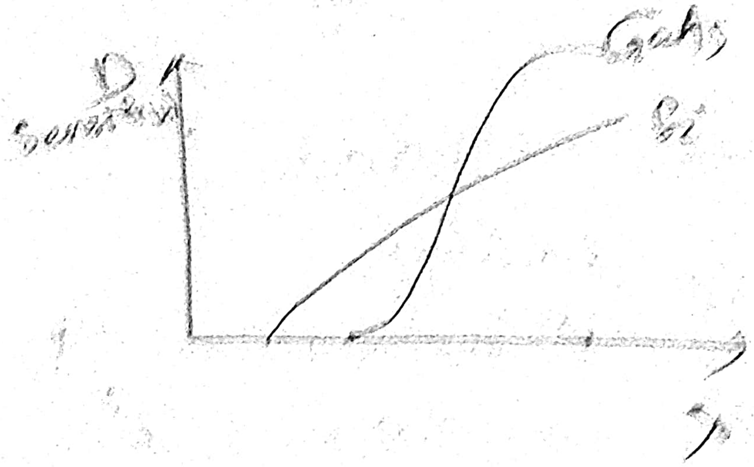


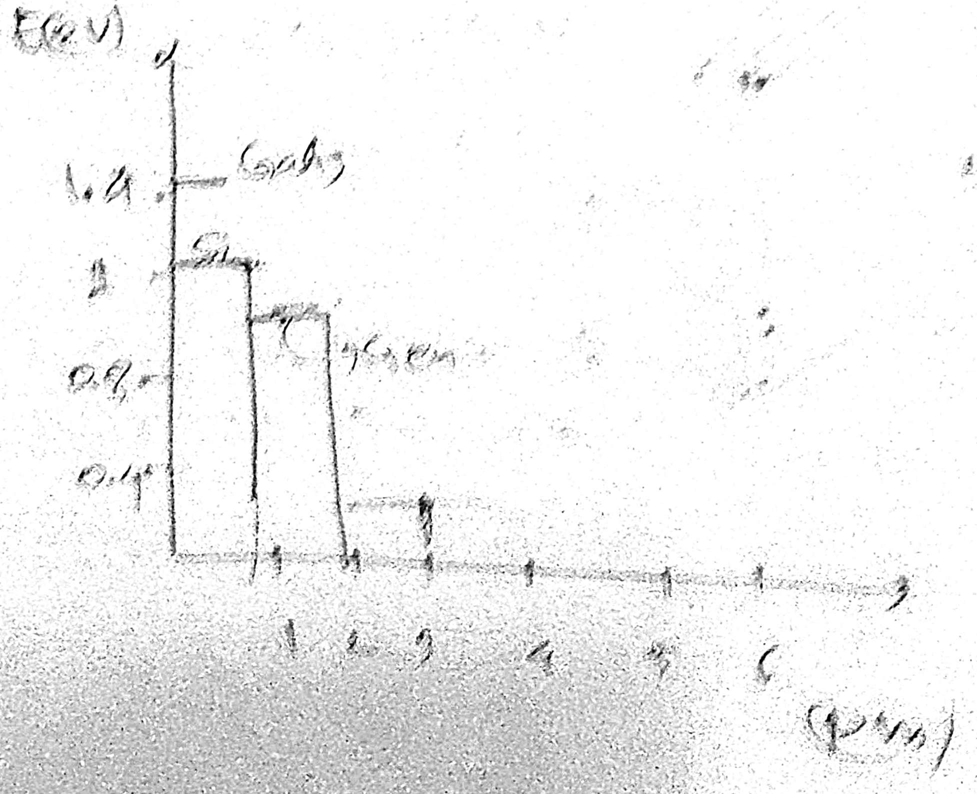
absorption Coefficient

$K \propto (h\nu - E_g)^{1/2}$

$, h\nu > E_g$

$\approx 0 \qquad h\nu < E_g$





Ge: 0.6 eV $\approx$ 1.9 μm

GaAs: 1.42 eV $\approx$ 1.88 μm

PbS: 0.37 eV $\approx$ 3.356 μm.

Photodiode array.

Length of each diode: 15 μm (L)

spacing between diode: 10 μm (d)

1024 ~~Bo~~ diode array.

Length of detector (15+10) 1024

= 25 mm.

Linear dispersion for each diode.

$= \frac{d\lambda}{dx} = \frac{5\ nm}{mm}$

Spectral Resolution: $\frac{d\lambda}{dx} \times L$

$= 5 \times 15 \times 10^{-3}$

$= 0.125$ nm.

spectral range

$$\frac{dy}{dx}(L+a) = \frac{.5 \times 10^{-9} m \times 25/100}{[illegible] \cdot 10^{-3}/}$$

=

Also called Multi-class

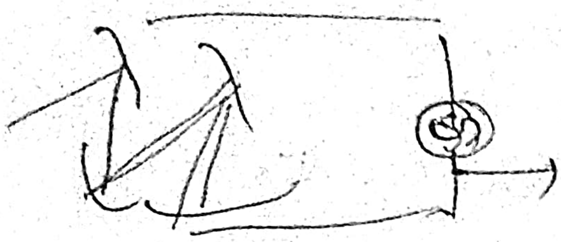
CCD

Array MOS diode / Pixels

Date - 05.02.025

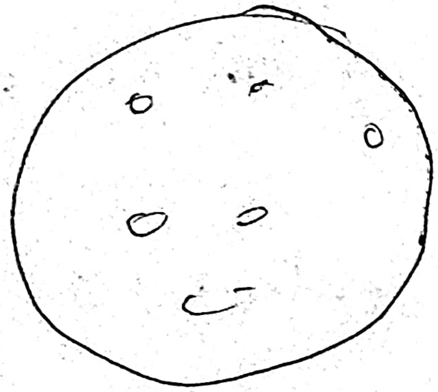
PMT

series of dynodes.



$$e = \frac{Q}{V} = \frac{\eta^N e}{V}$$
$$= \frac{G e}{V}$$

Microchannel plate



60% holes

Source of Noise

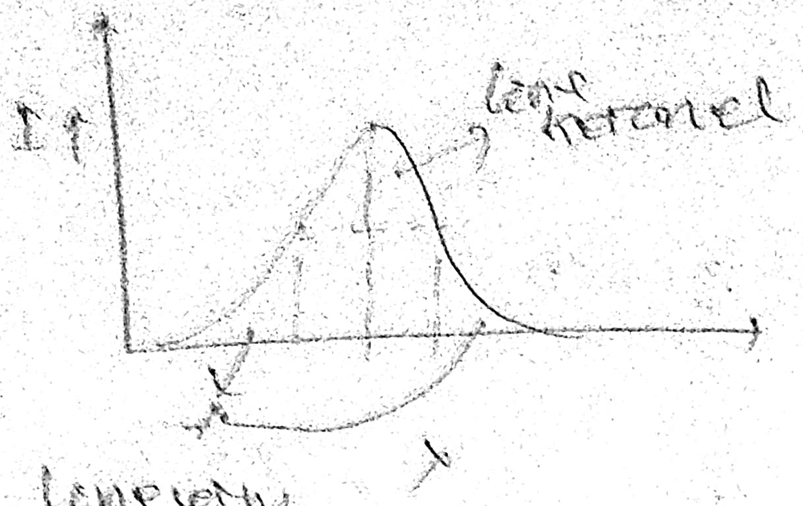
① Thermal Noise → Richardson eqn (also called dark noise.)

$$I = a T^2 e^{-(e\phi/kT)}$$

② shot noise → discrete nature of ele charge.

③ Johnson noise → Thermal aggitation of charge.

④ stray light →



Natural line broadening.

oscillator model

damp oscillat. $\ddot{x} + \gamma \dot{x} + \omega_0^2 x = 0$

$$x(t) = x_0 e^{-\gamma t/2} \cos(\omega t + \sigma)$$

$$\omega = \sqrt{\omega_0^2 - \left(\frac{\gamma}{2}\right)^2}$$

$$\gamma \ll \omega_0$$

$$\approx x_0 e^{-\gamma t/2} \cos \omega_0 t$$

Superposition of oscillation of difference frequency.

$$x(t) = \frac{1}{2\sqrt{2\pi}} \int A(\omega)\, e^{i\omega t}\, d\omega$$

$$A(\omega) = \frac{1}{\sqrt{2\pi}} \int x(t)\, e^{-i\omega t}\, d\omega$$

$$= \frac{1}{\sqrt{2\pi}} \int_0^{\infty} x_0 \cos(\omega_0 t)\, e^{-i\omega t}\, d\omega$$

$$A(\omega) = \frac{x_0}{\sqrt{8\pi}} \left[\frac{1}{i(\omega-\omega_0) + \frac{\gamma}{2}} + \frac{1}{(\omega+\omega_0) + \frac{\gamma}{2}} \right.$$

$$I(\omega) = A(\omega)\, A^*(\omega)$$

$$I(\omega) = \frac{c\, (\omega-\omega_0)^2}{(\omega-\omega_0)^2 + \left(\frac{\gamma}{2}\right)^2} \quad \text{for } \omega = \omega_0$$

$$\rightarrow \frac{1}{2\pi} \frac{\gamma}{(\omega-\omega_0)^2 + \left(\frac{\gamma}{2}\right)^2}$$

$$\int I(\omega \approx \omega_0)\, d\omega = 1$$

$$\ddot{x} + \gamma \dot{x} + \omega_0^2 x = 0$$

multiply by $m\dot{x}$

$$m\dot{x}\ddot{x} + \gamma m \dot{x}^2 + m\omega_0^2 \dot{x} x = 0$$

$$m\dot{x}\ddot{x} + \frac{1}{2} m\omega_0^2 x\dot{x} = -r\, m\dot{x}^2$$

$$\Rightarrow \frac{d}{dt}\left[\frac{1}{2}m\dot{x}^2 + \frac{1}{2}m\omega_0^2 x^2\right] = -rm\dot{x}^2$$

$$\Rightarrow \frac{dw}{dt} = -rm\dot{x}^2$$

$$x = x_0 e^{-rt} \cdot \cos\omega_0 t$$

$$\cancel{\dot{x} = x_0\left(-\frac{r}{2}\right) e^{-rt/2} \cos\omega_0 t}$$

$$\dot{x} = x_0\left[\cos\omega_0 t\,(-r)\, e^{-rt} + e^{-rt}\,\omega_0 \sin\omega_0 t\right.$$

$$\approx x_0 e^{-rt/2}\,\omega_0 \sin\omega_0 t$$

$$r = \frac{1}{\tau}$$

$$\left\langle\frac{dw}{dt}\right\rangle = \langle rm\dot{x}^2\rangle$$

$$= -\langle r m x_0^2 \omega_0^2 e^{-rt}\rangle$$