Thermal detector

$$\xrightarrow{P} \boxed{P} \longrightarrow \boxed{Ts}$$

Bolometer

Thermal imageing
Infra red astronomy
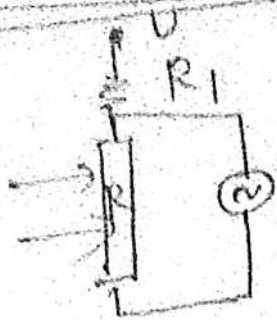

heat sink

electure
insulating
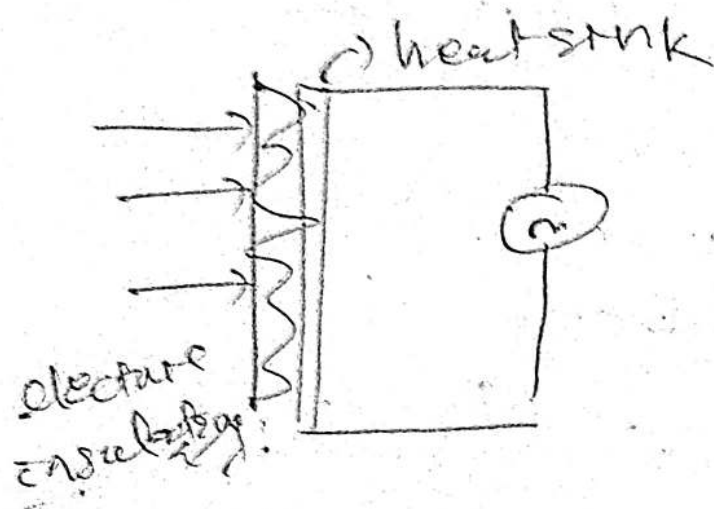
change in voltage.

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

N = no. of thermocouple.

$\frac{dV}{dT}$ = Sensitivity of each thermo couple

Thermistor

temp. coeff. of resistance.

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

$$\delta U = \overset{\circ}{i}R = i \, \alpha \cdot R \, \Delta T$$
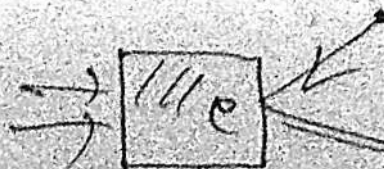
$$= \frac{V_o R}{R + R_1} \alpha \Delta T$$

for Semiconductor

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

Golay cell

→ use for   · photo a coupler ·

· speetroscopy

Photodide

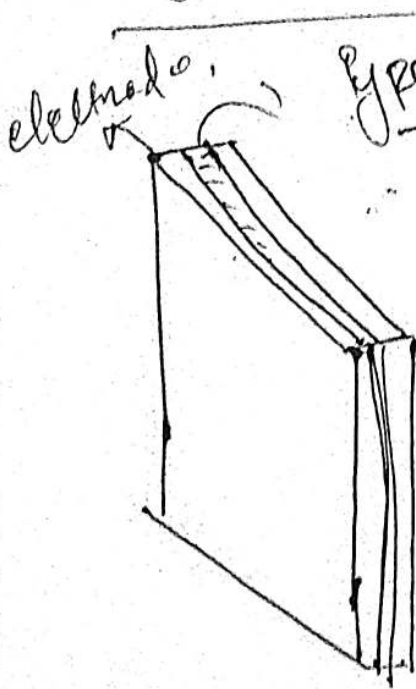c i . cell of thin membrane

light detector

filled with gase.

$$PV = NRT$$

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

→ change in reflected position)
of light ∾ change in capacitance

Pyroelectric detectors

electrode   Pyroelectric..

It has permanent c.
dipole moment.
which arrange with
temp.

C

do needles p →
change in surface
charge

Photodetector
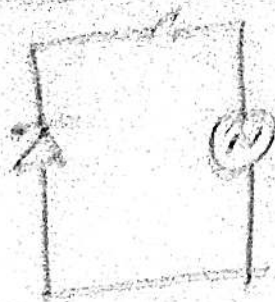
(Diagram: circuit with resistor and meter)

$$K \cdot q \cdot (1 - e^{-...})$$

$$C_j(w) > x_{iq}$$

(graph: D/sensitivity vs λ, curves labeled GaAs, Si)

$E(eV)$

1.4 — GaAs

1 — Si

0.9 — (...)

0.4

(μm)
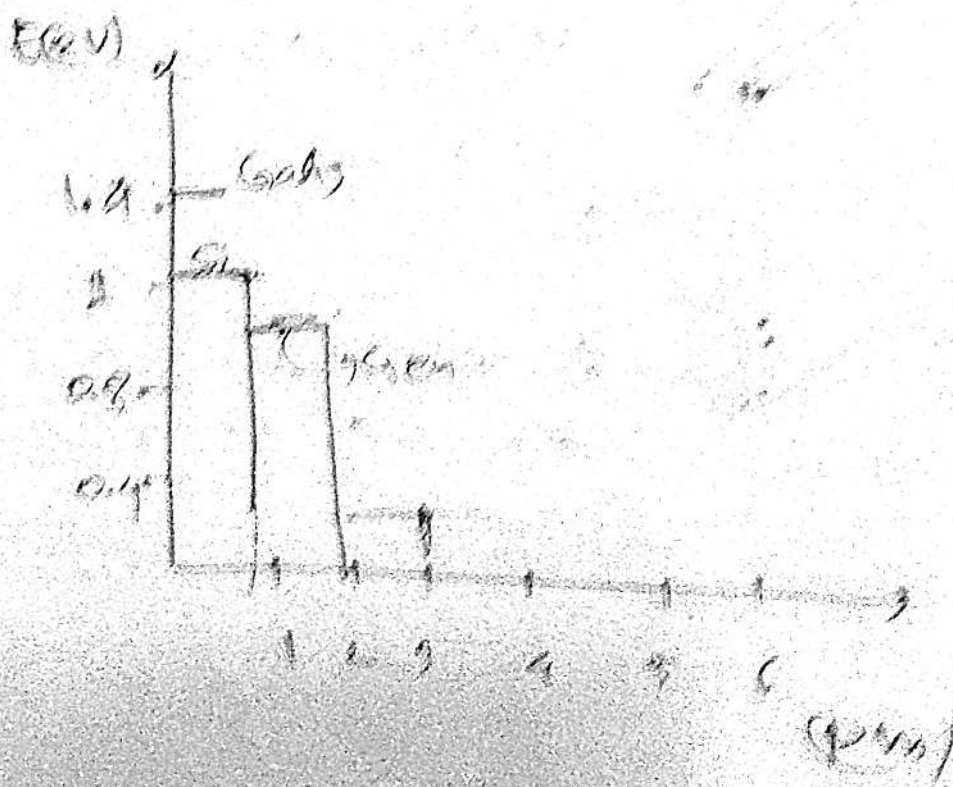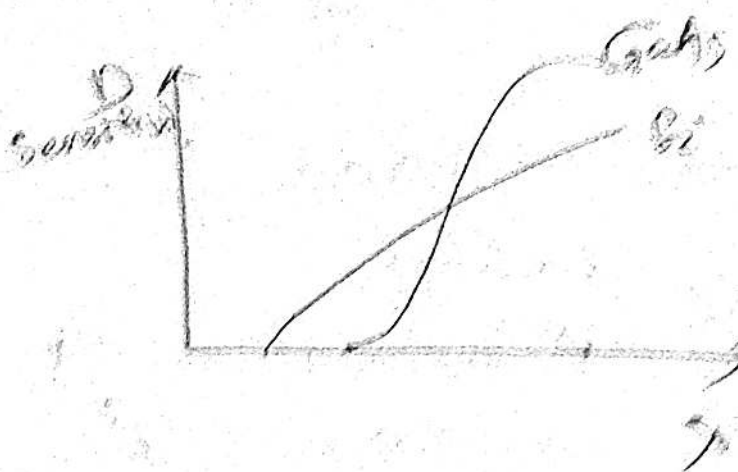
Ge: 0.6 ev $\approx$ 1.9 μm

GaAs: 1.42ev $\approx$ 1.88 μm

PbS: 0.37ev $\approx$ 3.356 μm.

Photodiode array.

Length of each diode : 15 μm (L)

Spacing between diode : 10 μm (d)

1024 diode array.

length of detector (15+10) 1024

$$= 25 \text{ mm}.$$

Linear dispersion for each diode.

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

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

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

$$= 0.125 \text{ nm}.$$

Spectralcharge

$$\frac{d\gamma}{dx}(L+q) = \cdot 5 \times 10^{-9} \ln x \ 3q \times 10$$
$$\overline{\qquad\qquad\qquad\qquad\qquad} \cdot 10^{-2}$$
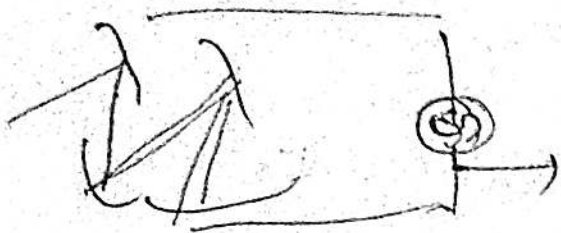
=

Also called Multichannel

CCD
————

array MOS diode / pixels
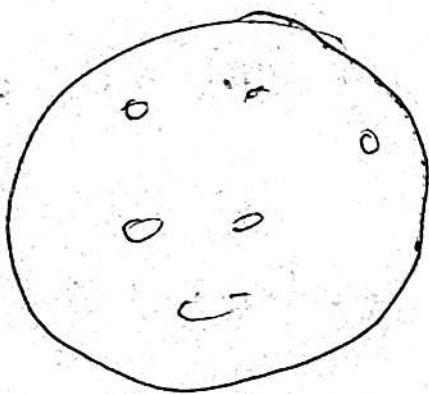
Date - 05.02.025

PMT

serces of dynodes.

$$c = \frac{Q}{V} = \frac{2^N e}{V}$$

$$= \frac{Ge}{V}$$

Microchannel plate
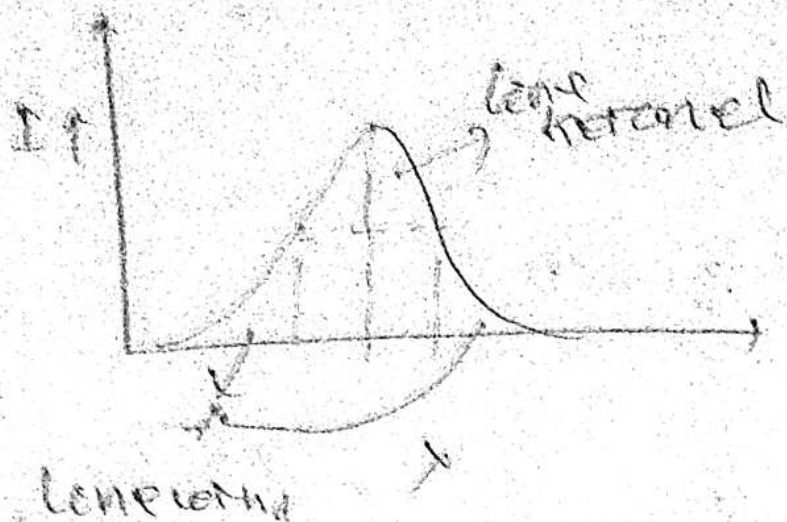

. 60% holes

Source of Noise.

① Thermal Noise → Richardson eqn

also called
darcknoise.

$$I = G T^2 e^{-C_2 \phi / T}$$

② . shot noise →
discrete nature of ele
charge.

③ . Johnson noise →
→ Thermal agitation
of charge.

④ . stray light →

Natural Ion Broadening.

oscillator model

damp oscillat.

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

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

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

$$\gamma \ll \omega_0$$

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

Superposition of oscillation of difference frequency.

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

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

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

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

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

$$I(\omega) = \frac{e^{(\omega - \omega_0)^2 \gamma}}{(\omega - \omega_0)^2 + (\frac{\gamma}{2})^2} \qquad \text{for } \omega = \omega_0$$

$$\longrightarrow \frac{\gamma}{2\pi} \frac{\gamma}{(\omega - \omega_0)^2 + (\frac{\gamma}{2})^2}$$

$$\int I(\omega + \omega_0) d\omega = 1 \quad \cdots$$

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

multiply bn $m\dot{x}$

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

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

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

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

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

$$\dot{x} = x_0\left(-\frac{\gamma}{2}\right) \cdot e^{-\gamma/2} \cos\omega t$$

$$\ddot{x} = x_0\left[\cos\omega_0 t \,(-\gamma)\, e^{-\gamma} \, \phi \, e \cos\gamma\omega t\right]$$

$$\Rightarrow x_0 \cdot e^{-\gamma t/2} \cos\sin\gamma t$$

$$\boxed{\gamma = \frac{1}{\tau}}$$

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

$$\therefore = -\langle \gamma m x_0^2 \omega_0^2 e^{-\gamma t}\rangle$$