Direct Detection of the Dark Matter:
Germanium detector Internal Amplification(GeIA)

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Parameter(1): Mean free path

- *Definition:
- How far the electron(hole) can run without colliding with others

- (Relaxation time) * (velocity)

Parameter(2): Relaxation time

- How long the electron(hole) can run without colliding with others
- Formula: $\frac{\mu \times m*}{e} = \tau$
- (1)μ(mobility) = $\frac{v_d(1+\frac{E}{E_{sat}})}{E}$

- (2)m* (Effective mass): bounded electron (F=m*a)
- ➔ Use effective mass to do the approximation
- ➔ electron* = 0.21*(free e- mass), hole* = 0.12*(free e- mass)
- (3)e(Charge constant)

Parameter(3): Velocity

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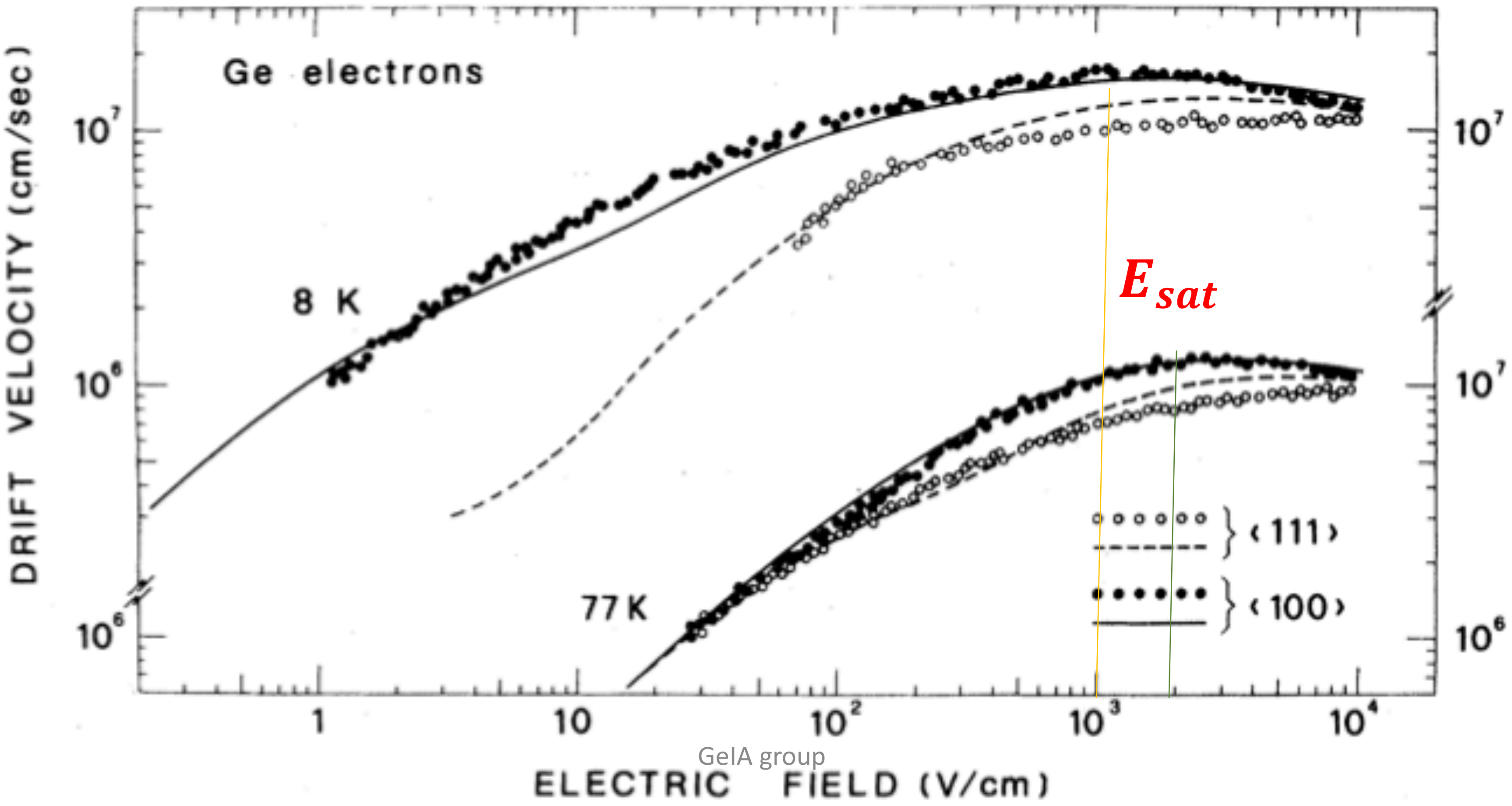


Parameter(4): Ionization rate

$$\alpha_s = \frac{a_s}{z}\exp\left(-\frac{b_s}{E(x)}\right) \quad \text{with} \quad s = \{n, p\} \quad (20a)$$

and

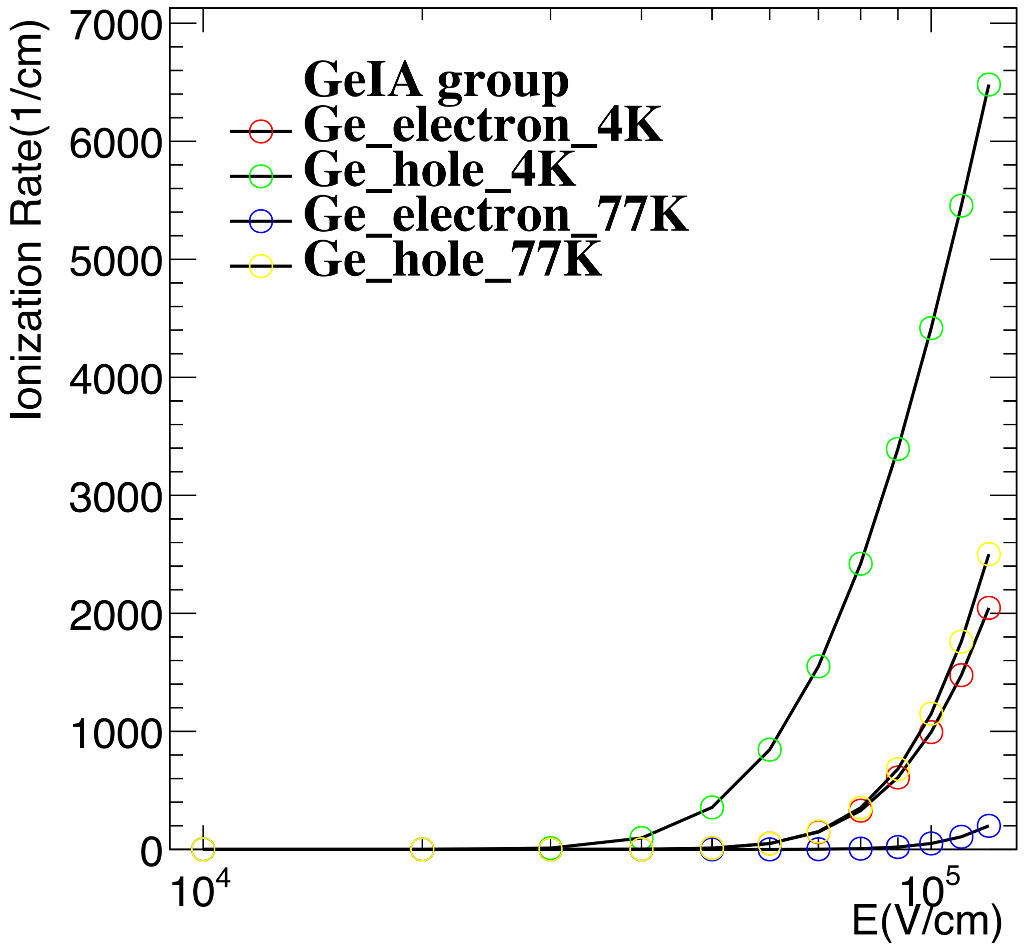
$$z(x) = 1 + \frac{b_n}{E(x)}\exp\left(-\frac{b_n}{E(x)}\right) + \frac{b_p}{E(x)}\exp\left(-\frac{b_p}{E(x)}\right) \quad (20b)$$

and

$$a_s = \gamma_s = \frac{1}{L_s} \quad \text{and} \quad b_s = \frac{U_c^s \gamma_s}{q} \quad (20c)$$

Important point: (1) Mean free path (2)Ionization energy

Results – Ionization rate(1/cm)



Conclusion and Prospect

- For the ionization rate of the Ge electron and hole
- ➔ 4K is bigger than 77K for both of them.

- We need to use more than $\mathbf{3\times10^4}(\frac{\boldsymbol{V}}{\boldsymbol{cm}})$ to drive the Ge electron and hole

- Next step:
- (1) Figure out the ionization rate of the impurities
- (2) Jump into the real point contact detector
- ➔ Use the real electric field in the detector to figure out the gain.