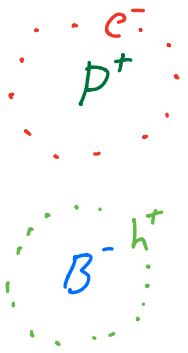
Doped Semiconductors

charged impurities

$Si \rightarrow P$ adds $1e^-$ "donor"

$Si \rightarrow B$ subtracts $1e^-$ "acceptor" (adds $1h^+$)

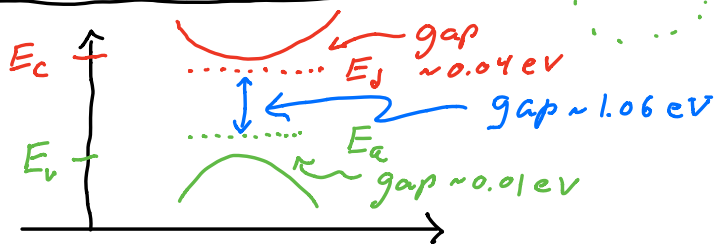


Valence	3	4	5
	B	C	N
	Al	Si	P
	Ga	Ge	As

filled valence bands

empty conduction bands

Mobile charge binds to ion:



Dopant levels can be empty, or spin ↑ or ↓

double occupation ↑↓ unfavorable

What is μ?

Donor doping $\Rightarrow$ $E_d < \mu < E_c$

As $T \rightarrow 0$ all donated electrons enter donor states — no conduction!

For $T > (E_c - E_d)/k_B \approx 460\,K$ ★ most are excited into C.B.

★ Actually a much lower T is ok due to high entropy in C.B.

Read Swendsen ch. 29.10 "Semiconductor Statistics" to learn why!