

Welcome to 3.091

Lecture 19

October 25, 2004

Taxonomy of Defects: **Classify by Dimensionality**

0-dimensional: point defects

1-dimensional: line defects

2-dimensional: interfacial defects

3-dimensional: bulk defects

Point Defects

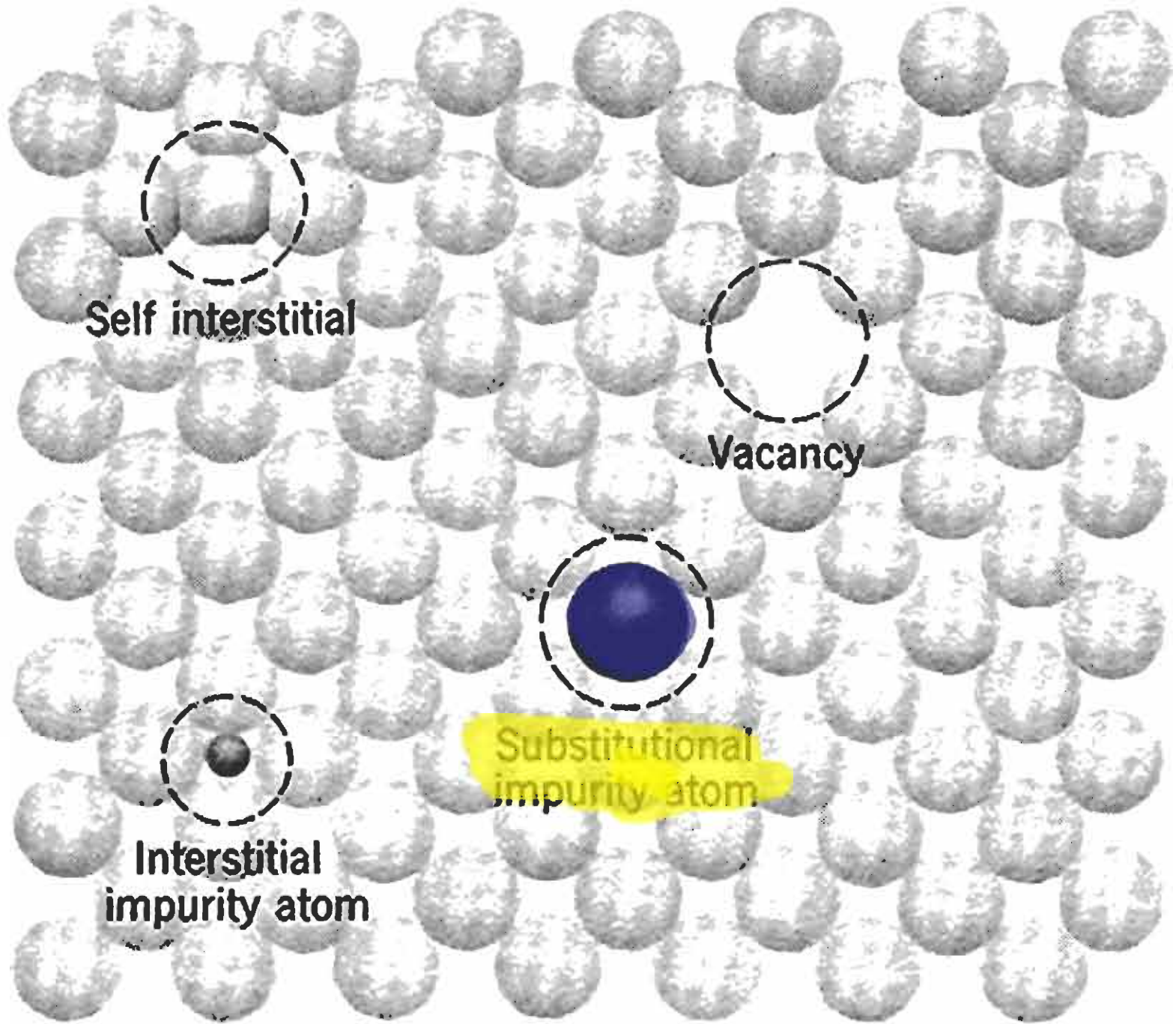
- localized disruption in regularity of the lattice
- on and between lattice sites

1. Substitutional Impurity

- occupies normal lattice site
- dopant ☺, e.g., P in Si; B in C_(diamond)
- alloying element ☺, e.g., Mg in Al; or Ni in Au
- contaminant ☹, Li⁺ in NaCl

2. Interstitial Impurity

- occupies position between lattice sites
- alloying element ☺, e.g., C in Fe; or H in LaNi₅
- contaminant ☹, H in Fe



Self interstitial

Vacancy

Substitutional impurity atom

Interstitial impurity atom

Point Defects

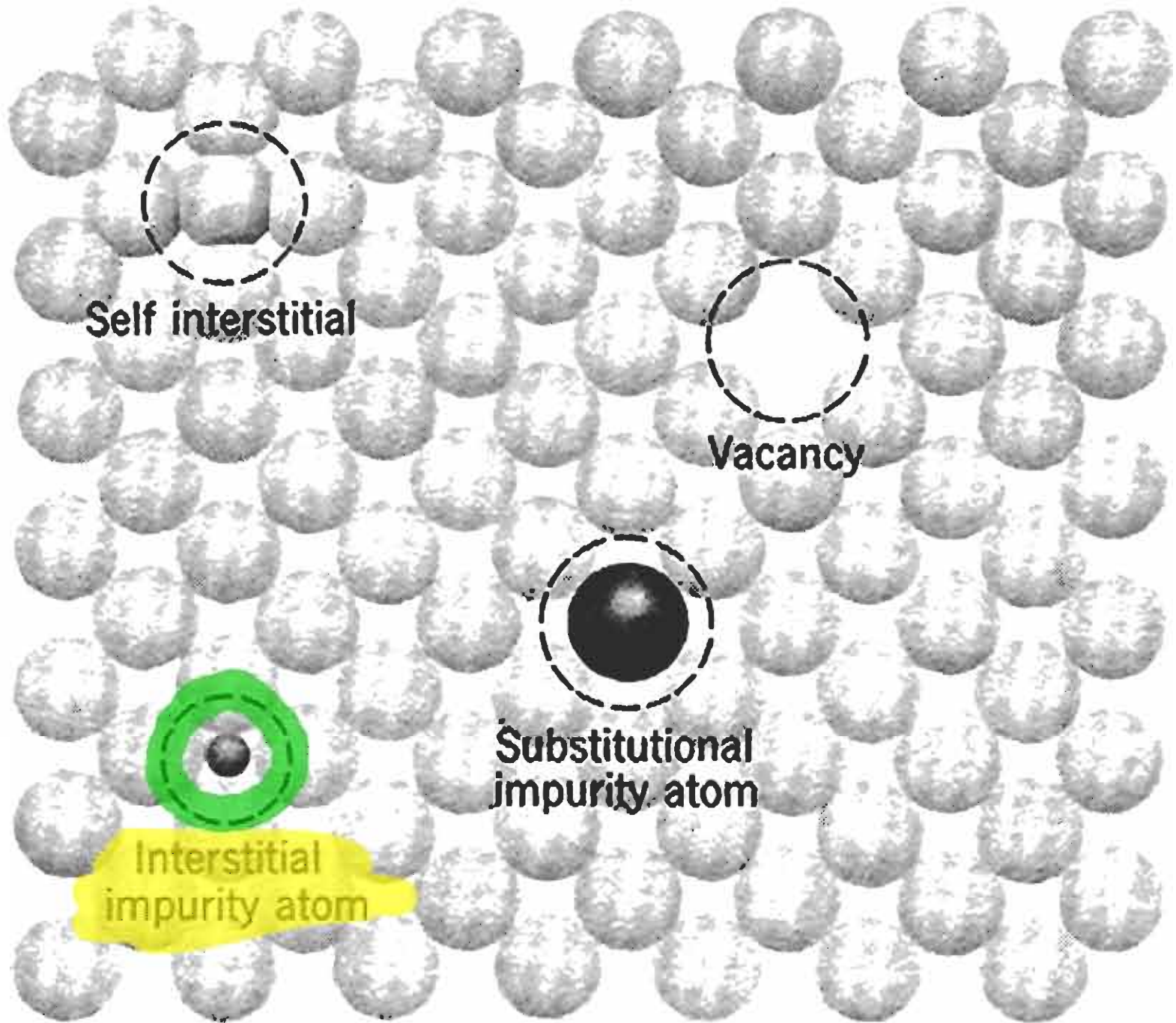
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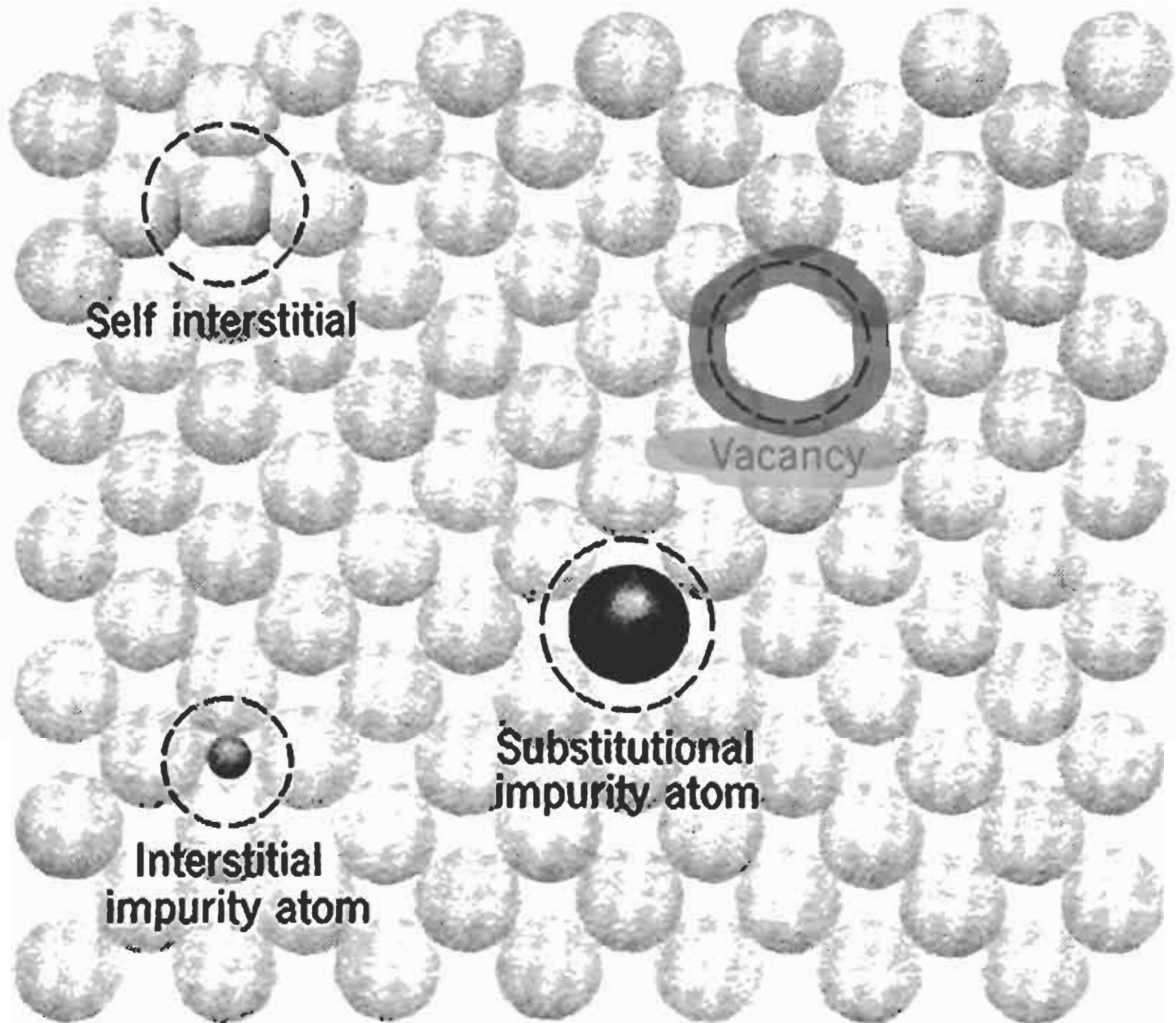
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3. Vacancy

- unoccupied lattice site
- formed at time of crystallization
- formed in service under extreme conditions



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Point Defects in Ionic Crystals

- special issues associated with the need to maintain global charge neutrality

1. Schottky Imperfection

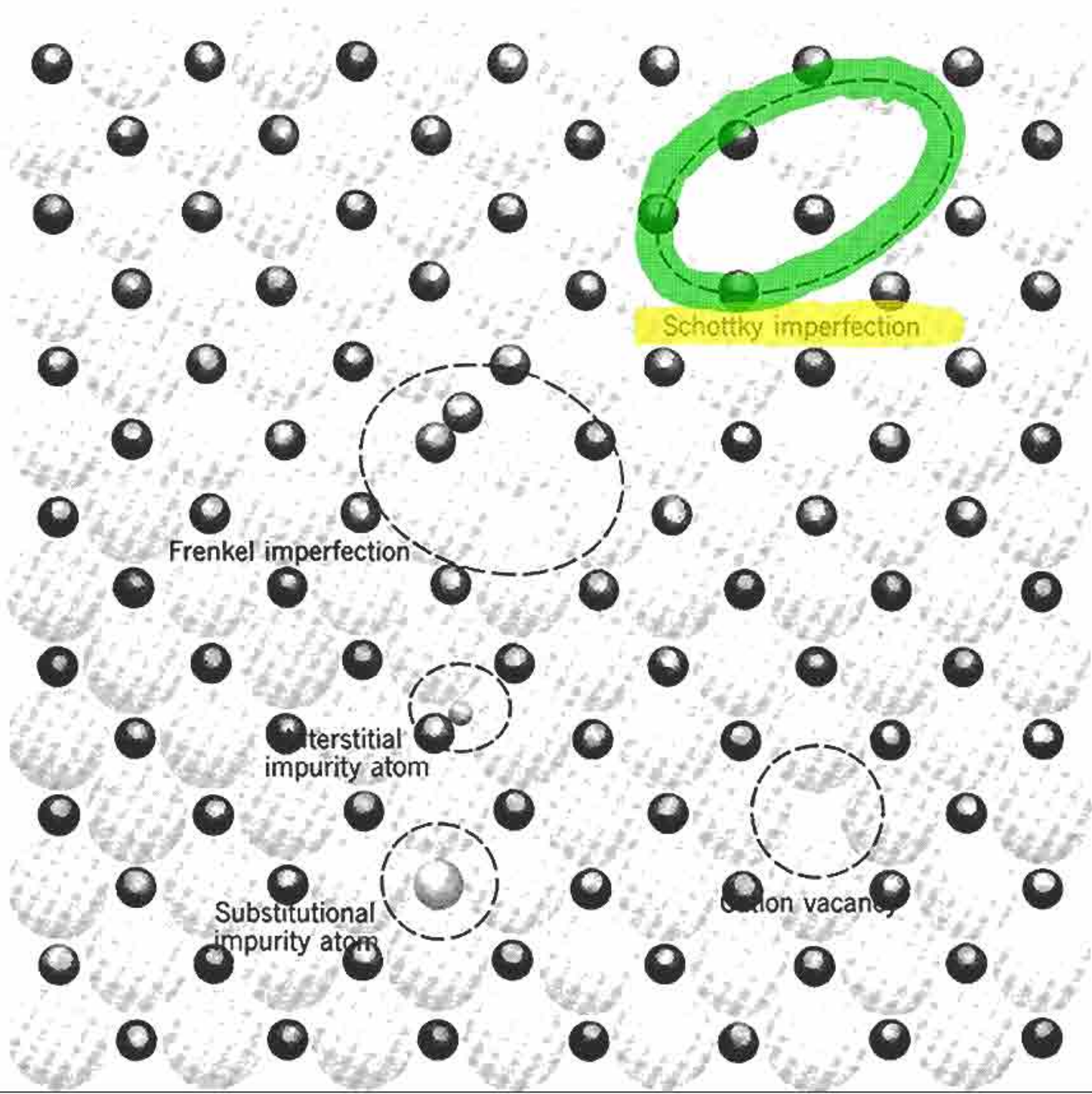
- formation of equivalent (not necessarily equal) numbers of cationic and anionic vacancies

2. Frenkel Imperfection

- formation of an ion vacancy and an ion interstitial

3. F-Center

- formation of an ion vacancy and bound electron



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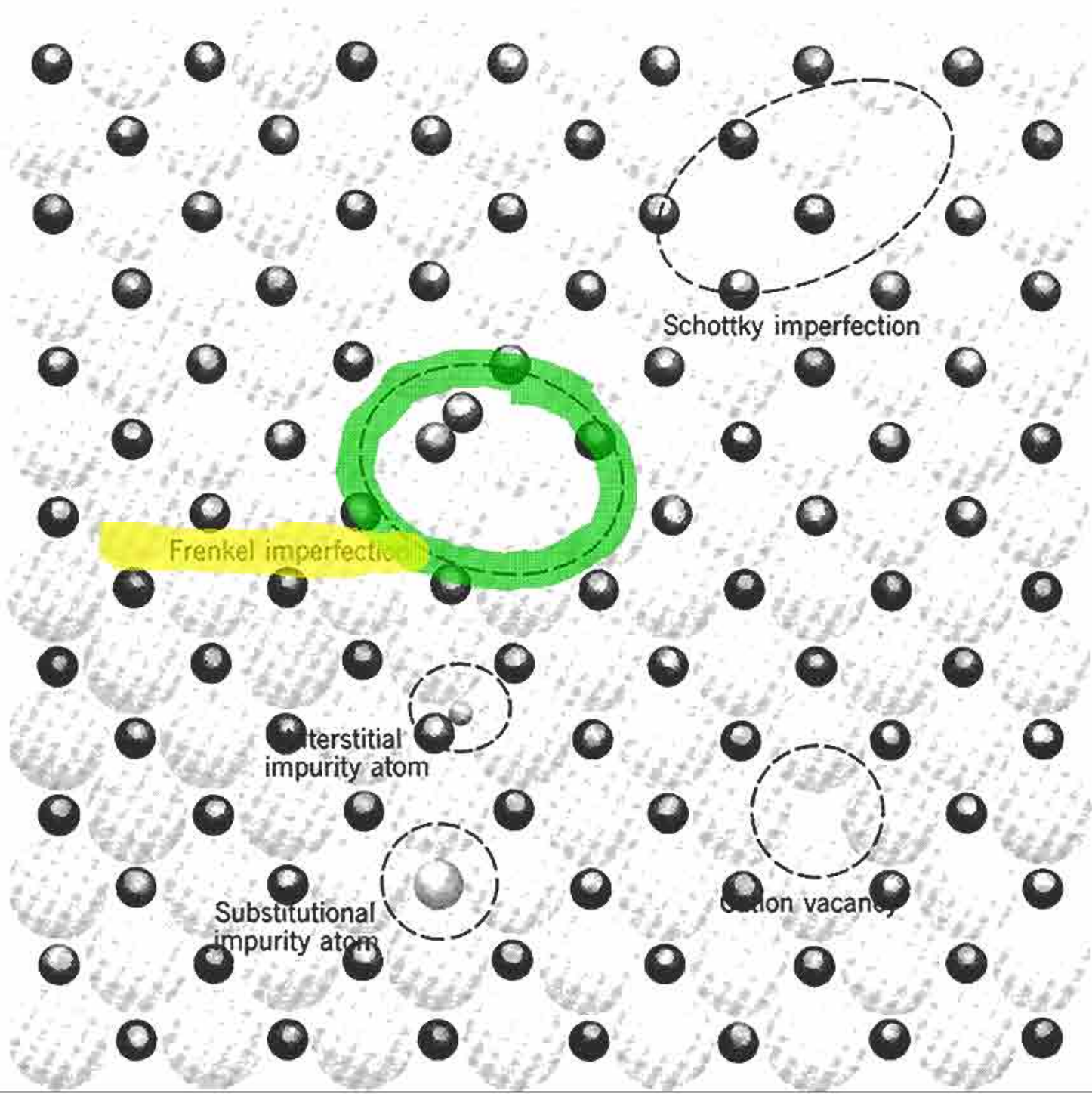
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Frenkel imperfection

Schottky imperfection

Interstitial impurity atom

Substitutional impurity atom

Cation vacancy

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crystal structure	CN	close packed direction	highest density plane	close packed plane
FCC	12	$\langle 011 \rangle$	$\{111\}$	yes
BCC	8	$\langle 111 \rangle$	$\{011\}$	no
SC	6	$\langle 001 \rangle$	$\{001\}$	no
HCP	12		basal	yes