Diffusion Limitations

Lecture 13

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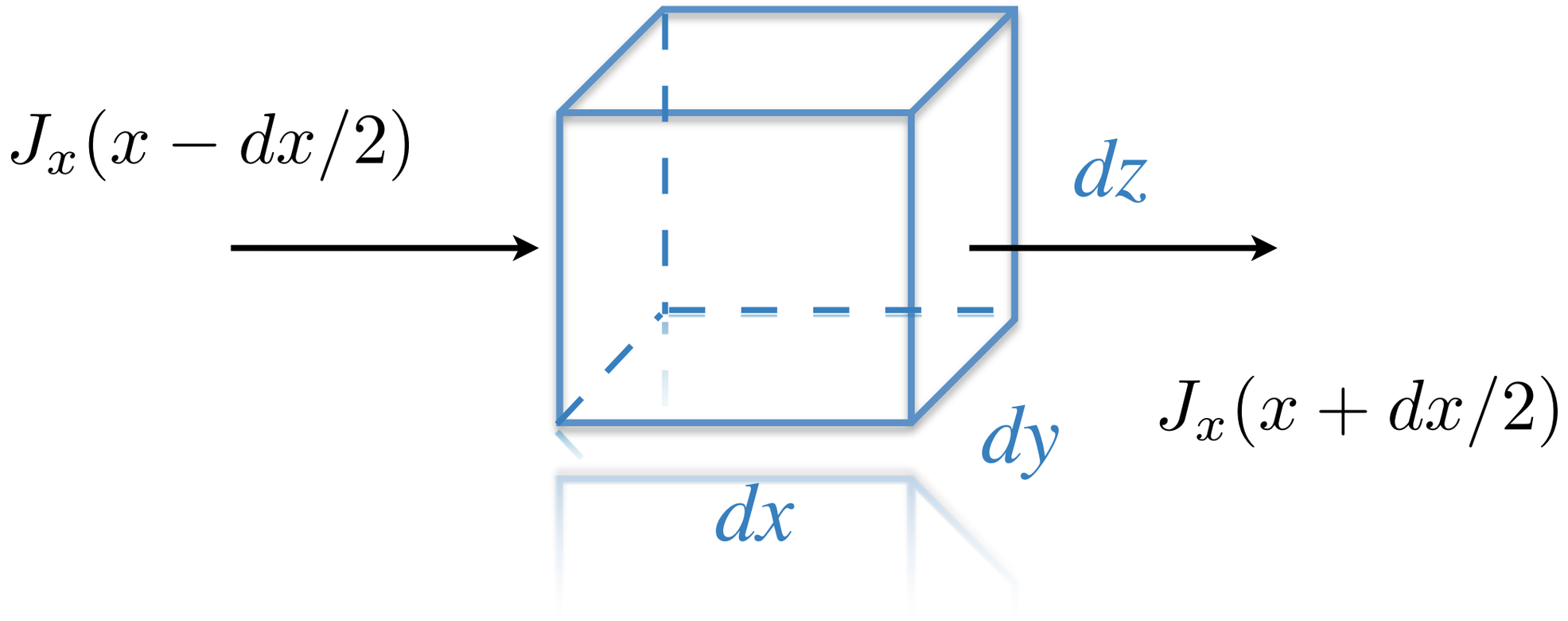
Main Limitations in Rechargeable Batteries

- [x] Capacity and Energy Limited
- [x] Ohmic Losses Limited
- [ ] Diffusion Limited
- [ ] Reaction Limited
- [ ] All of the Above

Equations of Continuity and the Diffusion Equation



$$\frac{\partial \rho}{\partial t} = -\nabla \cdot \vec{J}_\rho \qquad \frac{\partial c_i}{\partial t} = -\nabla \cdot \vec{J}_i$$

Typical Diffusion Values in Lithium-Ion Batteries

material	value (m^2/s)	limit [mol/m^3]
$LiPF_6$ in EC/DMC	9×10^{-11} to 2.58×10^{-10}	4744
$LiMn_2O_4$	1×10^{-13}	23720
$LiCoO_2$	1×10^{-15} to 5×10^{-16}	51555
$LiFePO_4$	1×10^{-14} to 1×10^{-20}	237
graphite	3.9×10^{-14}	28464

Lithium Transport into the Cathode Material (Discharge)

$$\vec{N} \cdot \hat{n} = \frac{i}{zF}$$

$$\frac{\partial c}{\partial t} = \nabla \cdot D \nabla c$$

reaction zone

δ

For Lithium:

$$Li^+ + e^- \leftrightarrows Li$$

Lithium Transport into the Cathode Material (Charge)

$$\vec{N} \cdot \hat{n} = \frac{i}{zF}$$

$$\frac{\partial c}{\partial t} = \nabla \cdot D \nabla c$$

reaction zone

δ

For Lithium:

$$Li^+ + e^- \leftrightarrows Li$$