

Title: Quantum Matter Lecture (230505)

Speakers: Ganapathy Baskaran

Collection: Quantum Matter (2022/2023)

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URL: <https://pirsa.org/23050003>

Quantum Matters in BIOLOGY

Wk.: Qu Bio

① Role of Q Magnetism in Biology

② Qu Coherence in Photosynthesis

③ Oxygen: O_2

(8) in BIOLOGY

2002

$$S_i^T S_j^- + S_i^- S_j^T$$

in Biology



$|2\rangle$

$|2\rangle$

—

↓

$|1\rangle$

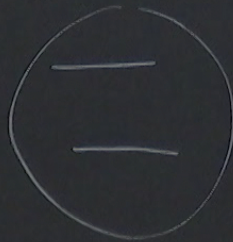
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↑

$|0\rangle$

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$$FM = H = -J \sum_{\langle i,j \rangle} \vec{S}_i \cdot \vec{S}_j$$

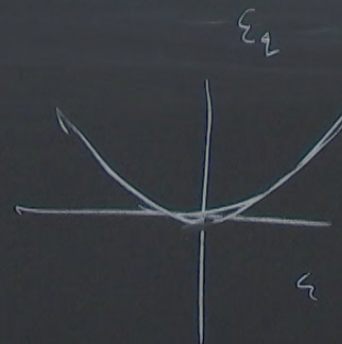
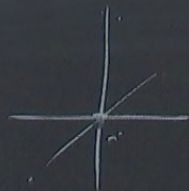
$$S_i^+ = \frac{1}{\sqrt{2s}} (s - a_i^\dagger a_i)^{\frac{1}{2}} a_i$$

$$\sim \frac{1}{s} \boxed{S_i^+ \approx a_i}$$

$$S_i^2 = s \cdot a_i^\dagger a_i$$

↑ ↑ ↑ ↓

$$S_i^+ S_j^- + S_i^- S_j^+ \rightarrow S^2 S^2$$



$$H = -J \sum_{\langle i,j \rangle} \vec{S}_i \cdot \vec{S}_j$$

$$-J S \sum \gamma(k) a_k^\dagger a_k = J(\dots) \sum k^2 a_k^\dagger a_k$$

$$\frac{1}{2S} (S - a^\dagger a) \frac{1}{2} a$$

$\uparrow \uparrow \uparrow \downarrow \uparrow \uparrow \uparrow$

$$\gamma(k) = \frac{1}{2} \sum_{\vec{\delta}} e^{i k \cdot \vec{\delta}} \quad \sum \frac{\hbar^2 k^2}{2m} a^\dagger a$$

$$S_i^+ \approx a_i$$

$$= S \cdot a^\dagger a$$

$$\sim J(k a)^2$$

$\uparrow \downarrow \uparrow \downarrow$

$$H = J \sum_{\langle i,j \rangle} \vec{S}_i \cdot \vec{S}_j \quad J > 0$$

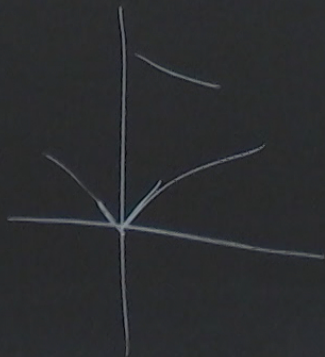
$$\vec{S}_1 \vec{S}_2 |\uparrow \downarrow\rangle \rightarrow \alpha |\downarrow \uparrow\rangle + \beta |\uparrow \downarrow\rangle$$

$$S_{i,a}^+ = a_i$$

$$S_{i,b}^+ = a_i^\dagger$$

$$s_{ia}^+ = a_i$$

$$s_{ib}^+ = a_i^+$$



$$\gamma \approx (a_i^+ b_j^+ + a_i a_j)$$

$$(a_i^+ b_j + a_i^+ b_j^+)$$

Quantum Matter(s) in BIOLOGY

Wk.: Qu Bio

① Role of Q Magnetism in Biology ←

② Qu Coherence in Photosynthesis

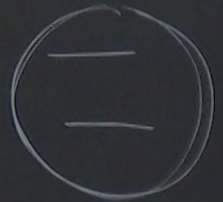
③ Oxygen: O_2

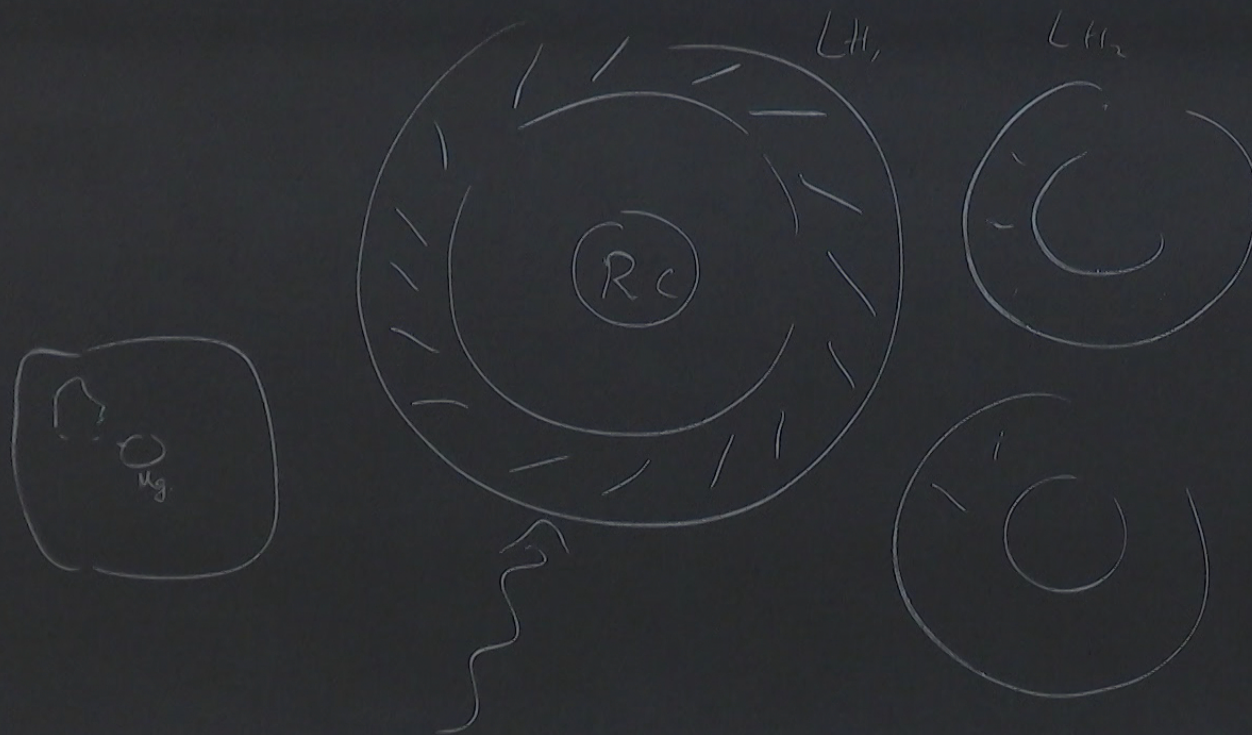
$|2\rangle$

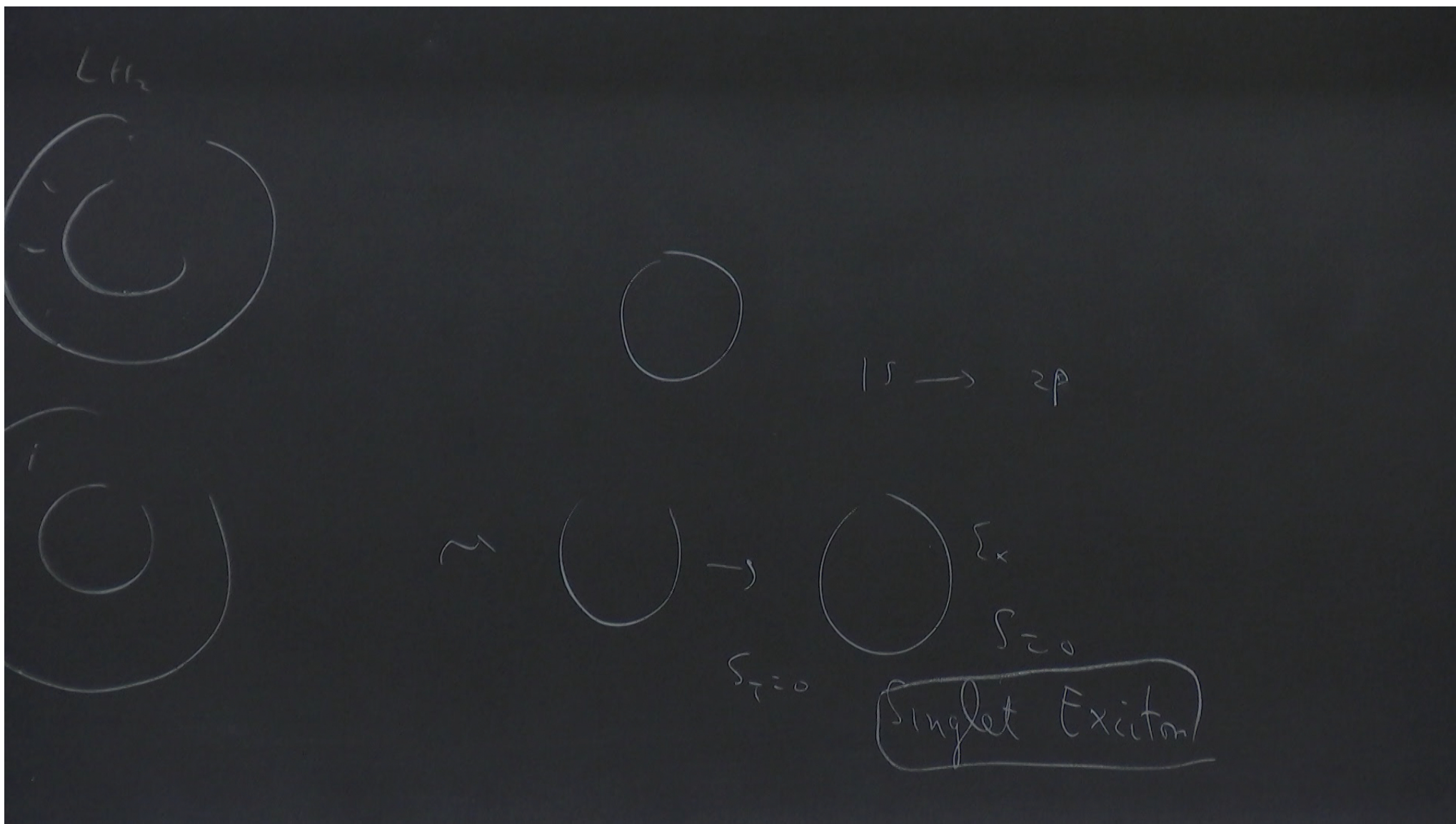
$|2\rangle$

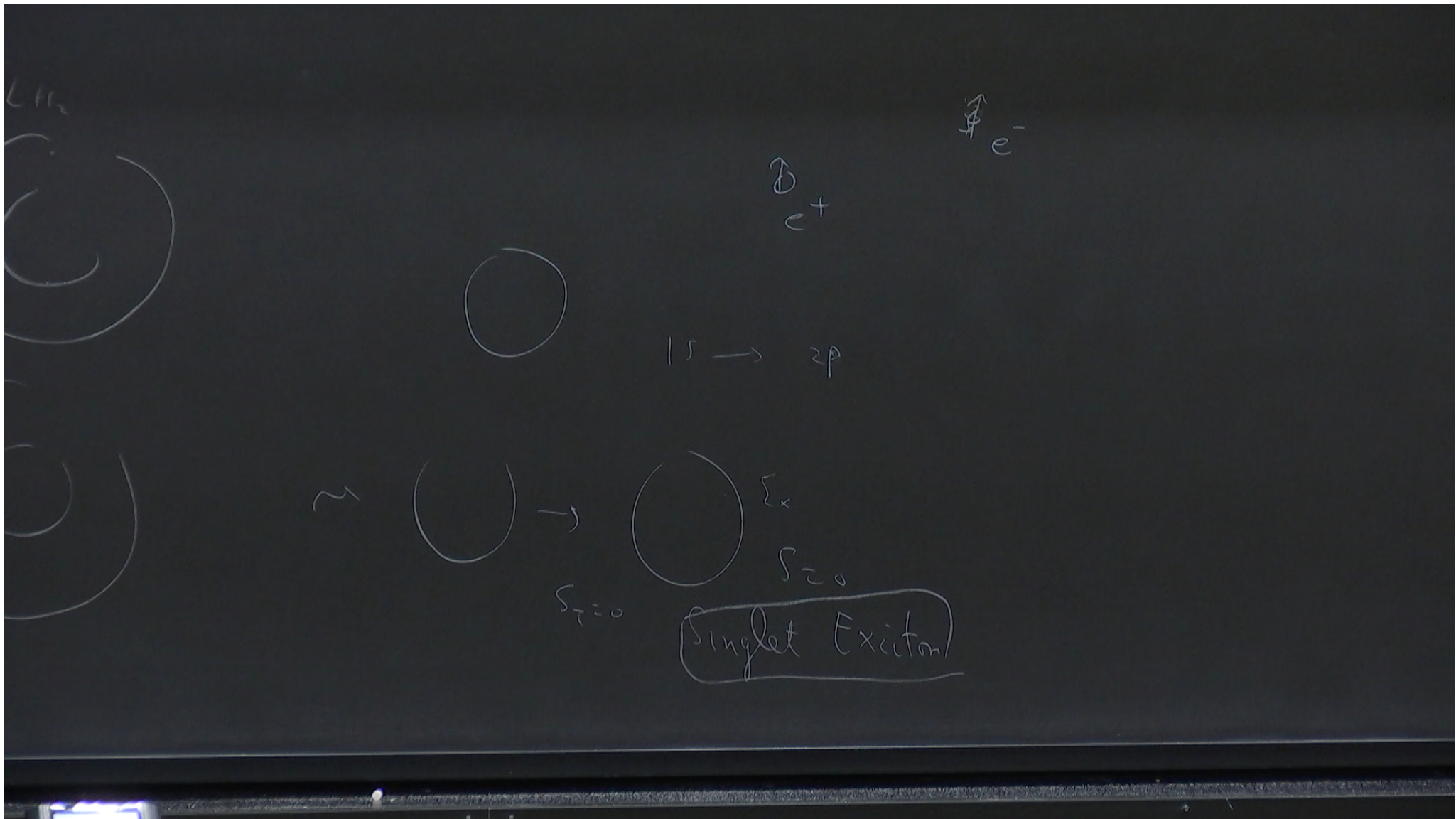
$|1\rangle$

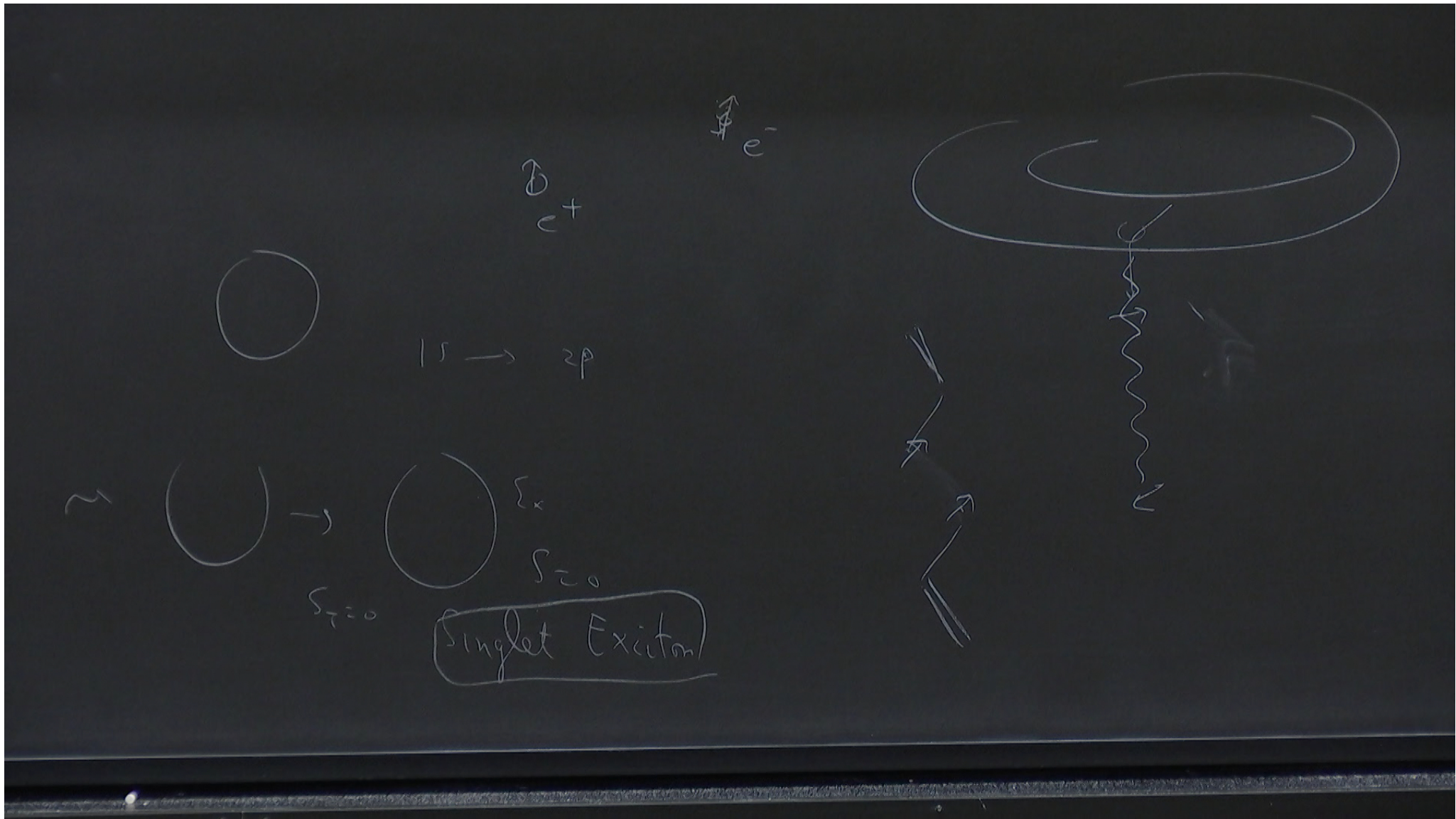
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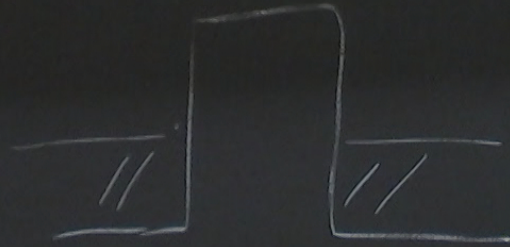




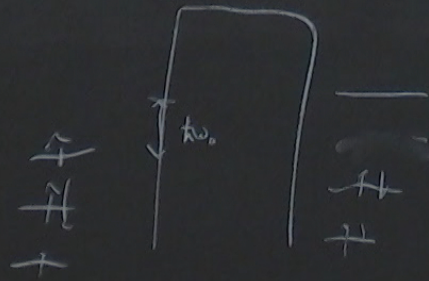




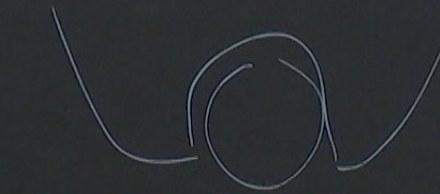
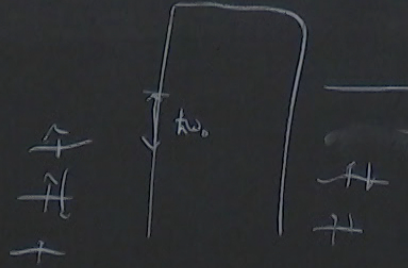
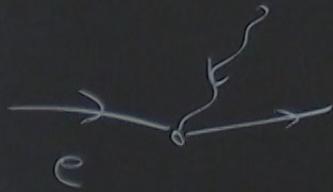
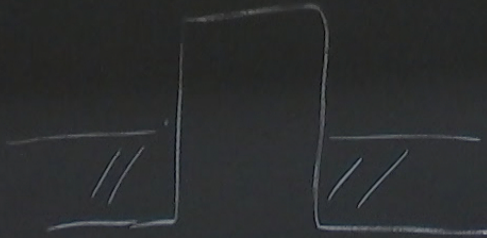




St. Georgy



St. Georgy



Luka Turin

$$\omega \sim \sqrt{\frac{1}{M}}$$