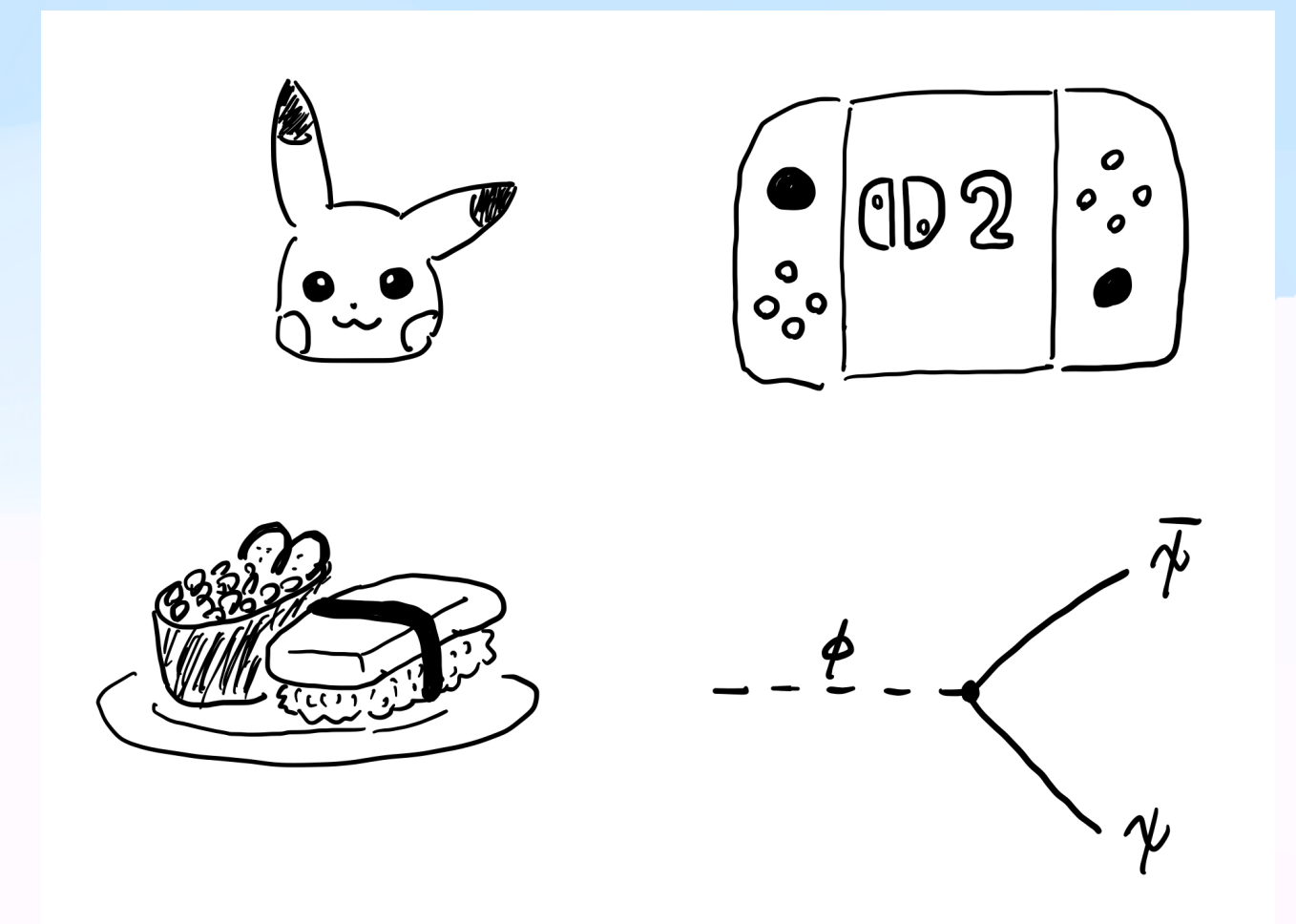


Axion DM detection using shift current

Genta Osaki (UTokyo, Japan)



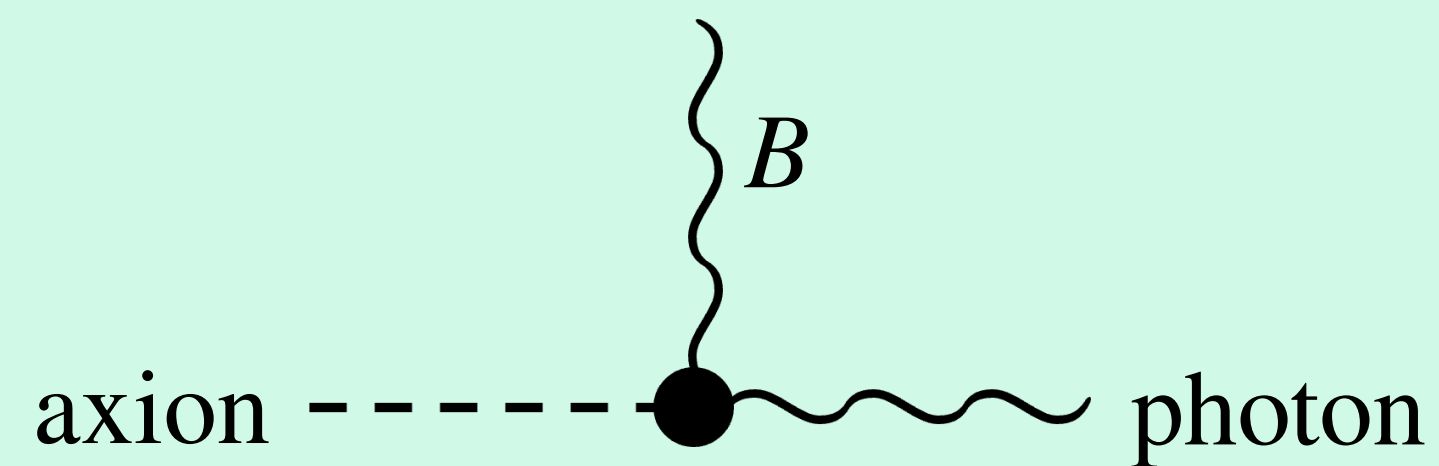
Based on the work: 2505.17007 in collaboration with Dan Kondo, Takahiro Morimoto, and Thanaporn Sichanugrist

Today's topic

Axion

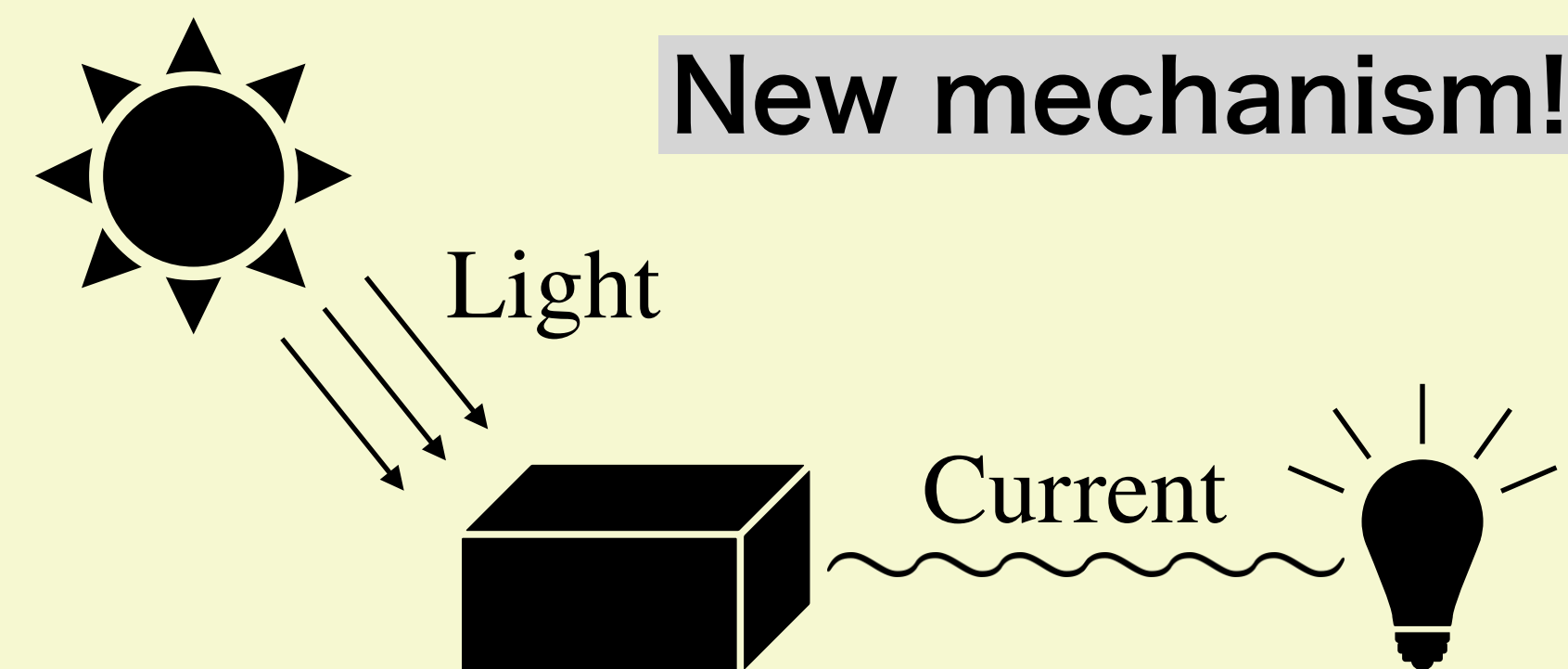
Dark matter candidate

Axion-photon coupling



Shift current

Light-induced current



Our idea: Axion DM $\rightarrow$ photon $\rightarrow$ shift current



期間指定なし

2025 年以降

2024 年以降

2021 年以降

期間を指定...

2011 — 2020

検索

Year	Papers
— 1960	25
1961 — 1970	26
1971 — 1980	63
1981 — 1990	107
1991 — 2000	344
2001 — 2010	913
2011 — 2020	3140
2021 —	3000

← Discovered around 1960

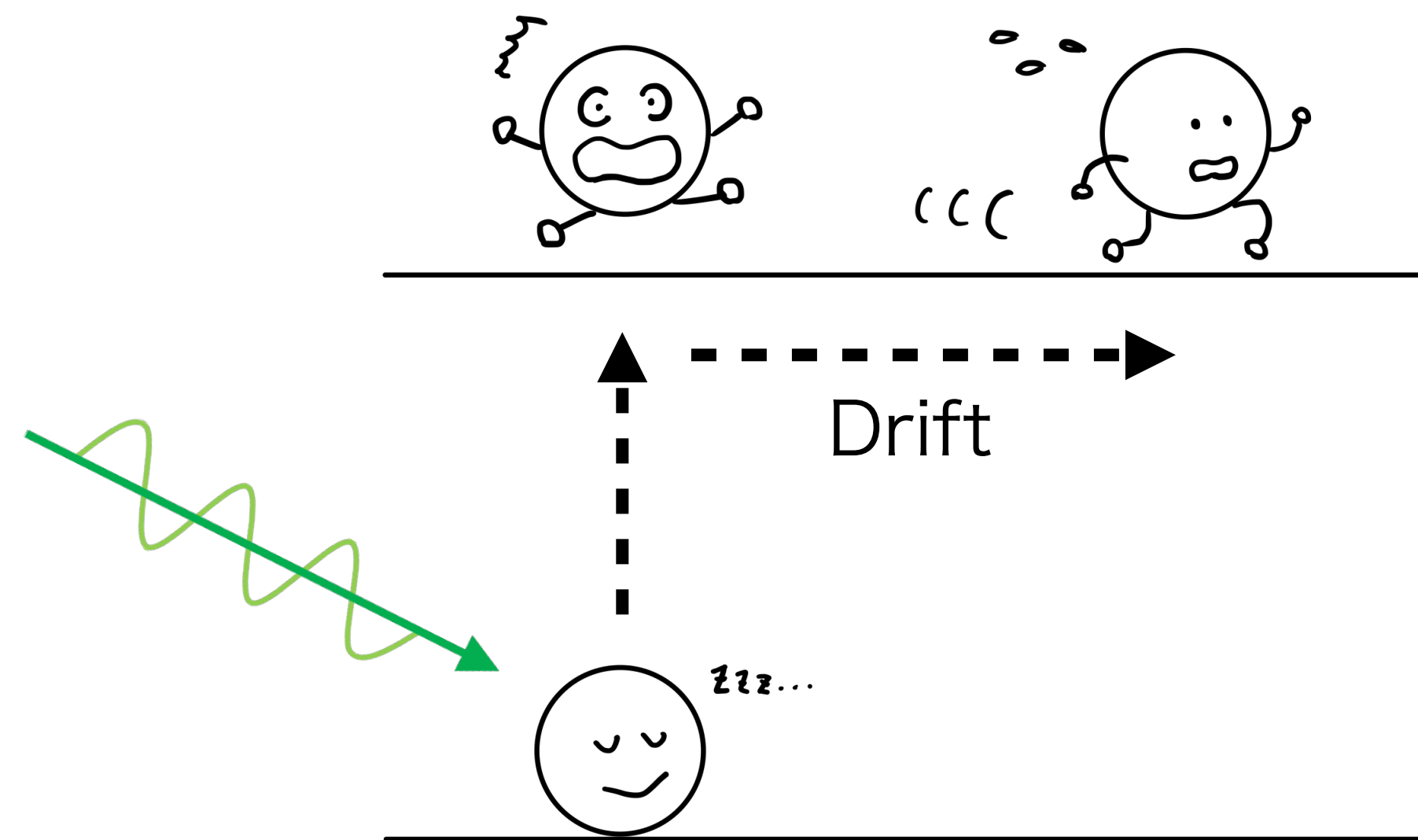
Exciting topic recently!!

Search for materials with high efficiency
Application for new photo devices

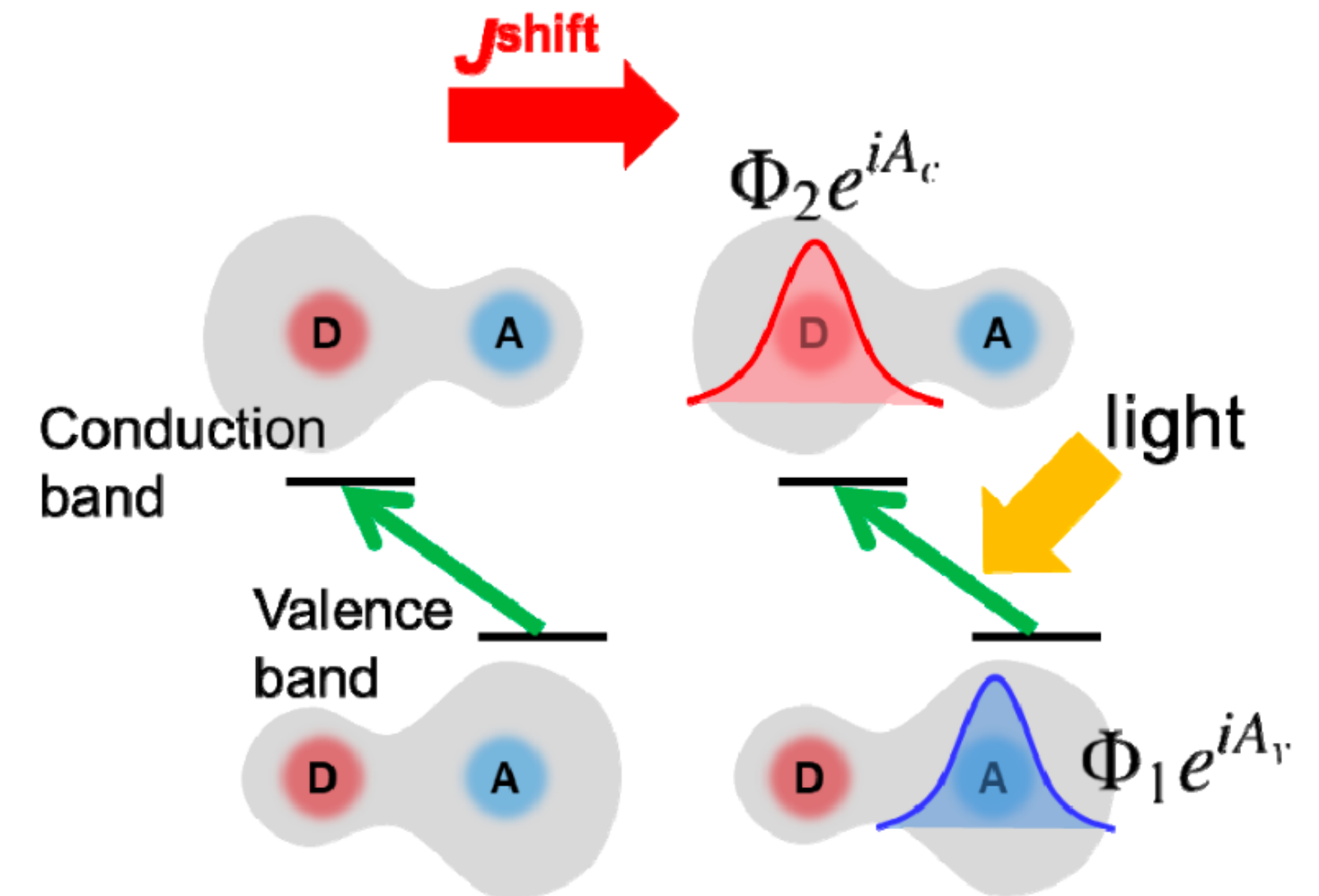
← Theoretically well understood
(by first principle calculation)

S. M. Young and A. M. Rappe, Phys. Rev. Lett. 109, 116601 (2012).

Conventional light-induced current

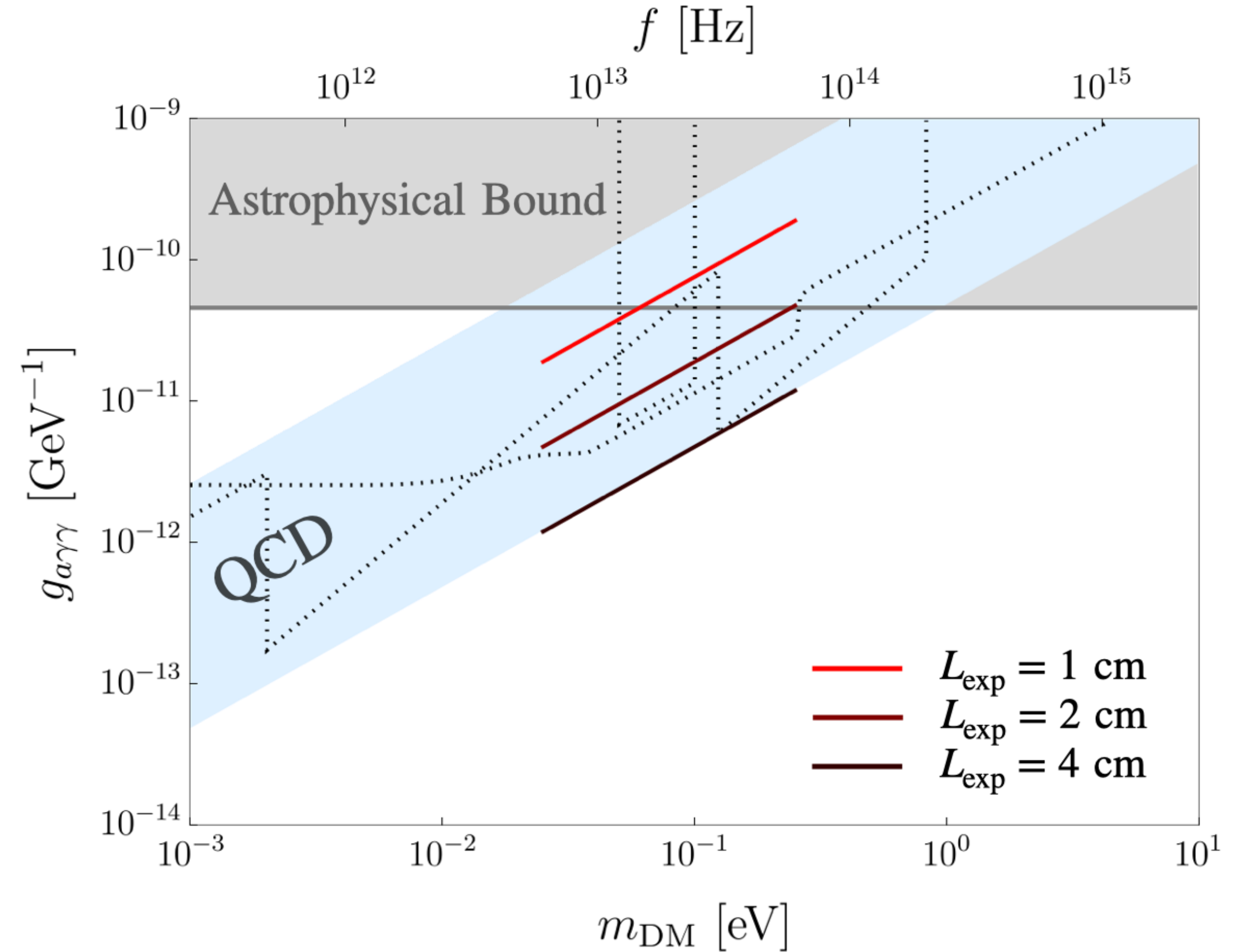
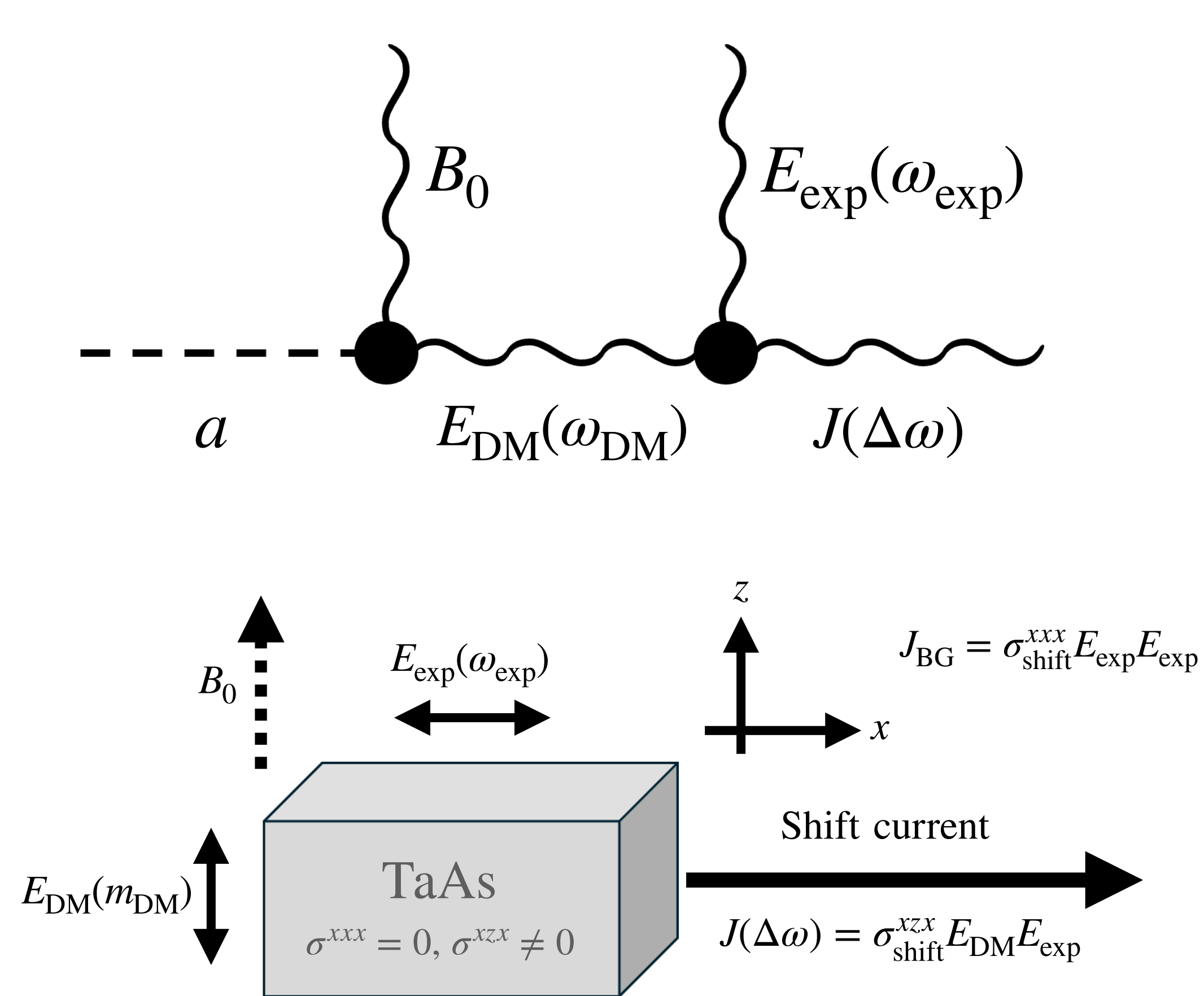


Shift current



Shift current does not involve carrier drift process.
→ Reduced energy dissipation and lower noise!!

Strategy: Axion DM $\rightarrow$ photon $\rightarrow$ shift current



Back up

Shift current response

Point!

The second-order response $\langle \hat{J}^\mu \rangle_{\text{shift}}^{(2)}(\omega) = \sigma_{\text{shift}}^{\mu\alpha_1\alpha_2} E^{\alpha_1}(\omega_1) E^{\alpha_2}(\omega_2)$

→ We can enhance the signal by applying another strong electric field.

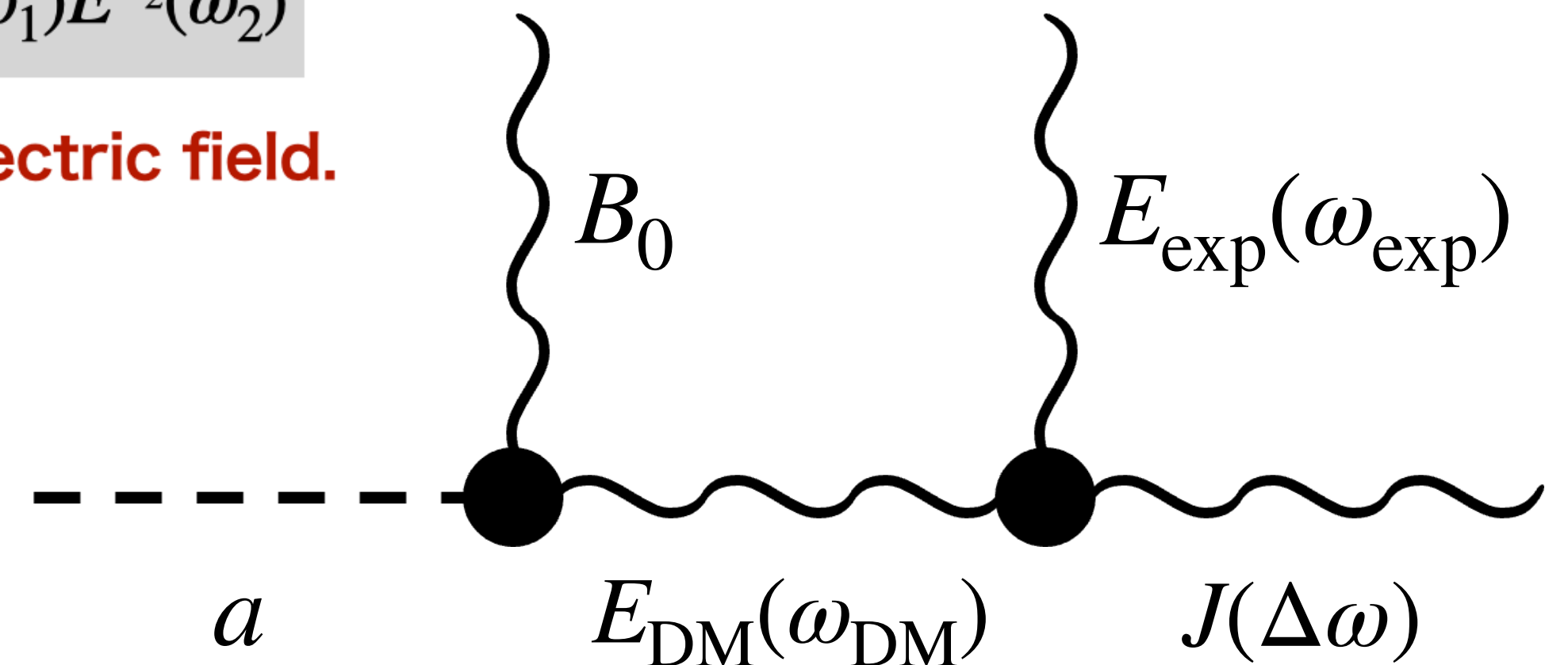
Input

$$E(t) = \text{Re} \left[E_{\text{DM}} e^{im_{\text{DM}}t - i\phi_{\text{DM}}} + E_{\text{exp}} e^{-i\omega_{\text{exp}}t} \right]$$

Output

$$\langle \hat{J}^\mu \rangle_{\text{shift}}^{(2)}(\Delta\omega) = \sigma_{\text{shift}}^{\mu\alpha_1\alpha_2}(\Delta\omega) E_{\text{DM}}^{\alpha_1} e^{-i\phi_{\text{DM}}} E_{\text{exp}}^{\alpha_2}$$

$$\Delta\omega = -m_{\text{DM}} + \omega_{\text{exp}}$$



Other terms

$J \propto E_{\text{DM}} E_{\text{DM}} \rightarrow \text{Negligible}$

$J \propto E_{\text{exp}} E_{\text{exp}} \rightarrow \text{Background}$