# Supplementary information for "Time-dependent Gutzwiller simulation of Floquet topological superconductivity"

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### Supplementary Note 1: Doping level and $U$ dependence of the $id_{xy}$-wave component of the superconducting pairing amplitude

In this section, we show the results in other hole doping levels $\delta$ and onsite interaction $U$. We present the doping dependence of $\overline{\Delta_{id_{xy}}}$ in the high-frequency region($\omega = 5.8t_0, E = 5.4t_0/a$) in Fig S1. The three-site term is proportional to the doping rate $\delta$, whereas in the Gutzwiller approximation, $\Delta_{d_{x^2-y^2}}$ decreases monotonically with $\delta$. Consequently, in the vicinity of $\delta \sim 0.2$, the absolute value of $\overline{\Delta_{id_{xy}}}$ is generally larger compared to the ones at the other $\delta$.

Next, we show the color plot of $\overline{\Delta_{id_{xy}}}$ as the function of electric field amplitude $E$ and doping rate $\delta$ in the low-frequency region ($\omega = 1.03t_0$) in Fig. S2. The transition point of the topological phase transition induced by changing the electric field amplitude, shown in Fig. 3(d), varies with the doping rate. This is because the three-site term being proportional to the doping rate, as seen from Eq. (12). Additionally, note that the Gutzwiller approximation tends to overestimate the superconducting pairing amplitude for doping levels less than the optimal dope so this result overestimates $\overline{\Delta_{id_{xy}}}$ for the values of $\delta$ lower than 0.2.

Furthermore, we present the dependency of $\overline{\Delta_{id_{xy}}}$ on $U/t_0$in the low-frequency region ($\omega = 1.03t_0, E = 0.96a/t_0$) in Fig. S3. A sharp change, along with a change in sign, is observed for $U < 11t_0$ while a more gradual change is observed for $U > 11t_0$. Qualitatively, $\overline{\Delta_{id_{xy}}}$ at this parameter $\omega = 1.03t_0, E = 0.96a/t_0$ mainly stem from the contribution of the $n = 10$ term in Eq. (19), and the change in sign of $U - n\omega$ in Eq. (19) leads to the sharp change for $U < 11t_0$.

While we employed the Gutzwiller approximation to simulate the time evolution of cuprates under circularly polarized light, we can alternatively use the slave-boson method instead of the Gutzwiller approximation. In the slave-boson method, the holon operators, which do not carry a spin index, are diagonal [1], and circularly polarized light does not affect the condensation of holon $\left\langle \hat{b}_i \hat{b}_j \right\rangle$ and spinon $\left\langle \hat{f}_{i\uparrow} \hat{f}_{j\downarrow} \right\rangle$, and hence the superconducting pairing amplitude $\left\langle \hat{c}_{i\uparrow} \hat{c}_{j\downarrow} \right\rangle \sim \left\langle \hat{f}_{i\uparrow} \hat{f}_{j\downarrow} \right\rangle \left\langle \hat{b}_i \hat{b}_j \right\rangle$. Therefore, it is expected that using the slave-boson method would yield similar results to those obtained with the Gutzwiller approximation. However, the Gutzwiller approximation tends to overestimate the superconducting pairing amplitude for doping levels less than the optimal, so in such cases, it is considered better to use the slave-boson method.

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[1] Ogata, M. & Fukuyama, H. The *t-J* model for the oxide high-Tc superconductors. *Rep. Prog. Phys.* **71**, 036501 (2008).

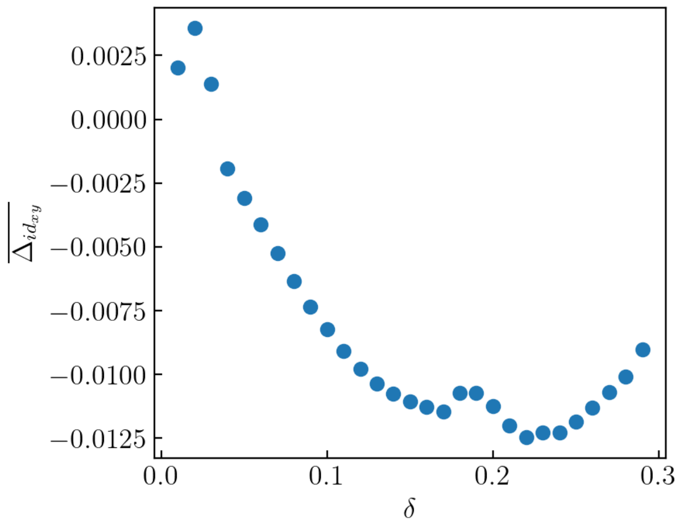


FIG. S1. Doping dependence of the $id_{xy}$-wave component of the pairing amplitude in the high-frequency region. We plotted $\overline{\Delta_{id_{xy}}}$ as a function of $\delta$. We adopted parameters: $\omega = 5.8t_0, E = 5.4t_0/a$.

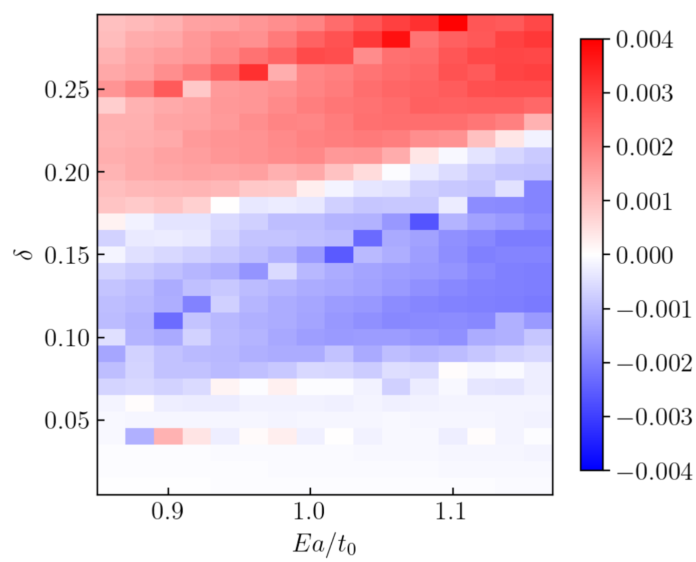


FIG. S2. A color plot of the $id_{xy}$-wave component of the pairing amplitude $\overline{\Delta_{id_{xy}}}$ as a function of electric field amplitude $E$ and doping rate $\delta$ in the low-frequency region (we set $\omega = 1.03t_0$).

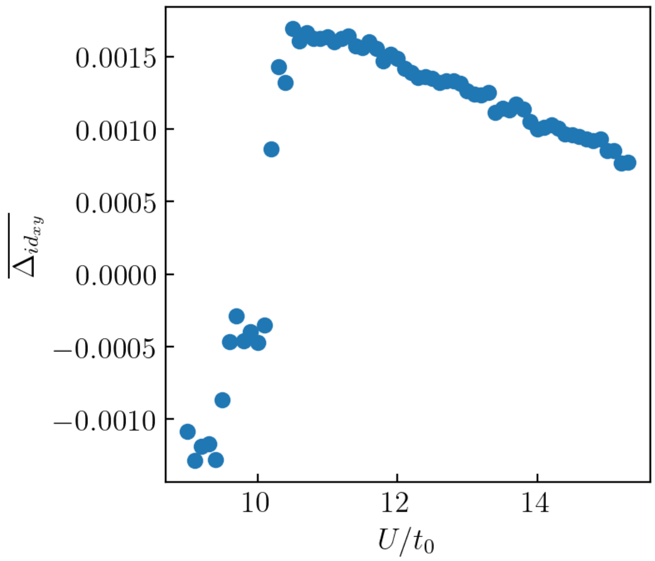


FIG. S3. $U$ dependence of the $id_{xy}$-wave component of the pairing amplitude $\overline{\Delta_{id_{xy}}}$ in the low-frequency region. We adopted parameters: $\omega = 1.03t_0, E = 0.96a/t_0$.