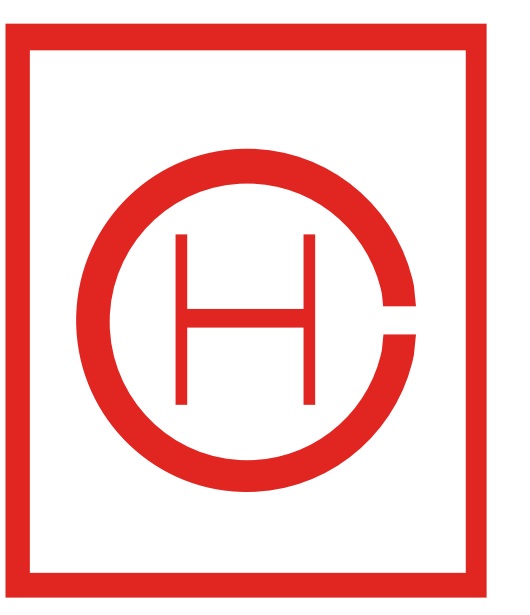




# Supersymmetric Landau Levels in Subwavelength Type-I Dirac Metasurfaces



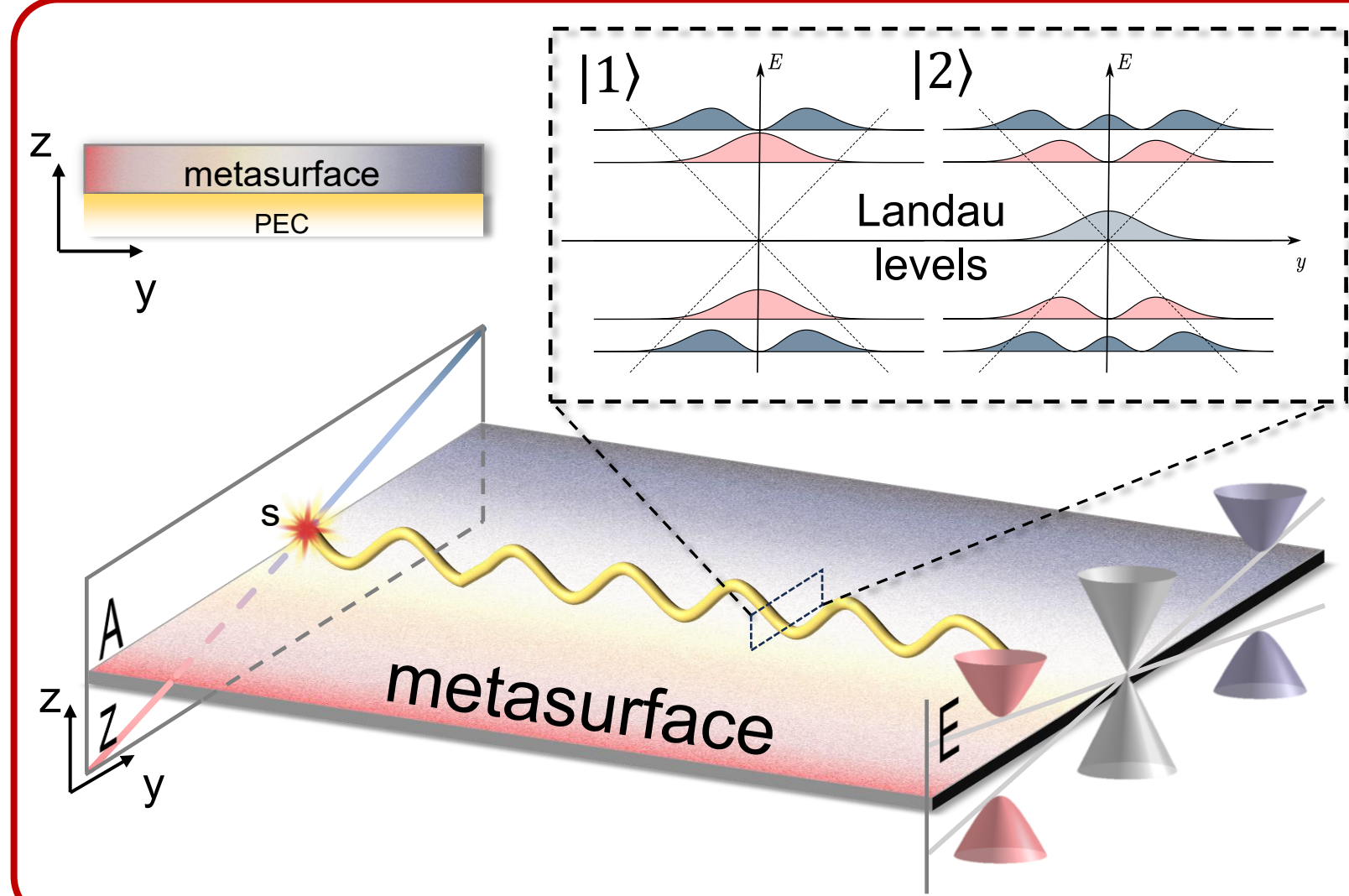
Yi Yuan<sup>1,†</sup>, **Yikai Xu<sup>2,†</sup>**, Liang Zhao<sup>2</sup>, Qiong He<sup>2</sup>, Shulin Sun<sup>1,\*</sup>, Shaojie Ma<sup>1,\*</sup>, Lei Zhou<sup>2,\*</sup>

<sup>1</sup>Department of Optical Science and Engineering, Fudan University, Shanghai 200433, China

<sup>2</sup>Department of Physics, Fudan University, Shanghai 200433, China

Email: ykxu22@m.fudan.edu.cn

## 15s-Summary



### Question:

It is useful to control electromagnetic wave based on topology, but most current studies are based on periodic scattering, such as hexagonal photonic crystals.

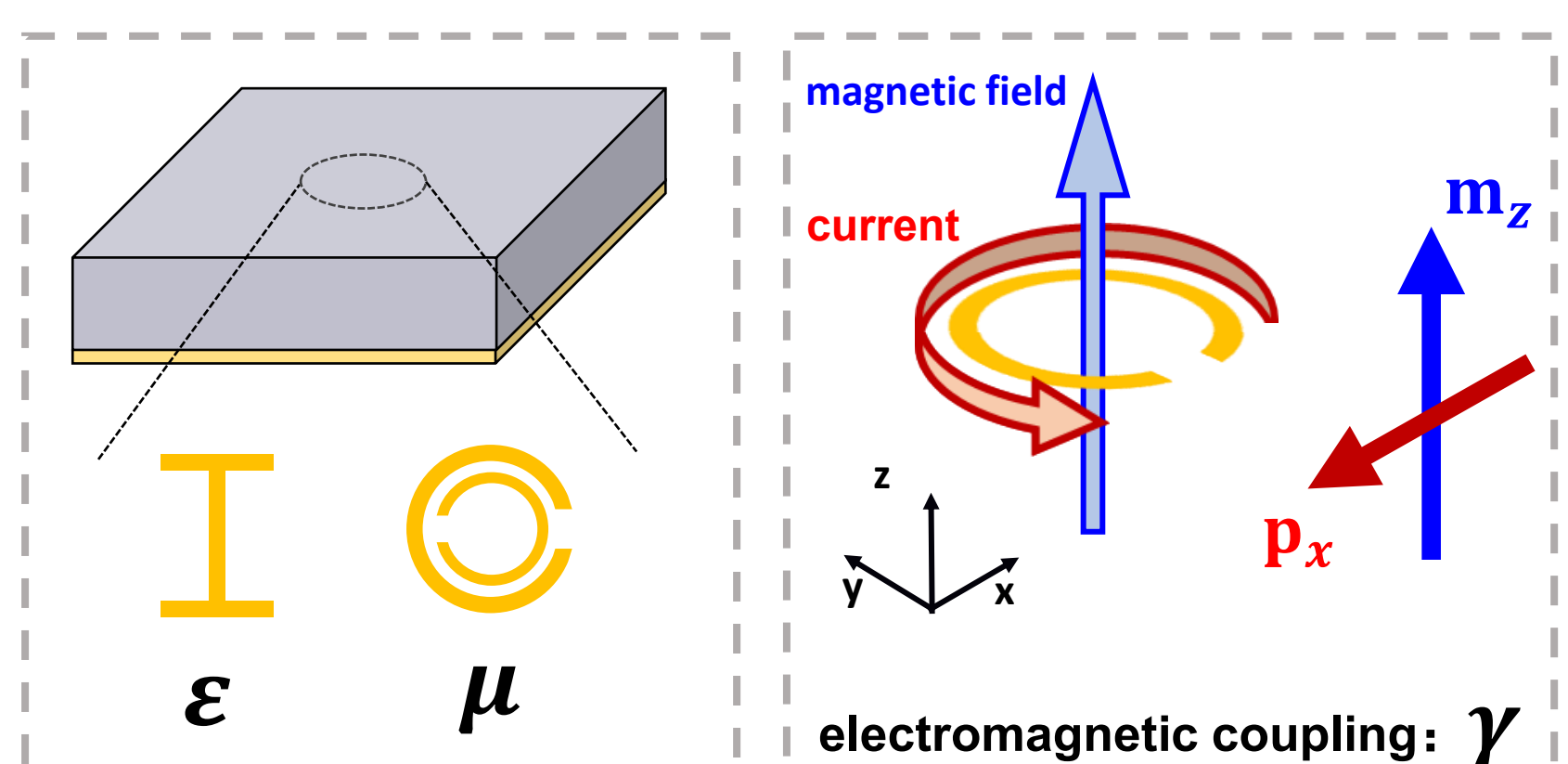
### Task:

Achieve topological control using metasurfaces to obtain more intrinsic degrees of freedom.

### Result:

- Realize a type-I photonic Dirac semimetal using surface modes on metasurfaces.
- Construct an artificial gauge field by introducing inhomogeneous local symmetry breaking.
- Landau levels and chiral zero patterns observed experimentally.

## Effective media

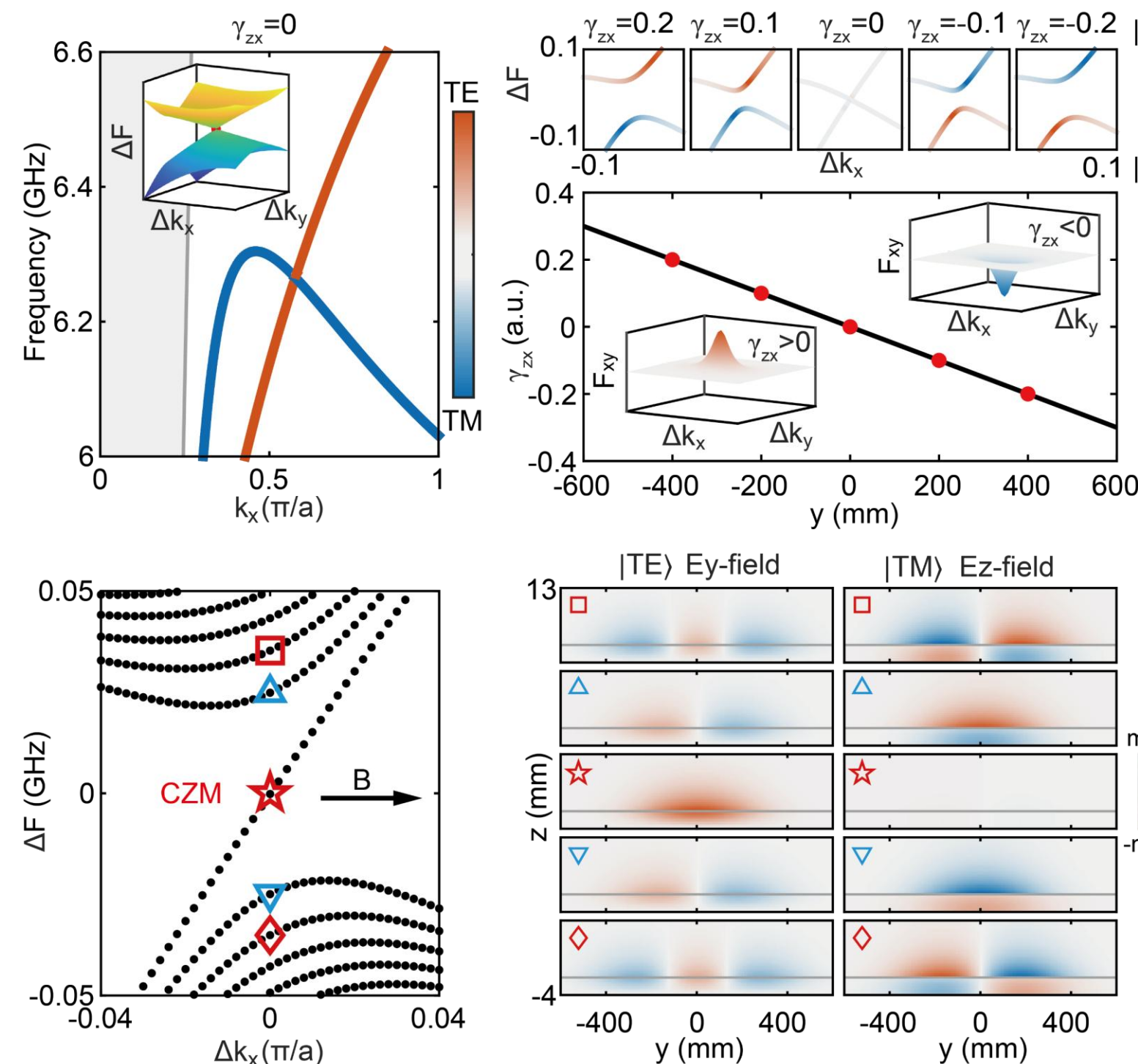


Effective Medium Theory  $\rightarrow$   $k \cdot p$  Hamiltonian

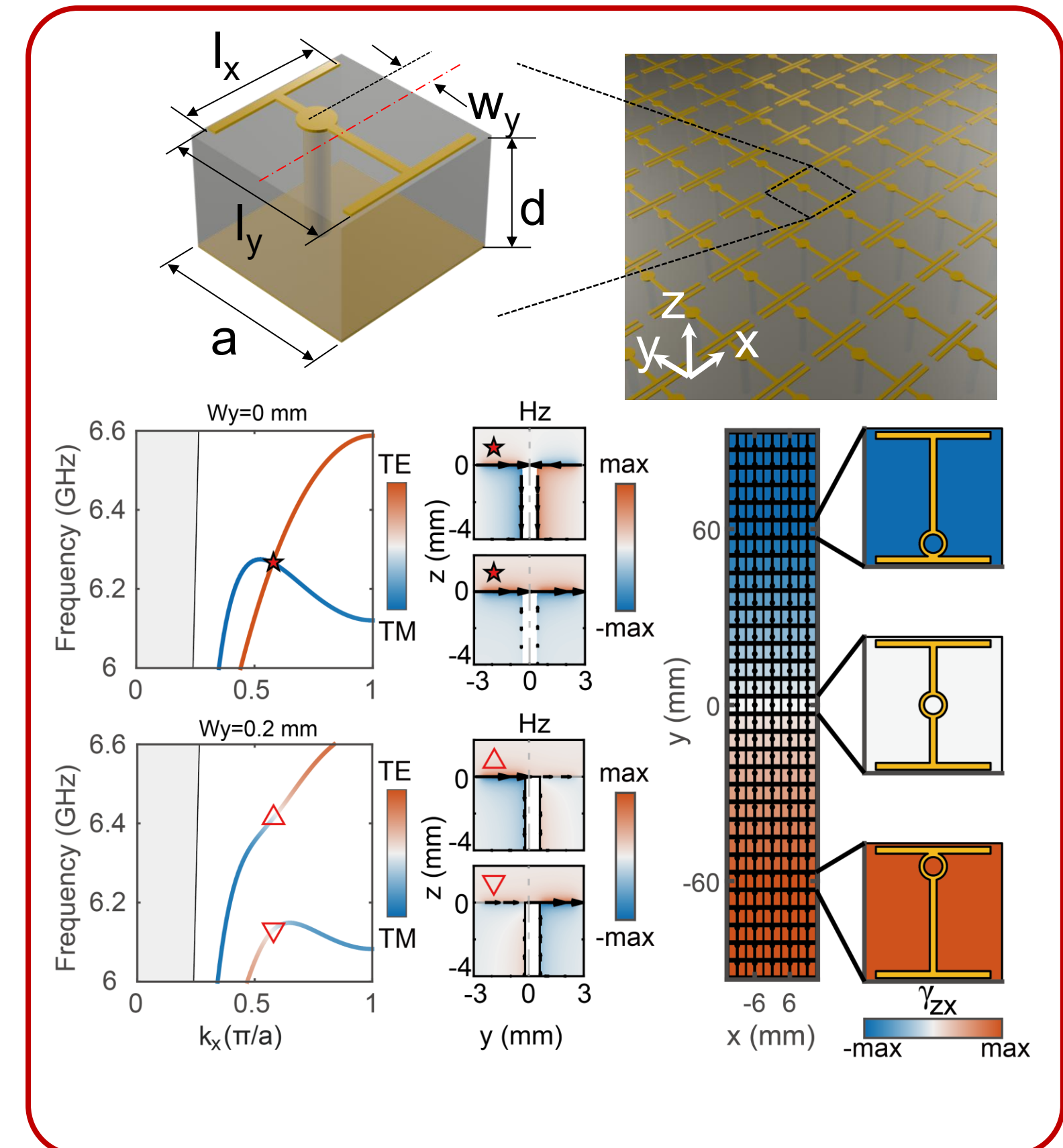
$$H = v_x k_x \cdot \sigma_x + v_y k_y \cdot \sigma_y + m \cdot \sigma_z$$

$$m = v_z \cdot \gamma_{zx}(y) = -A_z(y) = -B \cdot y$$

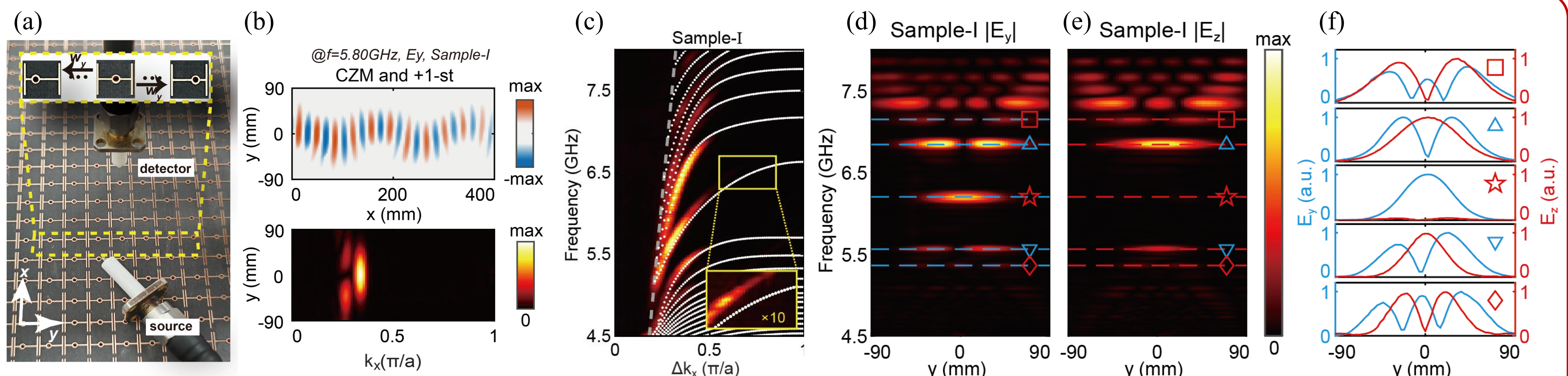
Illustration of Supersymmetric Landau Levels via Effective Medium Theory



## Metasurfaces Design

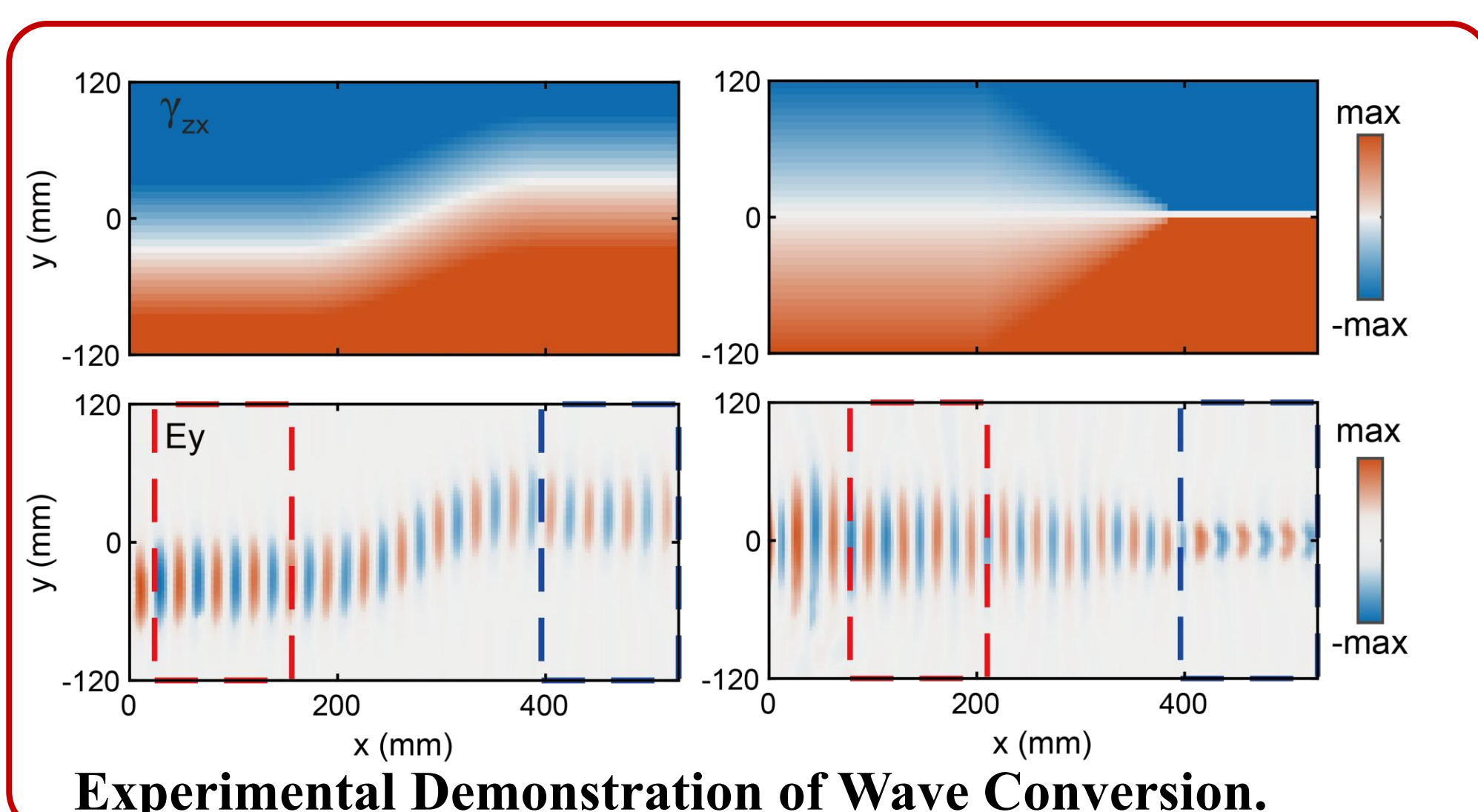


## Experimental observation



**Experimental observation of the supersymmetric Landau levels.** (a) Photograph of the metasurfaces sample and experiment setup. (b) Real-space distribution of the  $E_y$  fields at representative frequencies, along with the field distributions after performing a partial Fourier transform along the  $x$ -direction. (c) The measured dispersion spectrum along  $k_x$ . (d-e) The measured Landau levels spectrum at a fixed  $k_x$ . (f) The  $|E_z|$  and  $|E_y|$  field distribution detected at some typical Landau levels to characterize the supersymmetry.

## Wave Conversion



Experimental Demonstration of Wave Conversion.

## Metasurfaces VS Photonic Crystals

