

Topologikus Szigetelők

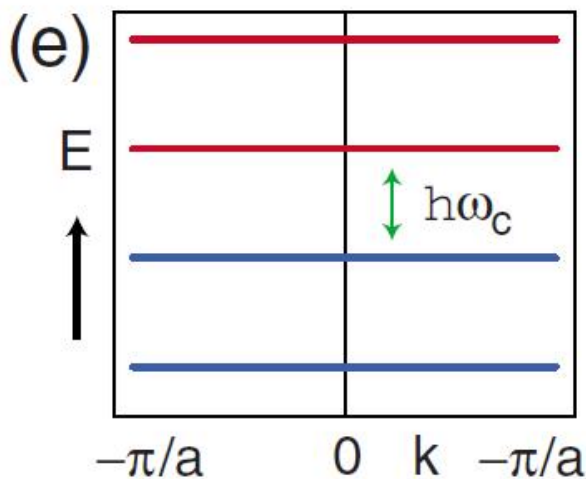
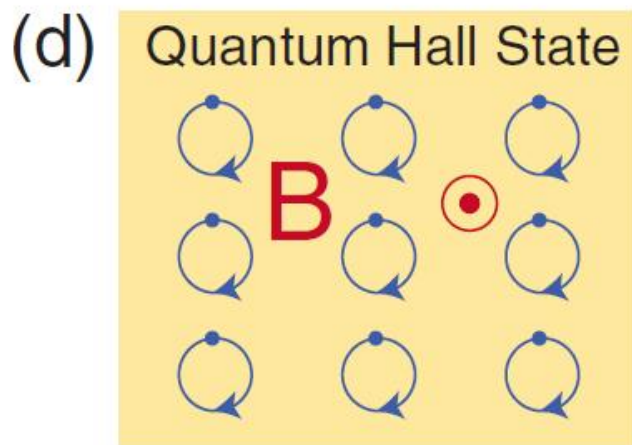
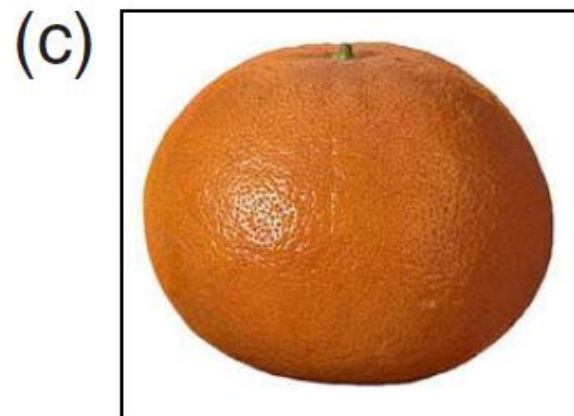
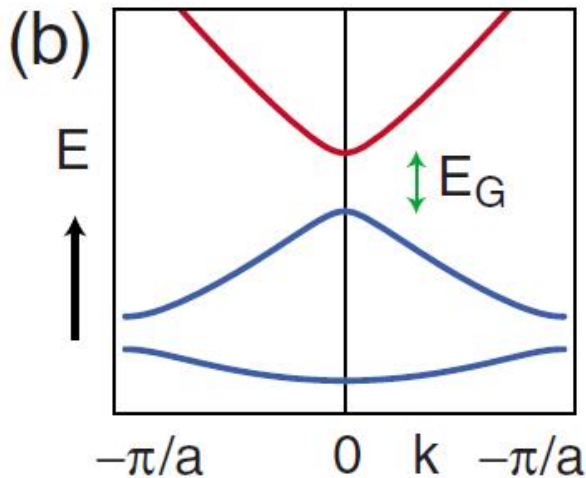
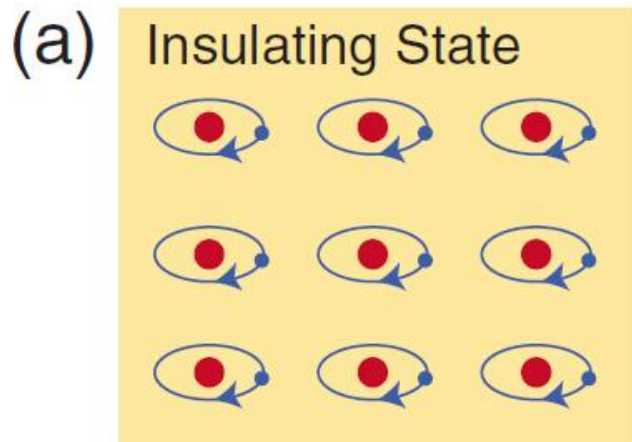
Modellek és egzotikus jelenségek

Szigetelők

- Sávszigetelők (egy részecske tiltott sáv)
- Peiers szigetelők (electron - phonon)
- Mott szigetelők (electron - electron)
- Anderson szigetelők (szennyezők)

- Topologikus szigetelők (?????)
Rev. Mod. Phys. **82**, 3045 (2010)

QHE, az első topologikus szigetelő



Tömb-felület korrespondencia

Tömb

A betöltött Bloch-állapotokból definiálható egy topológiai invariáns:

TKKN topologikus index

$$A_m = i \langle u_m | \nabla_k | u_m \rangle$$

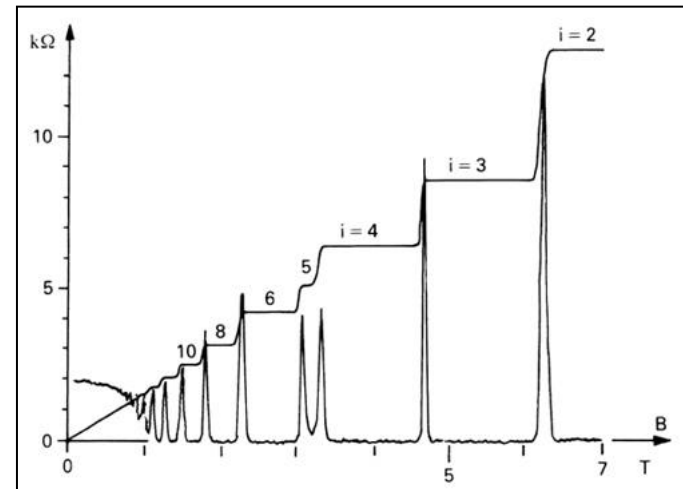
$$F_m = \nabla \times A_m$$

$$n = \frac{1}{2\pi} \sum_m \int d^2 k F_m$$

$$N = n$$

Felület

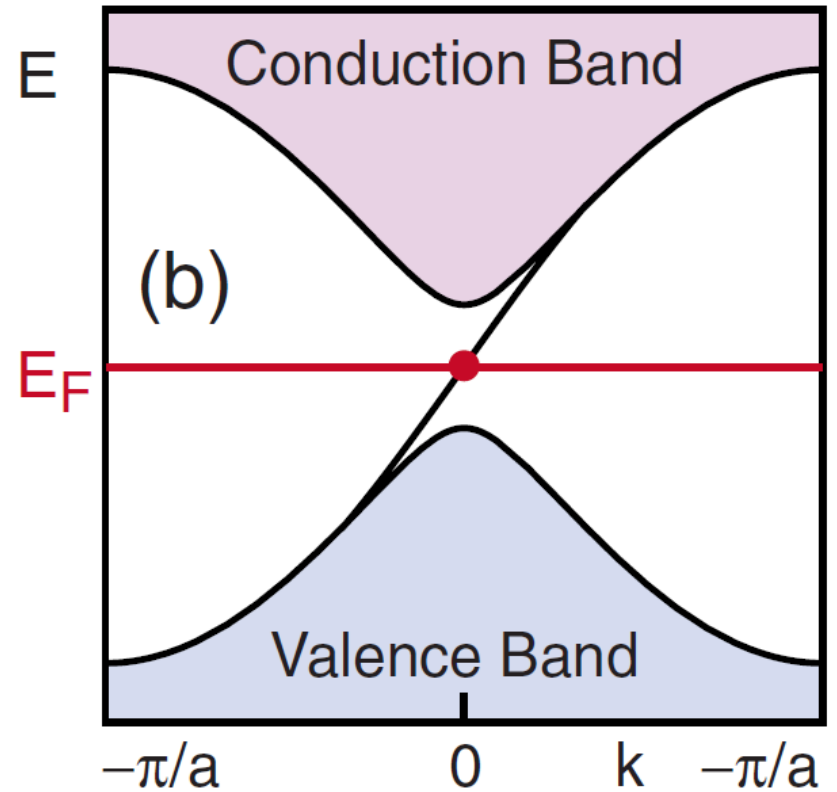
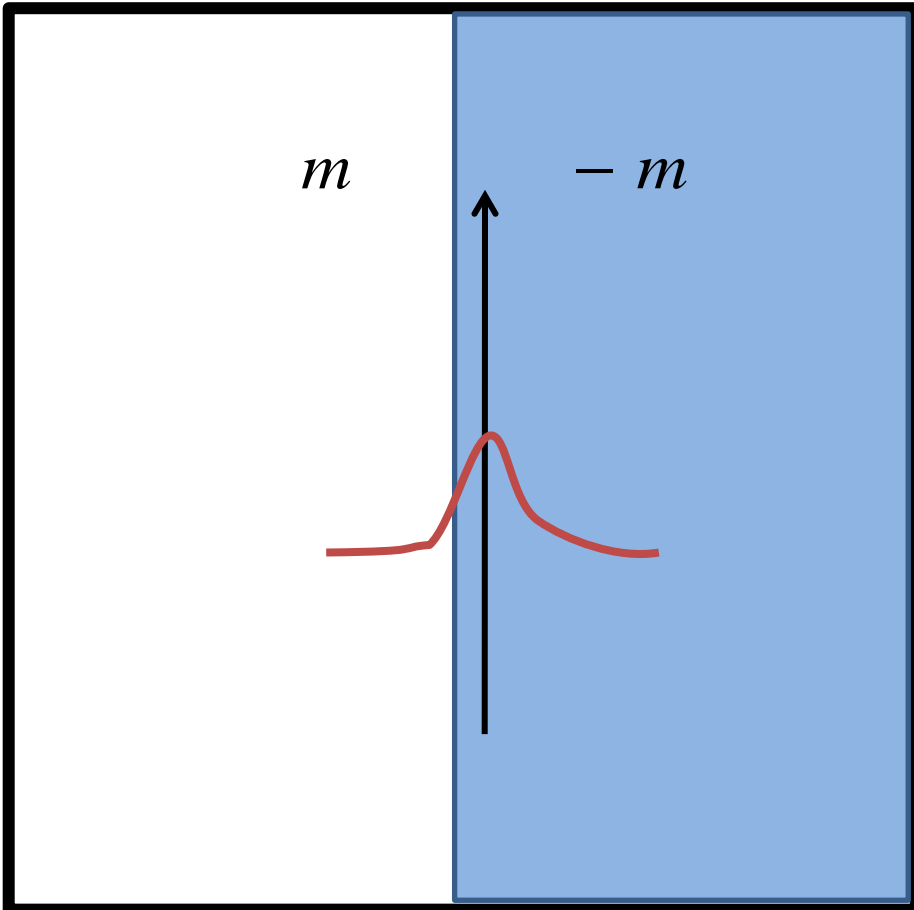
A minta felületén kialakulnak robusztus propagáló állapotok:



$$\sigma_{xy} = Ne^2 / h$$

Egy egyszerű modell

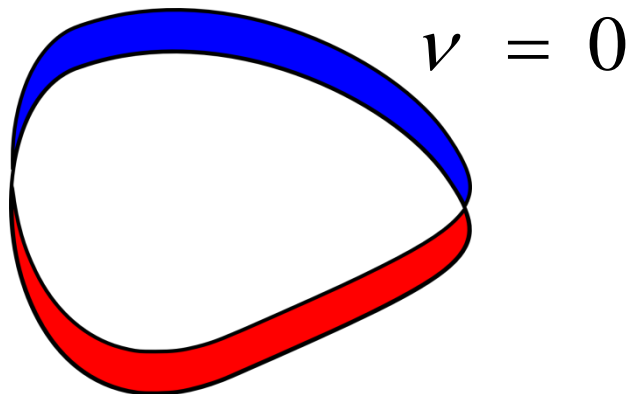
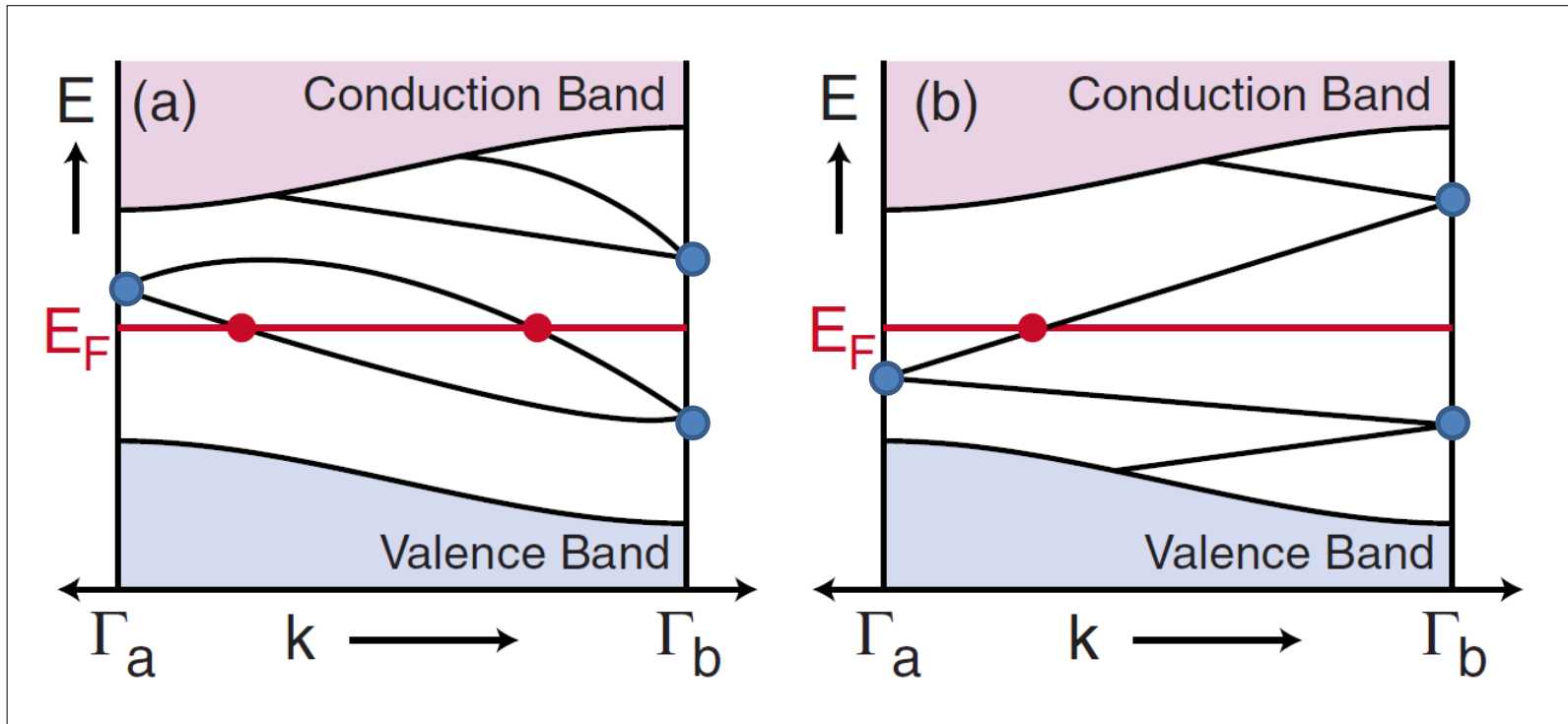
$$H = \vec{\sigma} \cdot \vec{p} + m(\vec{x})\sigma_z$$



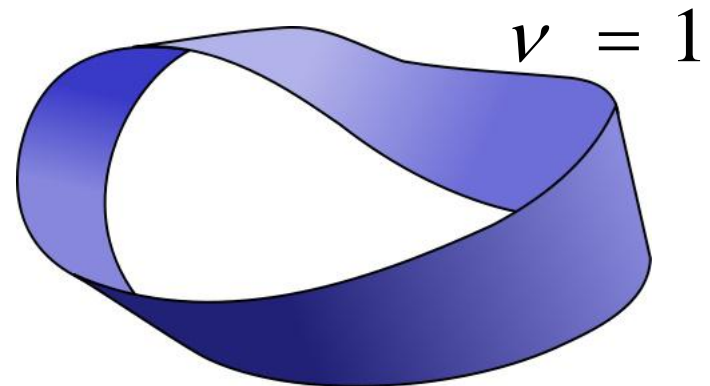
Z_2 TRS+SP topologikus szigetelők

$$n = 0$$

De van
egy másik
topologikus
szám!

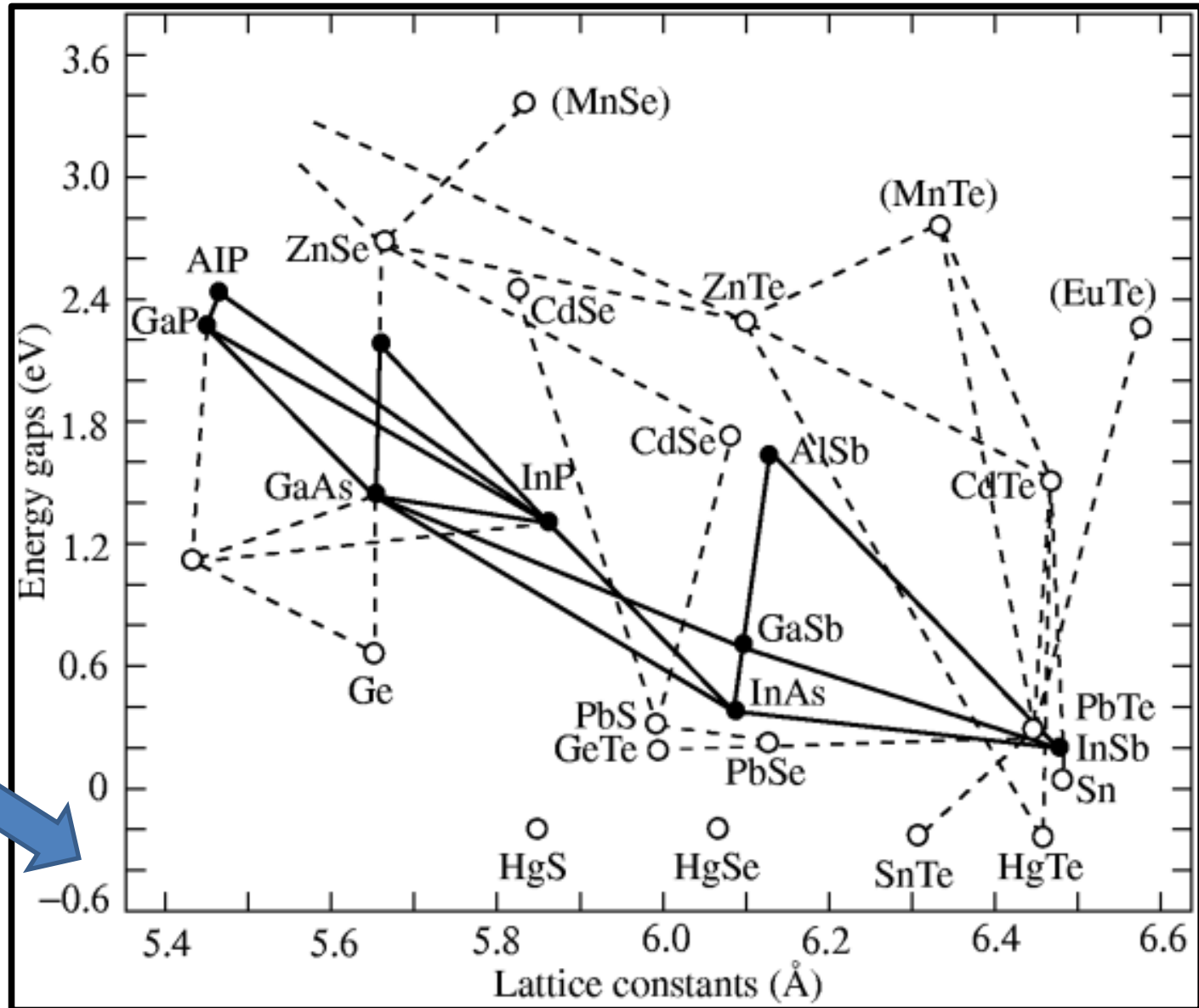


$$\nu = 0$$

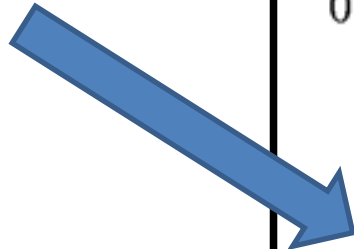


$$\nu = 1$$

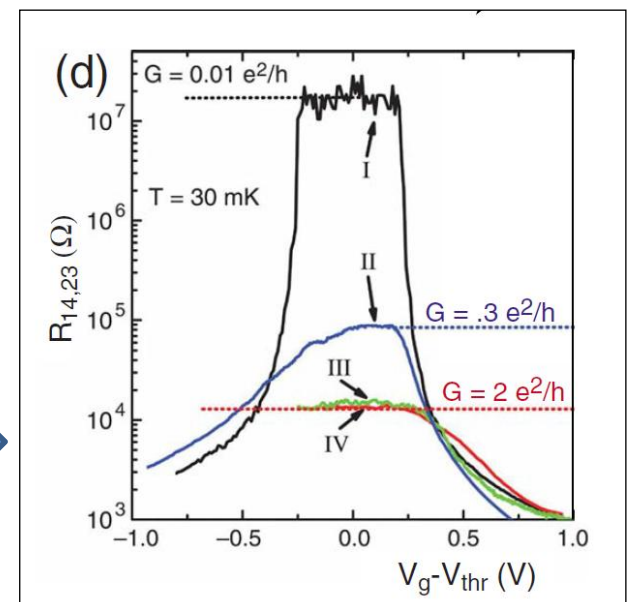
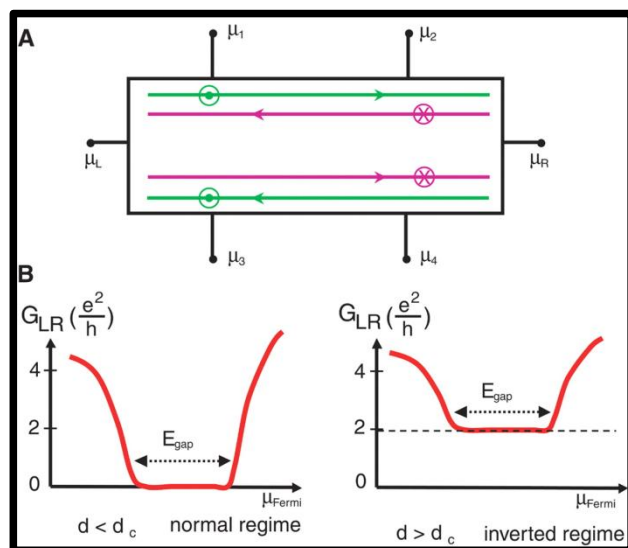
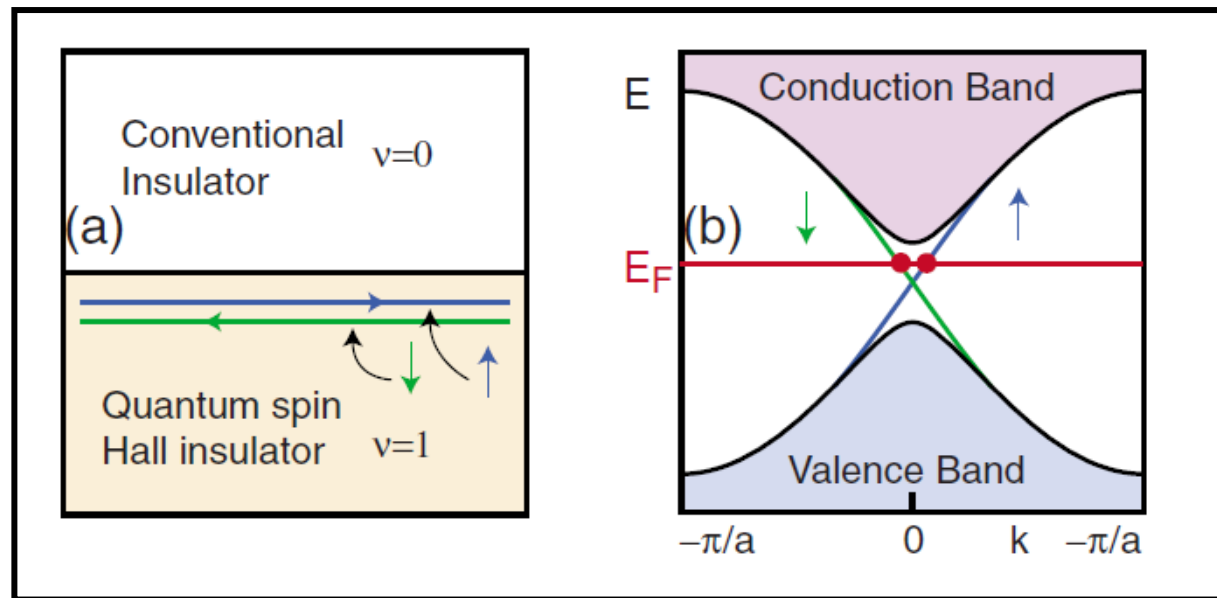
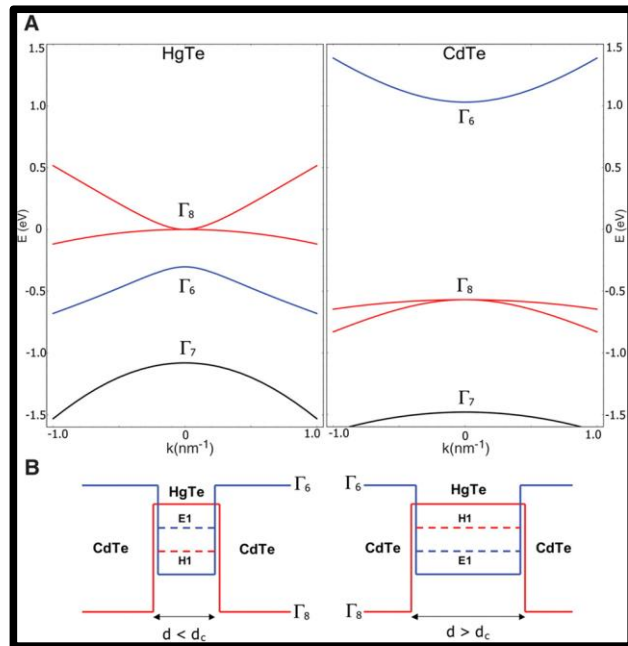
2D topologikus szigetelők - HgTe/CdTe



Negatív gap ?!

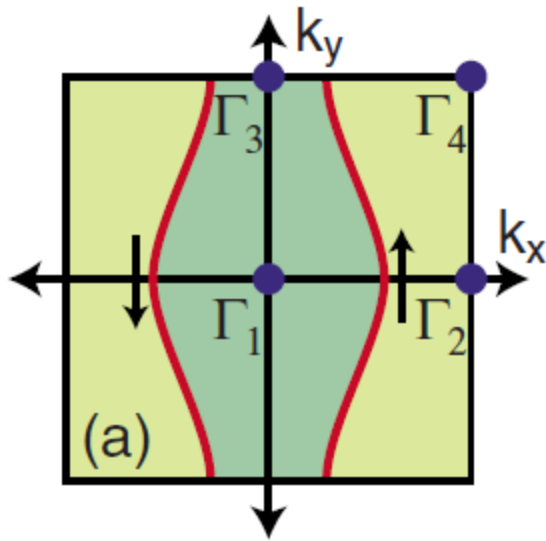


2D topologikus szigetelők-QSH



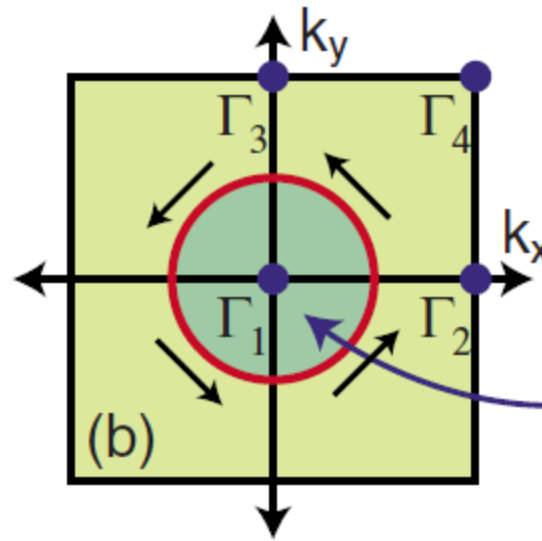
3D topologikus szigetelők

Gyenge

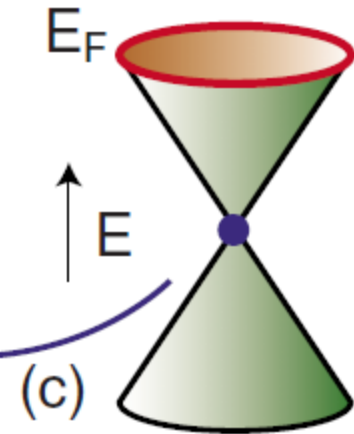


$$\nu = 0$$

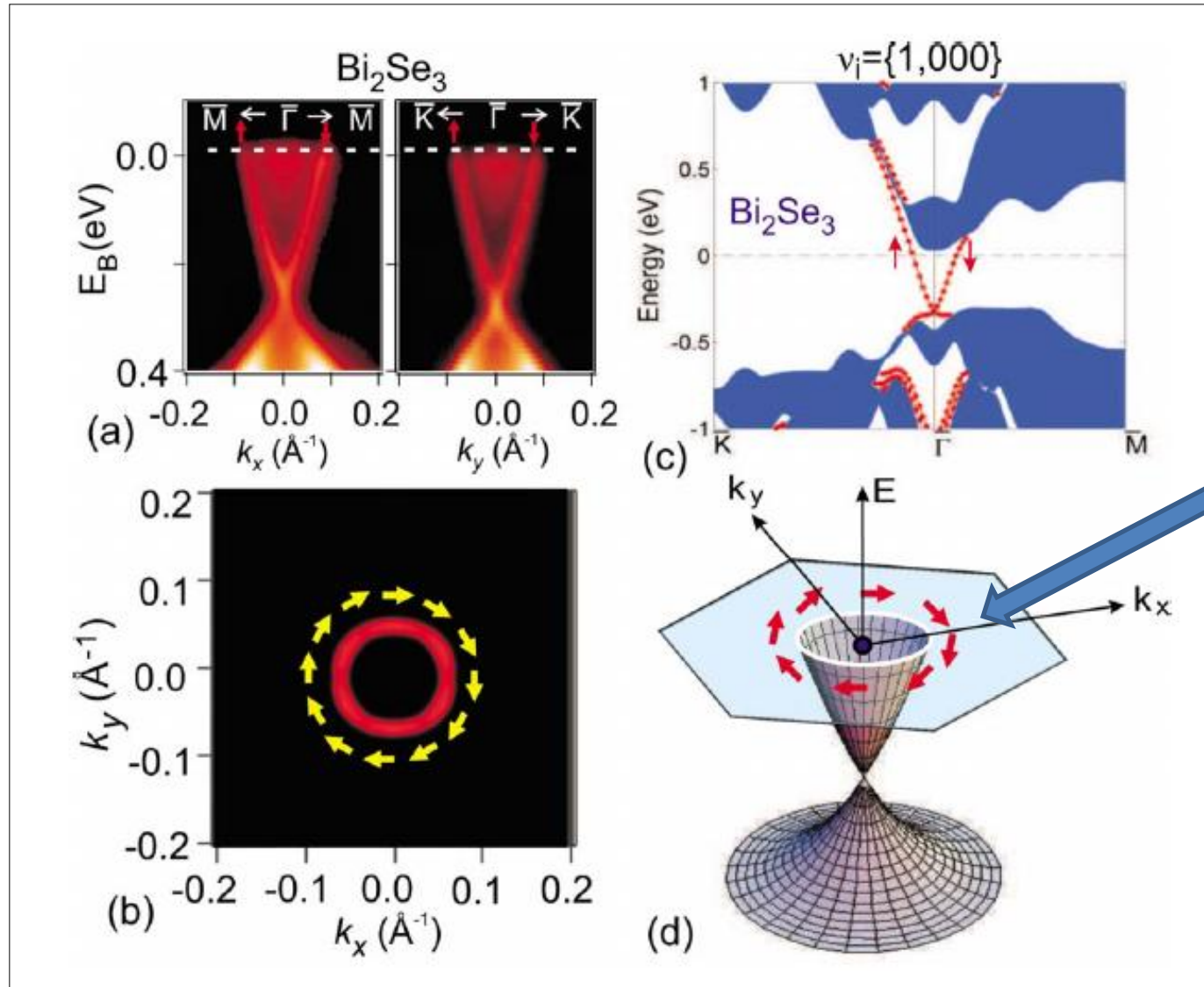
Erős



$$\nu = 1$$

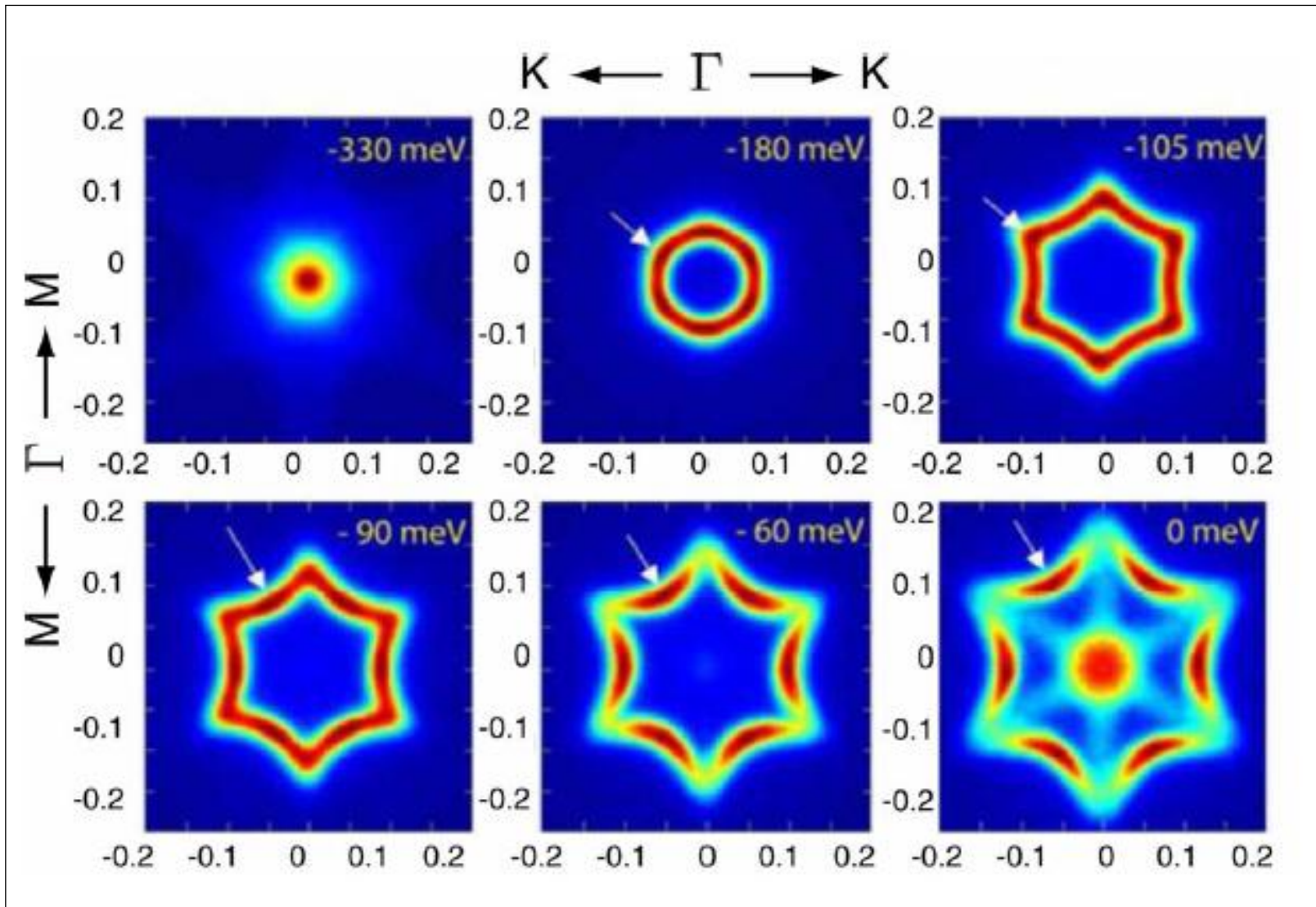


3D topologikus szigetelők - BiSe



helikális
spinstruktúra

3D topologikus szigetelők-BiTe



Modellek

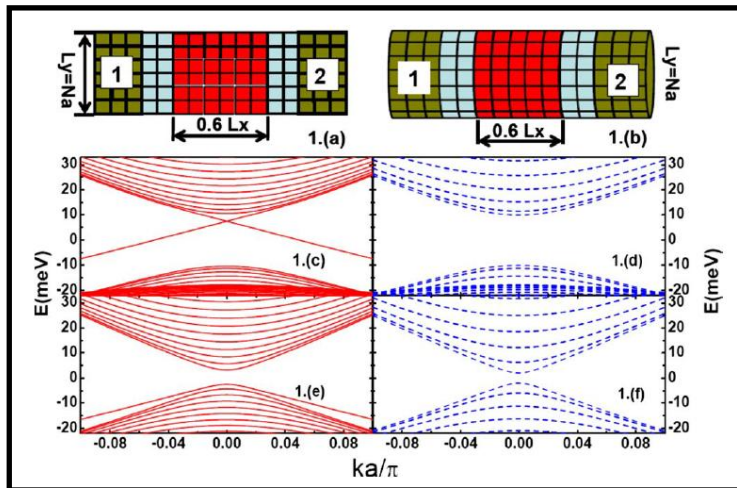
2D: HgTe/CdTe

$$H = \begin{pmatrix} h(\vec{k}) & 0 \\ 0 & h^*(-\vec{k}) \end{pmatrix} \psi = \begin{pmatrix} |s, \uparrow\rangle \\ p_x + ip_y, \uparrow\rangle \\ |s, \downarrow\rangle \\ p_x + ip_y, \downarrow\rangle \end{pmatrix}$$

$$h(\vec{k}) = \varepsilon(\vec{k})\sigma_0 + \vec{d} \cdot \vec{\sigma}$$

$$\varepsilon(\vec{k}) = C - Dk^2$$

$$\vec{d} = (Ak_x, Ak_y, B - Mk^2)$$

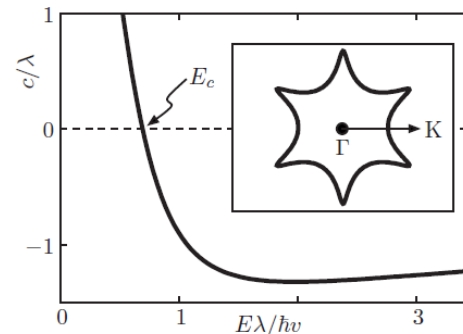


3D: BiTe, BiSe

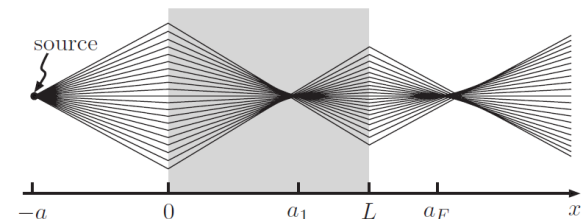
$$H(\vec{k}) = \varepsilon(\vec{k})\sigma_0 + \vec{d} \cdot \vec{\sigma}$$

$$\vec{d} = \begin{pmatrix} -k_y \\ k_x \\ \frac{\lambda}{2}(k_+^3 + k_-^3) \end{pmatrix} \left. \begin{array}{l} \text{helikális} \\ \text{spinstruktúra} \end{array} \right\} \text{ hatszöges torzulás}$$

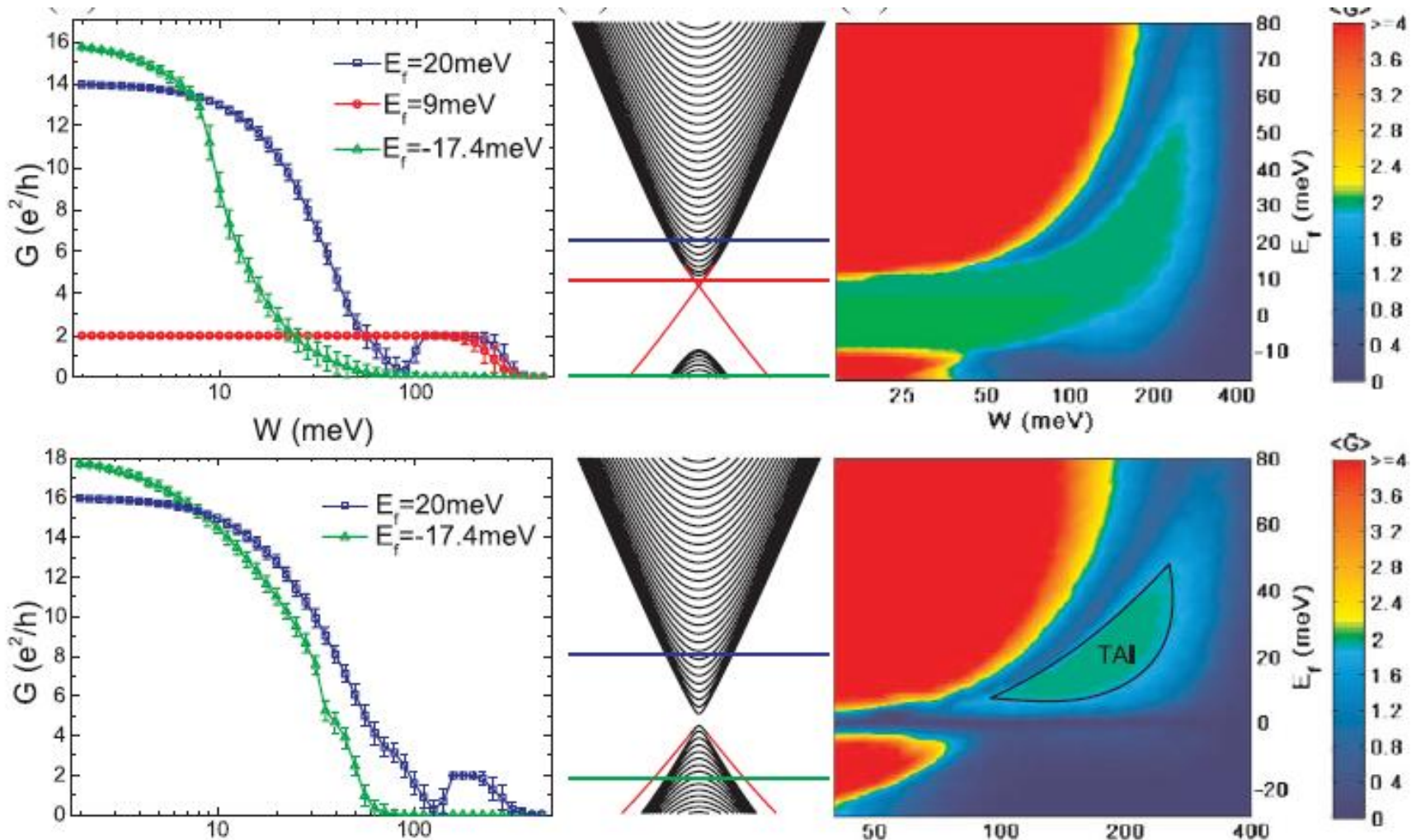
$$k_{\pm} = k_x \pm ik_y$$



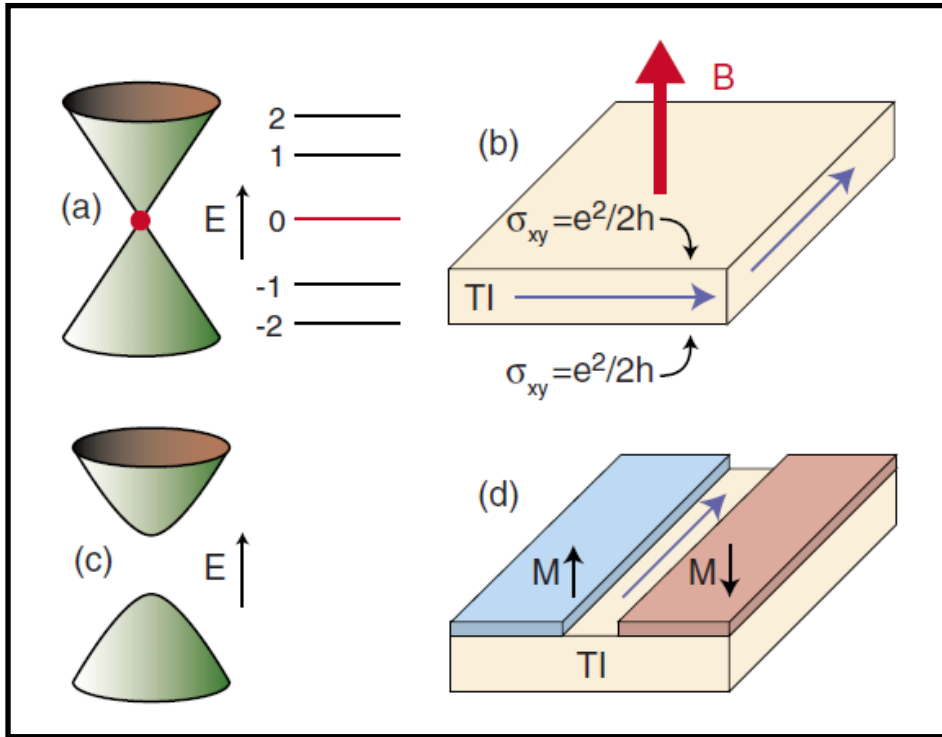
Phys. Rev. B **82**,
125423 (2010)



Topologikus Anderson szigetelő



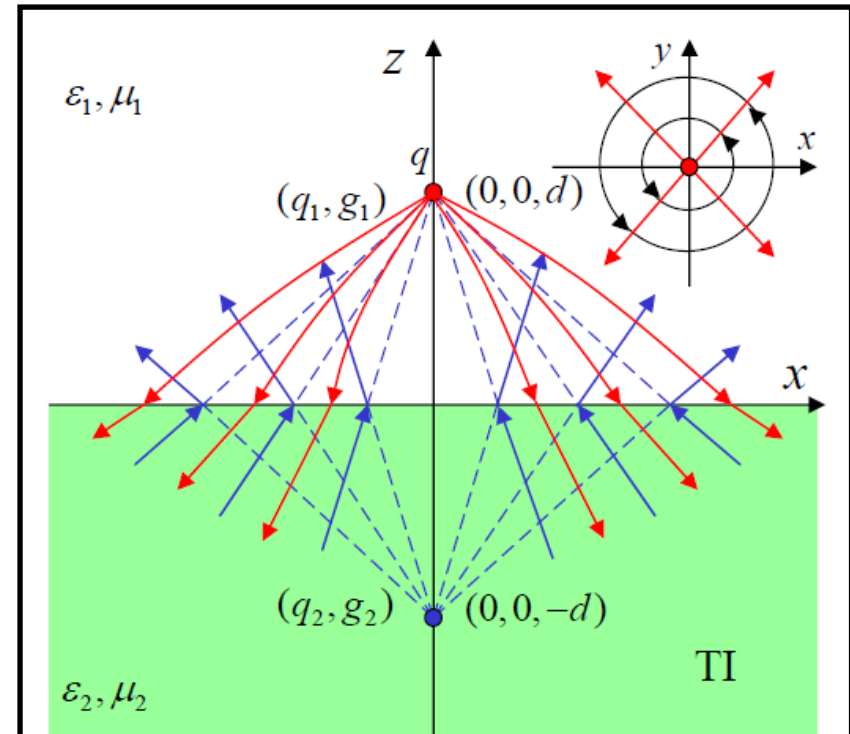
QHE és ME effektusok



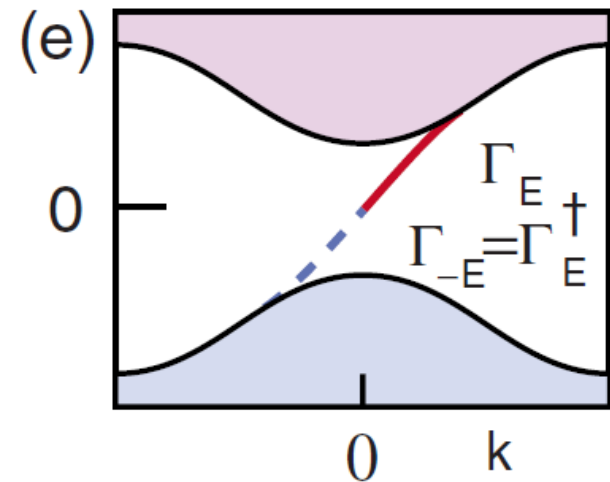
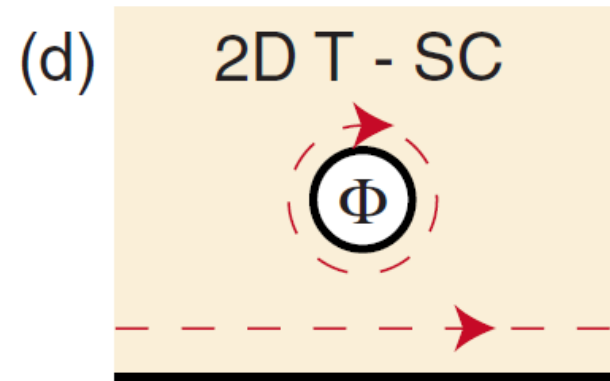
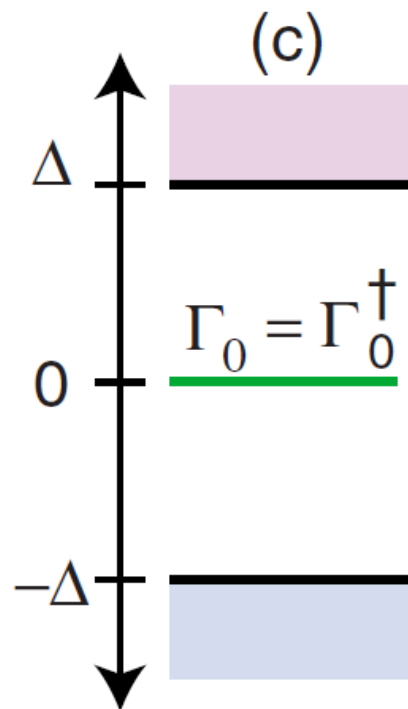
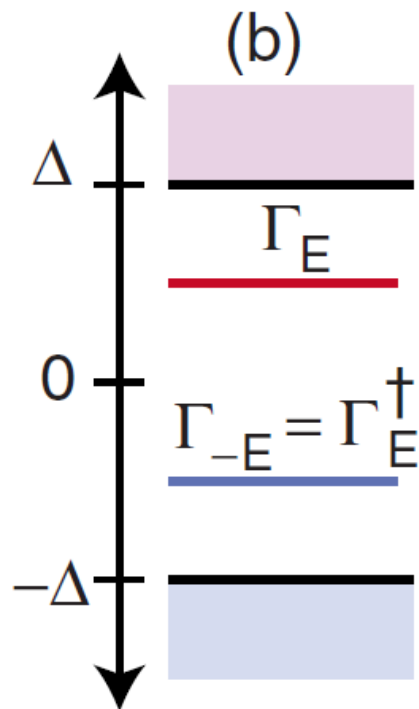
Maxwell-egyenletek:

$$\vec{D} = \vec{E} + 4\pi\vec{P} - 2\alpha\theta\vec{B}$$

$$\vec{H} = \vec{B} + 4\pi\vec{M} - 2\alpha\theta\vec{E}$$



Majorana fermionok-TSC



Majorana fermionok-TI+SC

