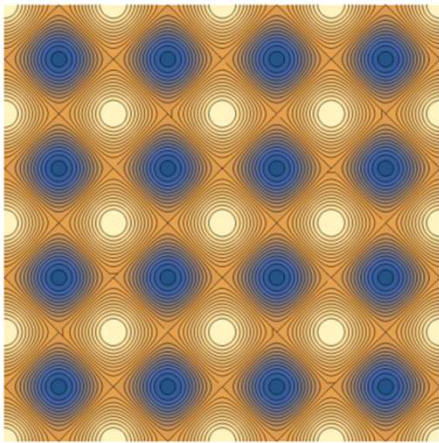


High-Symmetry Materials and Superconductivity

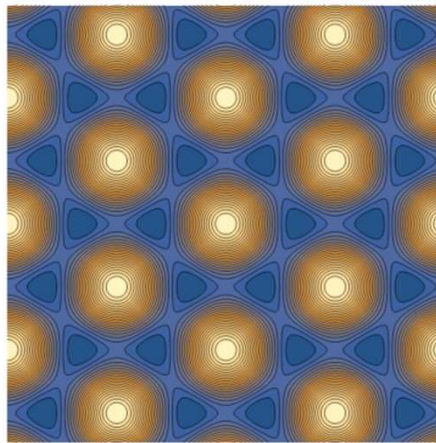
Mathew Pareles

Materials can be Symmetric under rotations

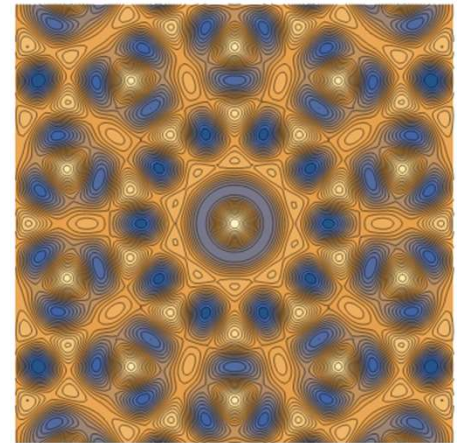
$n = 4$



$n = 6$

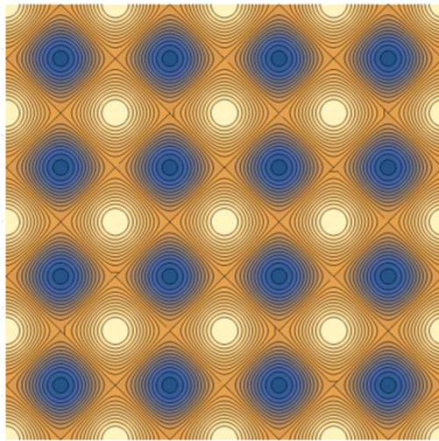


$n = 10$

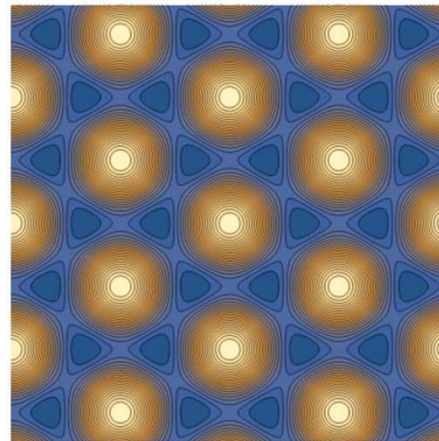


2, 3, and 4, and 6-fold rotationally
symmetric materials repeat in space

$n = 4$

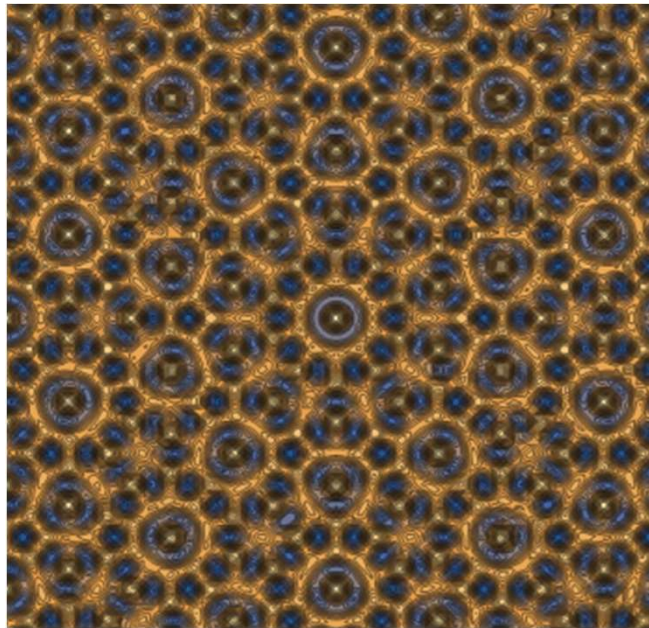


$n = 6$

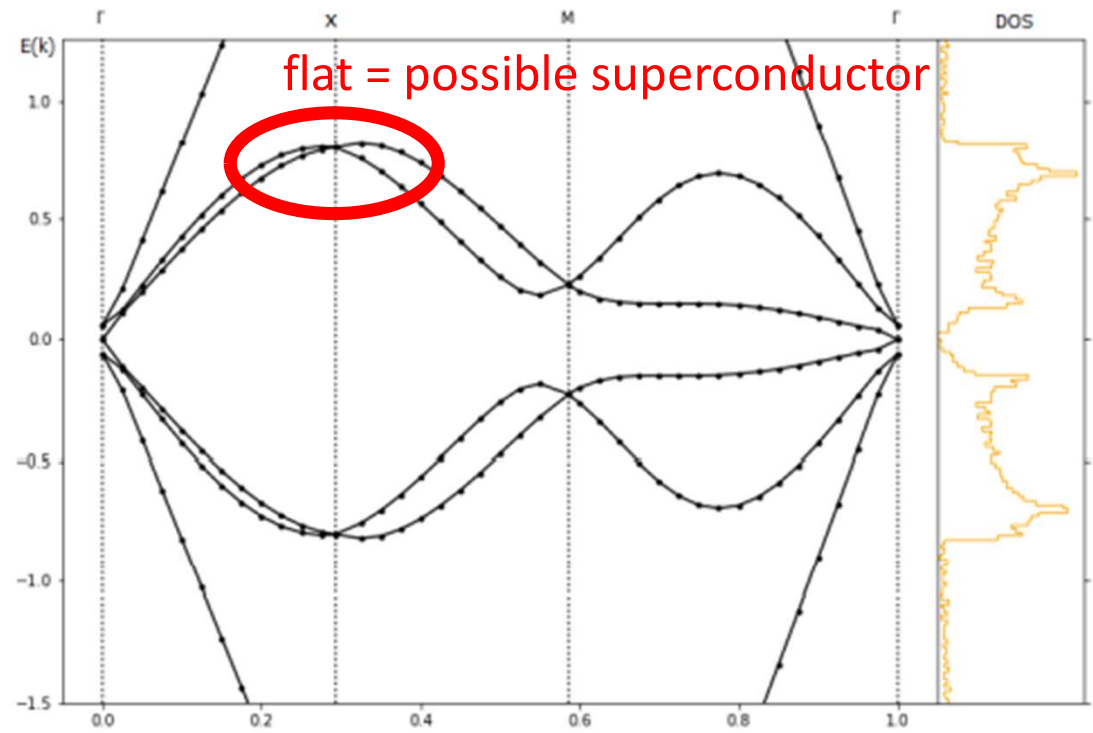
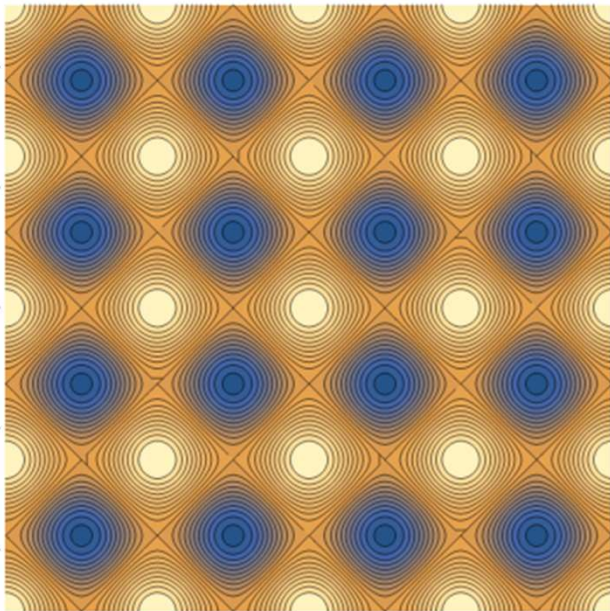


Other symmetries do not repeat in space

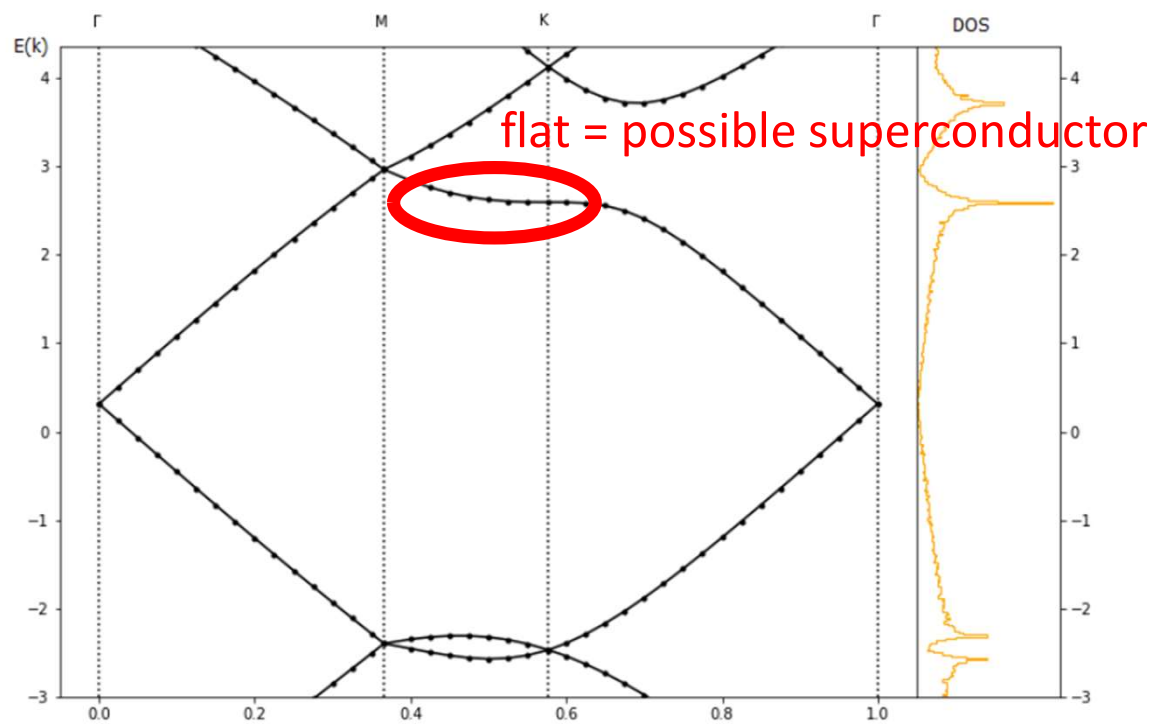
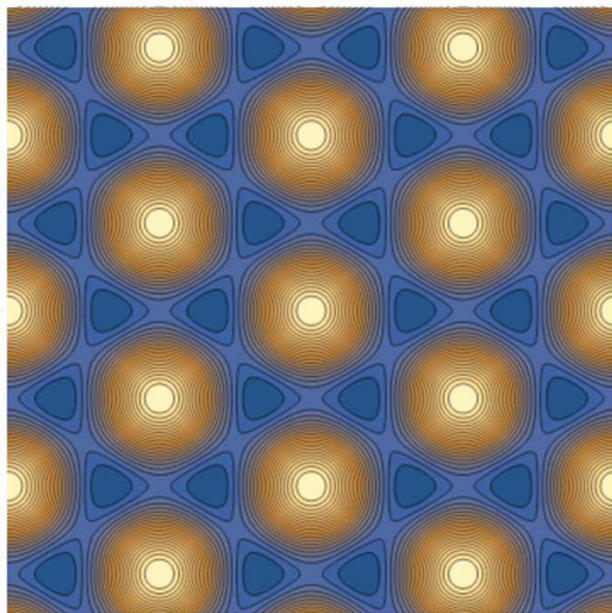
$n = 10$



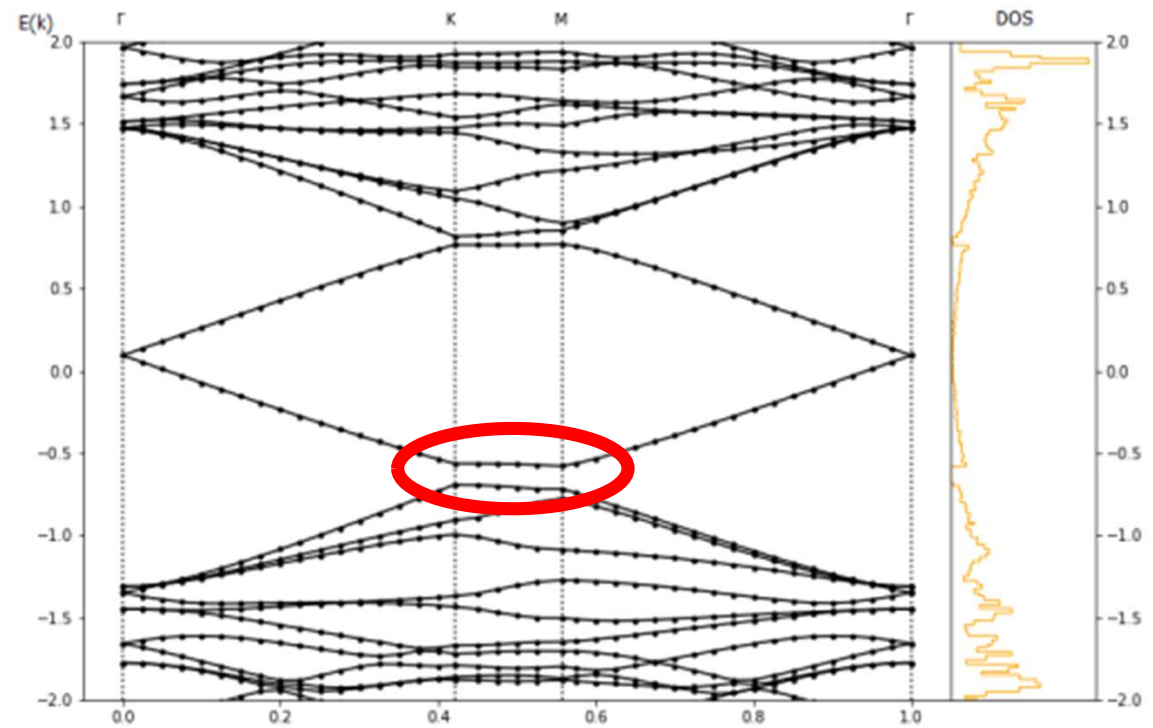
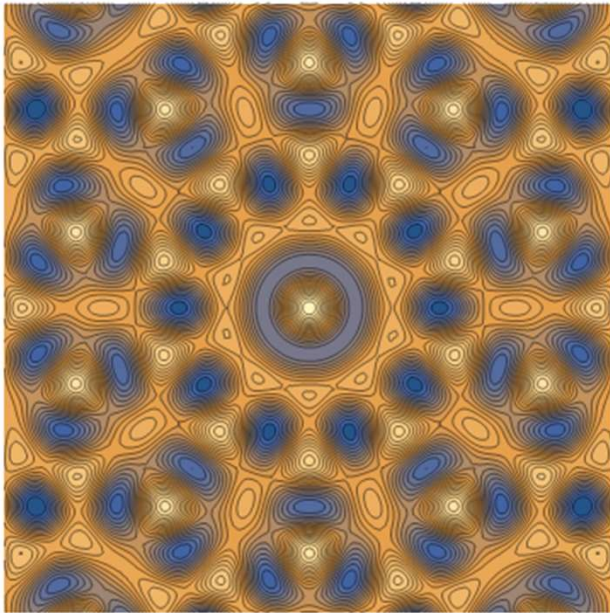
$$n = 4$$



$n = 6$

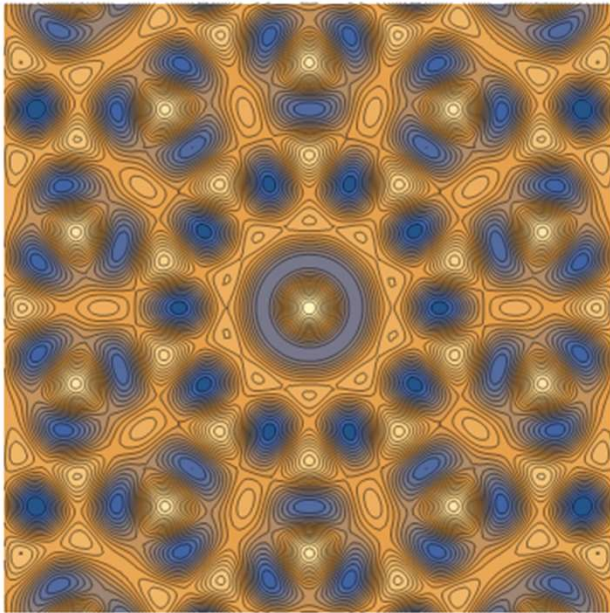


$n = 10$

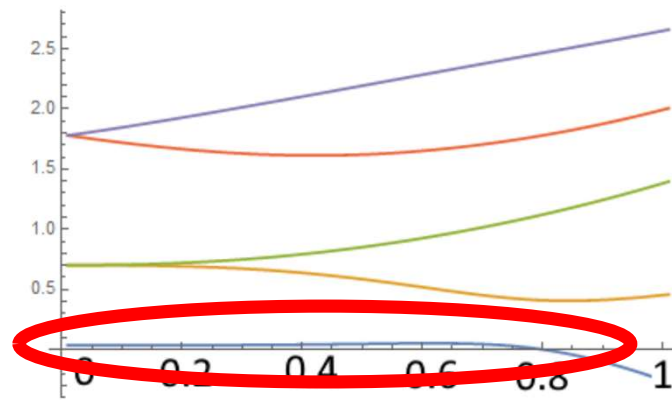


flat, but this computation is invalid, since there's a gap (not allowed by TR symmetry)

$n = 10$



Do the analysis with perturbation instead (very involved calculation):

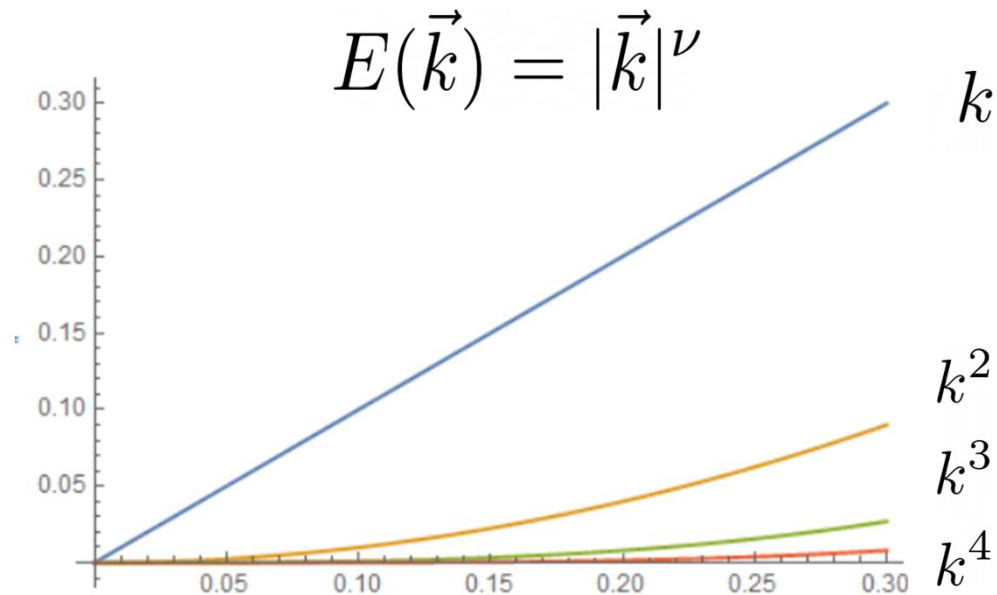


flat = possible superconductor

We found that High-Symmetry
Materials can easily be made flat.

I.e. they might be superconductors.

Define flatness using different powers of k



density of states in 2D $\sim E^{(2/\nu)-1}$

$\nu = 2$ Van Hove singularity

$\nu > 2$ High order Van Hove singularity

Bands in arbitrary materials have this form:

$$E(\vec{k}) = \Omega_x k_x + \Omega_y k_y + \alpha_{xx} k_x^2 + \alpha_{yy} k_y^2 + \alpha_{xy} k_x k_y + \dots$$

Bands in N-Fold Rotationally Symmetric Materials have this form instead:

$$E_N(\vec{k}) = \alpha k^2 + \beta k^4 + \gamma k^6 + \dots + \kappa k_x^N + \lambda k_x^{N-1} k_y + \dots$$

N-Fold Rotationally Symmetric Materials have fewer terms, so you can more easily tune their parameters to make flat bands:

$$\alpha \rightarrow 0$$

$$\beta \rightarrow 0$$

...