Crash Course on
Topological Phases of Quantum Matter

Gauss-Bonnet theorem (applied to compact surfaces without boundary):
\[ \frac{1}{4\pi} \int \kappa dA = \frac{\Omega}{4\pi} = (1 - g) \]

Differential geometry of wavefunctions:
\[ \Psi_n(r) = e^{ik \cdot r} u_{nk}(r) \]

Topological phases of matter:
Brillouin zone plays the role of the "surface"

"Berry connection" defines "Berry curvature" which replaces Gaussian curvature

Bulk-boundary correspondence: Identify Chern number \( N_{\text{Chern}} \) with the number of conducting edge states