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Wannier localizability as a tool to distinguish topological phases of matter

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The talk concerns the correspondence between the topological triviality of gapped quantum systems and the existence of an orthonormal basis of well-localized Wannier functions spanning the range of the Fermi projection.
For periodic systems in dimension 2 and 3 such a correspondence has been noticed and proved, and dubbed Localization Dichotomy. Under general assumptions, it has been proved that:
(i) either there exists a composite Wannier basis which is exponentially localized, and, correspondingly, the Chern class of the Fermi projection is zero; or
(ii) any possible choice of a composite Wannier basis yields an infinite expectation value of the squared position operator (in numerical simulations, such a value diverges when the spacing of the grid in quasi-momentum space tends to zero).
I will report on recent attempts to generalize such a Localization Dichotomy to non-periodic gapped quantum systems. These methods offer a way to describe topological non-triviality directly in position space, without using the decomposition with respect to quasi-momentum.
The results are based on joint works with G. Marcelli, M. Moscolari, and V. Rossi.

Orateur: PANATI, Gianluca (Università di Roma "La Sapienza")