

SEMINAR: Moire phonons, phasons, and a twisted response to light

HECTOR OCHOA

January 16, 2026

12:00 to 13:00

Seminar Room

The collective vibrations of moire superlattices or $i\frac{1}{2}$ moire phonons $i\frac{1}{2}$ arise from the relative motion of twisted van der Waals layers. Among these modes, there are always two acoustic branches associated with a free-energy invariance of the system against relative shifts of the layers; the phasons. The dynamics of these modes is very different compared to conventional acoustic phonons in crystalline solids, though. In combination with the inhomogeneous distribution of charge within the moire supercell, this dynamics gives rise to otherwise unexpected responses to electromagnetic fields. I will give three examples. First, in polar multilayers, like twisted transition-metal dichalcogenides, moire phonons can be tuned by the application of electric fields, which couples to the vertical polarization tied to the local stacking order. For small twist angles, increasing the electric field leads to a universal moire phonon spectrum characterized by a substantially softened longitudinal phason and several flat optical bands. Second, in non-polar multilayers, like twisted bilayer graphene, moire phonons couple to electromagnetic fields by borrowing optical spectral weight from the electron-hole continuum via interband matrix elements of the electron-phonon coupling. In particular, phasons become infrared active by carrying a dipole moment proportional to the amount of free charge added to the system, a response that admits a geometrical interpretation in terms of a sliding Chern number. Finally, I will describe how electron scattering off phason modes may explain the linear-in-T resistivity of twisted bilayer graphene and, in particular, its survival down to temperatures much lower than the Debye or Bloch-Grüneisen scales. I will show new numerical and experimental evidence in support of this idea.

Hosted by: Prof. Dr. Carmen Rubio-Verdu