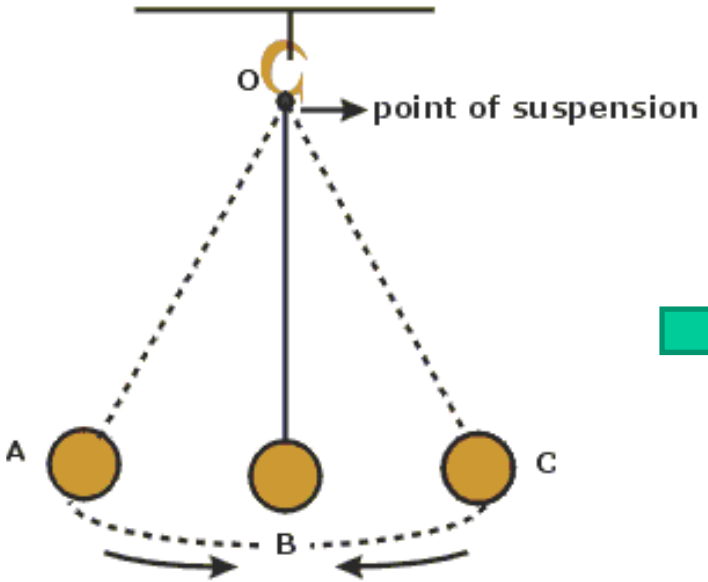
PH427

are ***periodic*** oscillations ubiquitous
or merely just a paradigm?

Paradigm: Periodic Systems

Instructor: Matt Graham



Winter 2016

smaller goal: full mathematical description of physically & electronically coupled systems

BIG GOAL: *show how symmetry, oscillations and quantum mechanics really describe "everyday stuff"*
i.e. quantum mechanics you can get paid to do!!

35% → problem sets (3)

15% → pick a “solid state physics” journal article, give a 10 min. talk

50% → final exam (M of exam week)

~Feb 2016 ~				
Mon	**Tue**	**Wed**	**Thu**	**Fri**
22 Coupled Oscillators	23 Coupled Oscillators	24 -**PS1 (0,1,2) due** Dispersion for 1D mass/spring system	25 Dispersion for 1D mass/spring system	26 Lattices at finite temperature **-PS1(3,4)due**
29 Phonon Dispersion & heat capacity **-Journal proposals due**	1 Lattices (diatomic materials, final topics)	2 **-PS2 (1,2) due** Double potential well	3 Linear combination of atomic orbitals (LCAO)	4 **-PS2 due** Electronic band structure
7 **Journal Presentations**	8 **Journal Presentations** - LCAO model	9 **-PS3 (1,2) due** Tight-Binding Model	10 Electronic Band Structure	11 Review, session I **-PS3 due**

Roadmap

DAYS 1- 7:

•Coupled pendulum, railroad cars, atoms, etc.

•From atoms to crystals → extend coupling to infinity and define a dispersion relation for an atomic system

DAYS 7- 15:

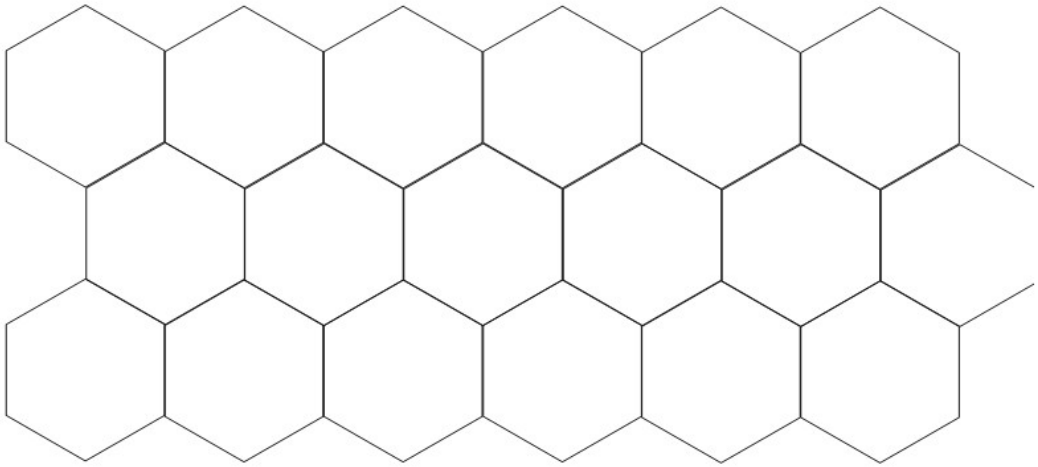
•Quantum wavestates in periodic systems

• 5 minute journal presentations

Translational Symmetry and Noether's Theorem

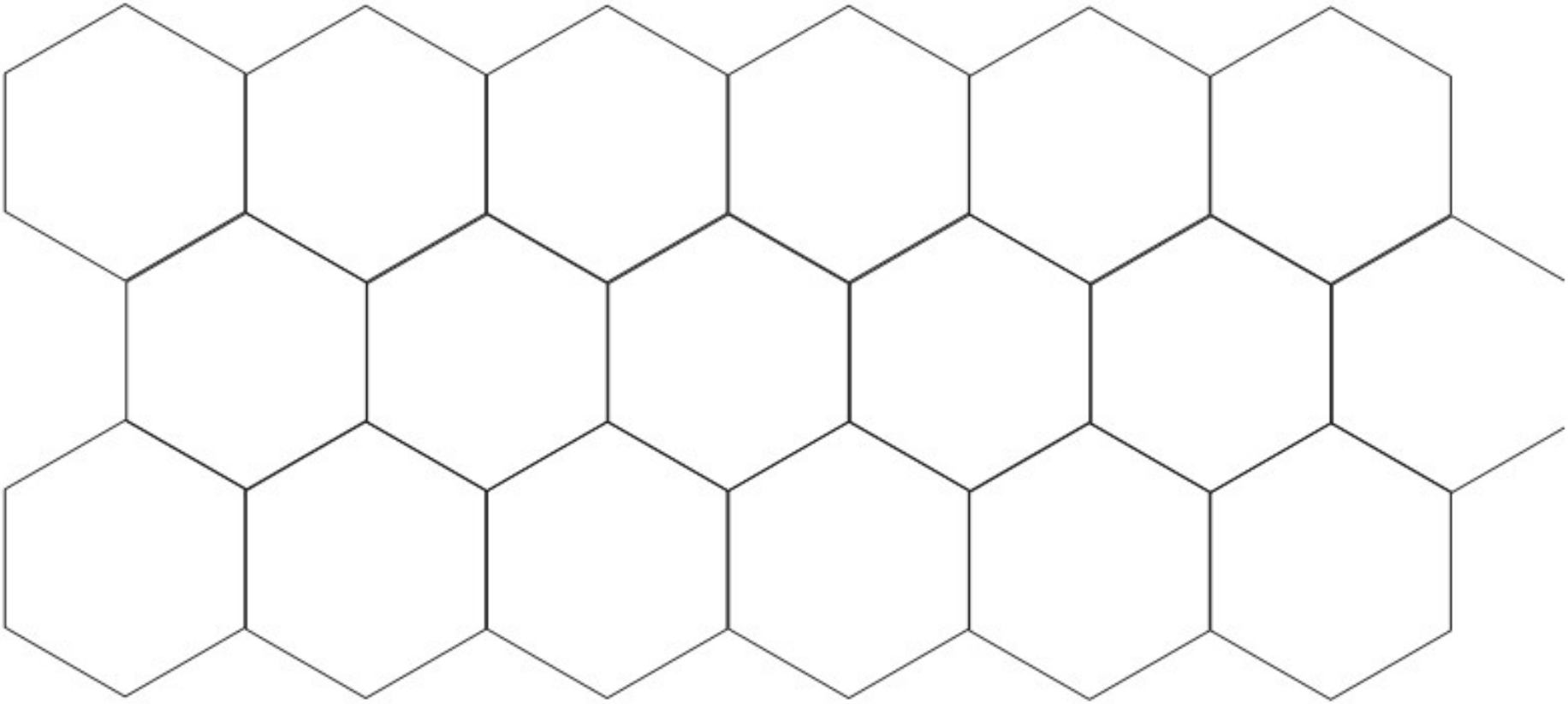
Any system with translational symmetry has an associated momentum conservation law.

→ An electron moving through a perfectly periodic crystal maintains its momentum like the electron was travelling though a vaccuum



Graphene

Draw the “Unit Cell”



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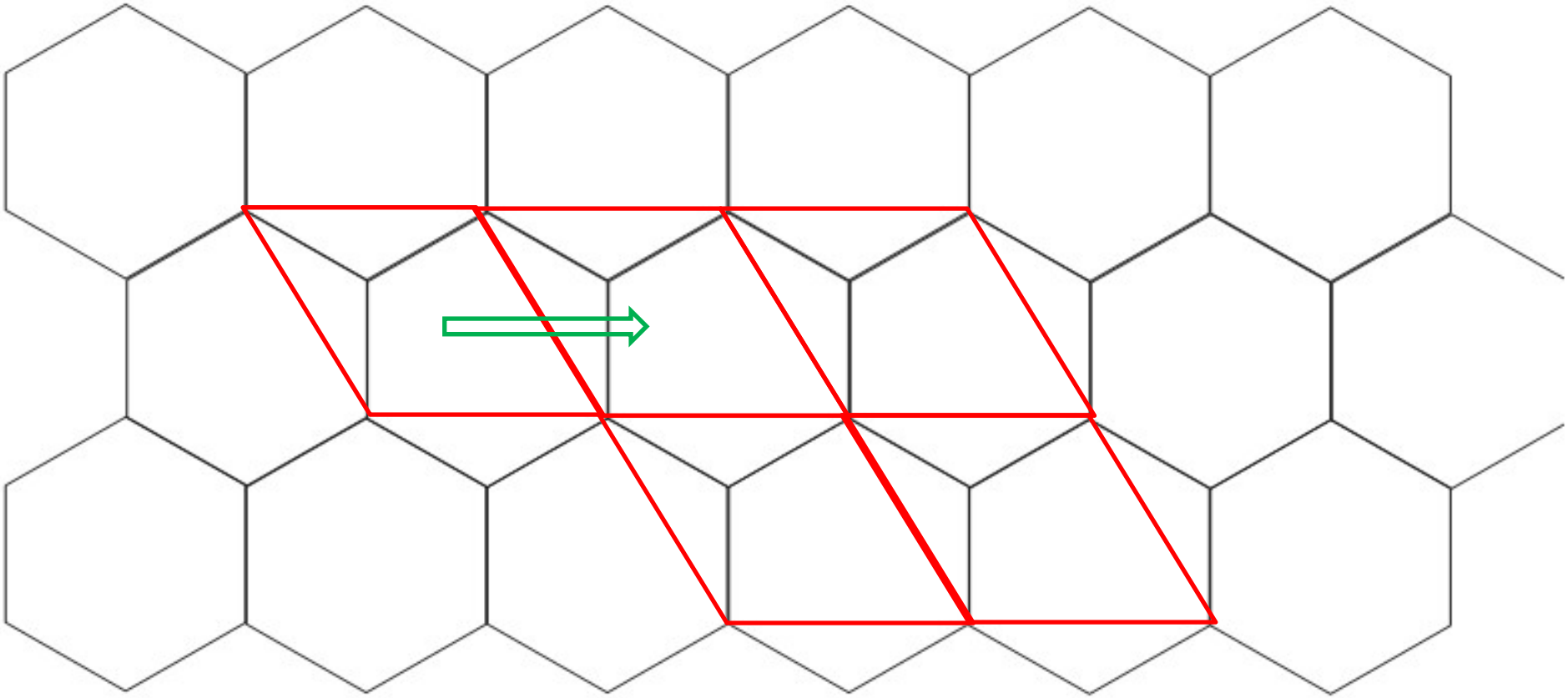

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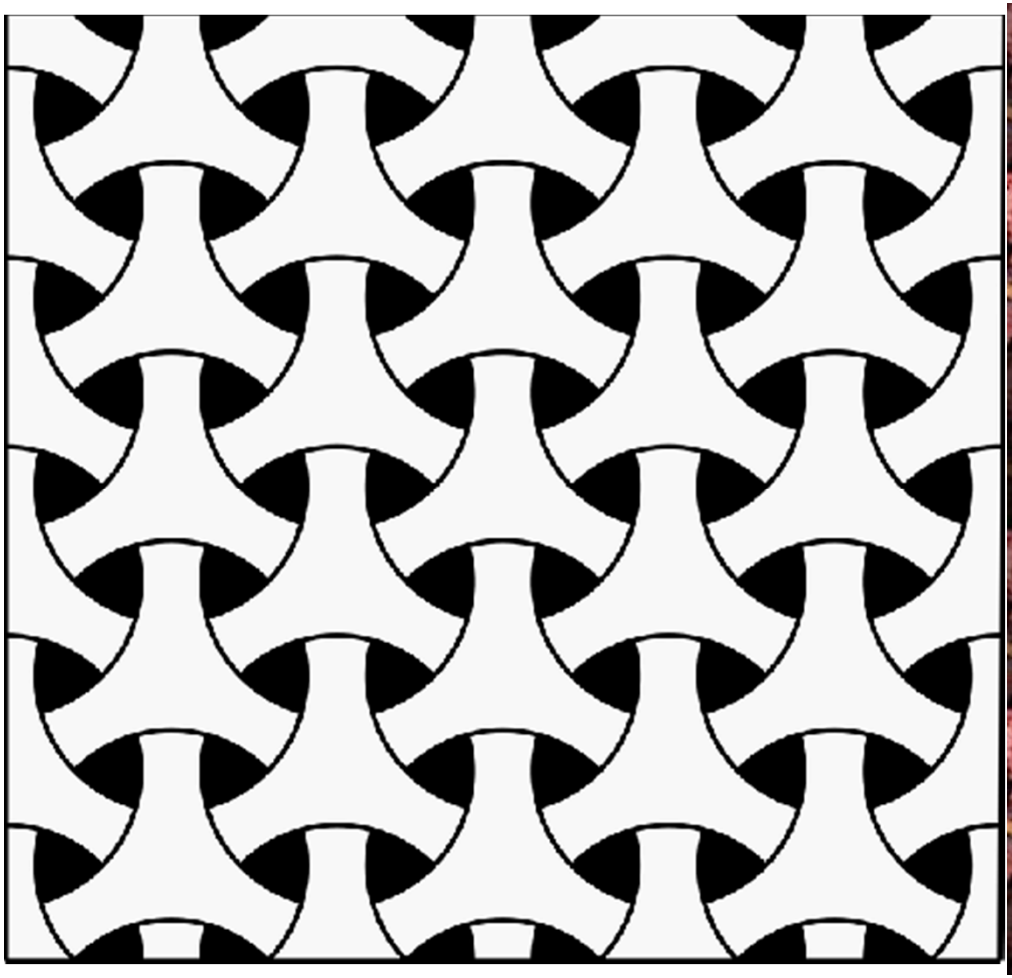
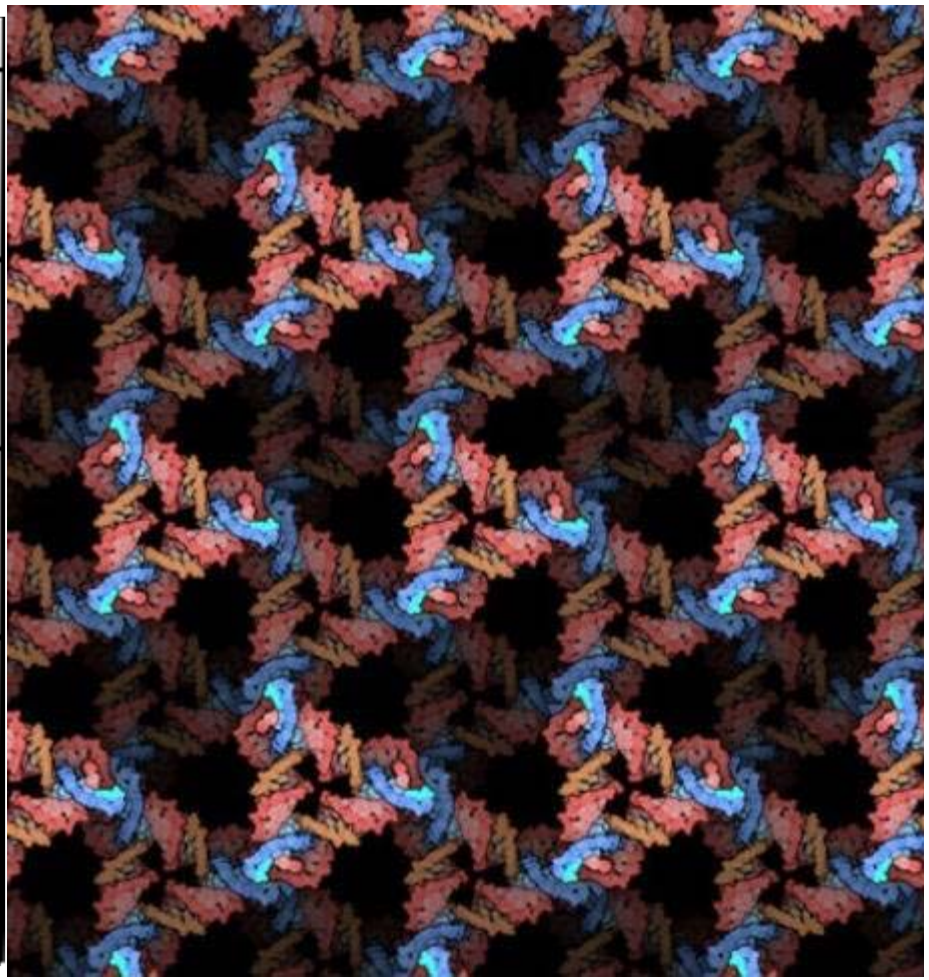
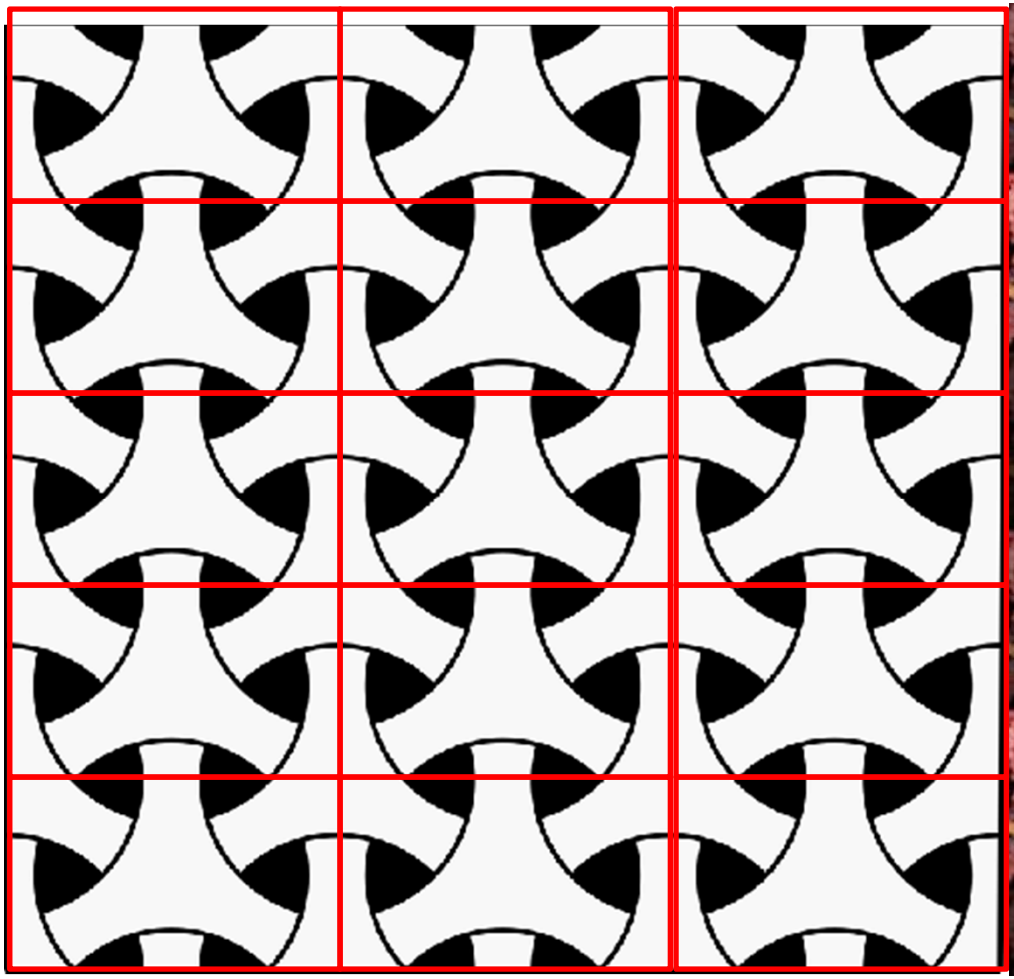


Celtic knot

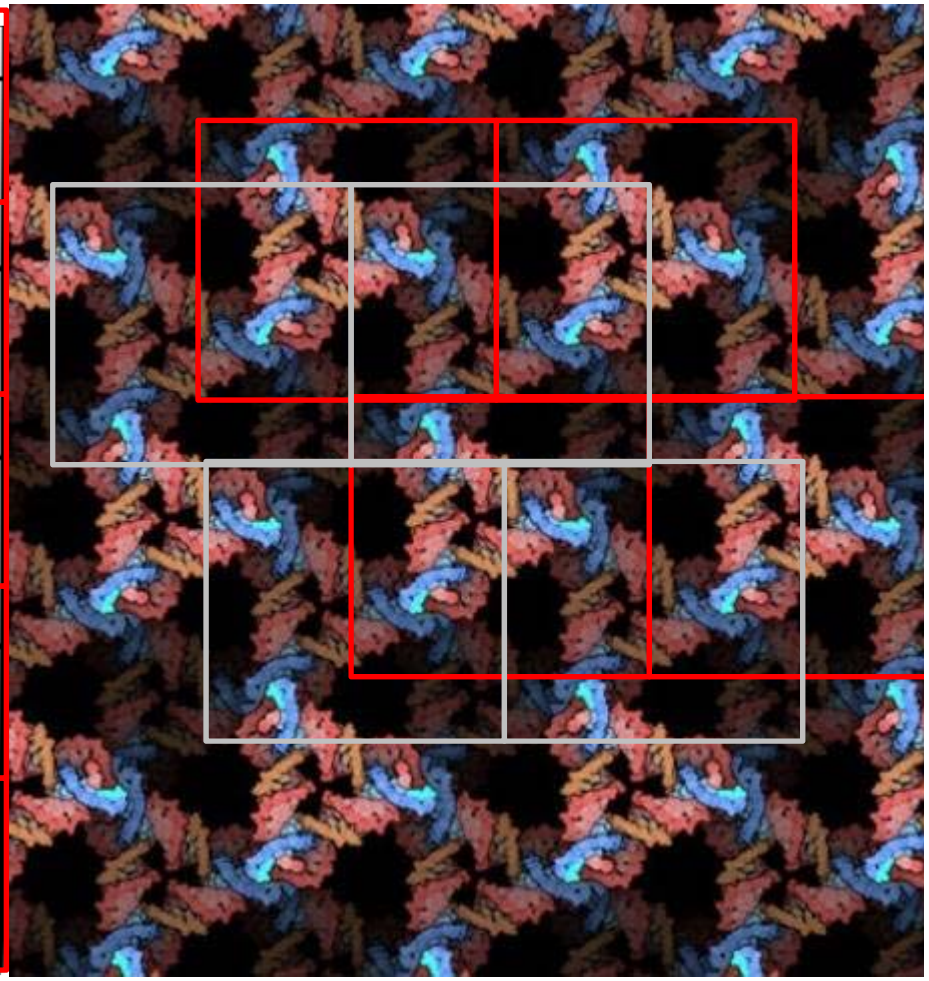


Protein/DNA

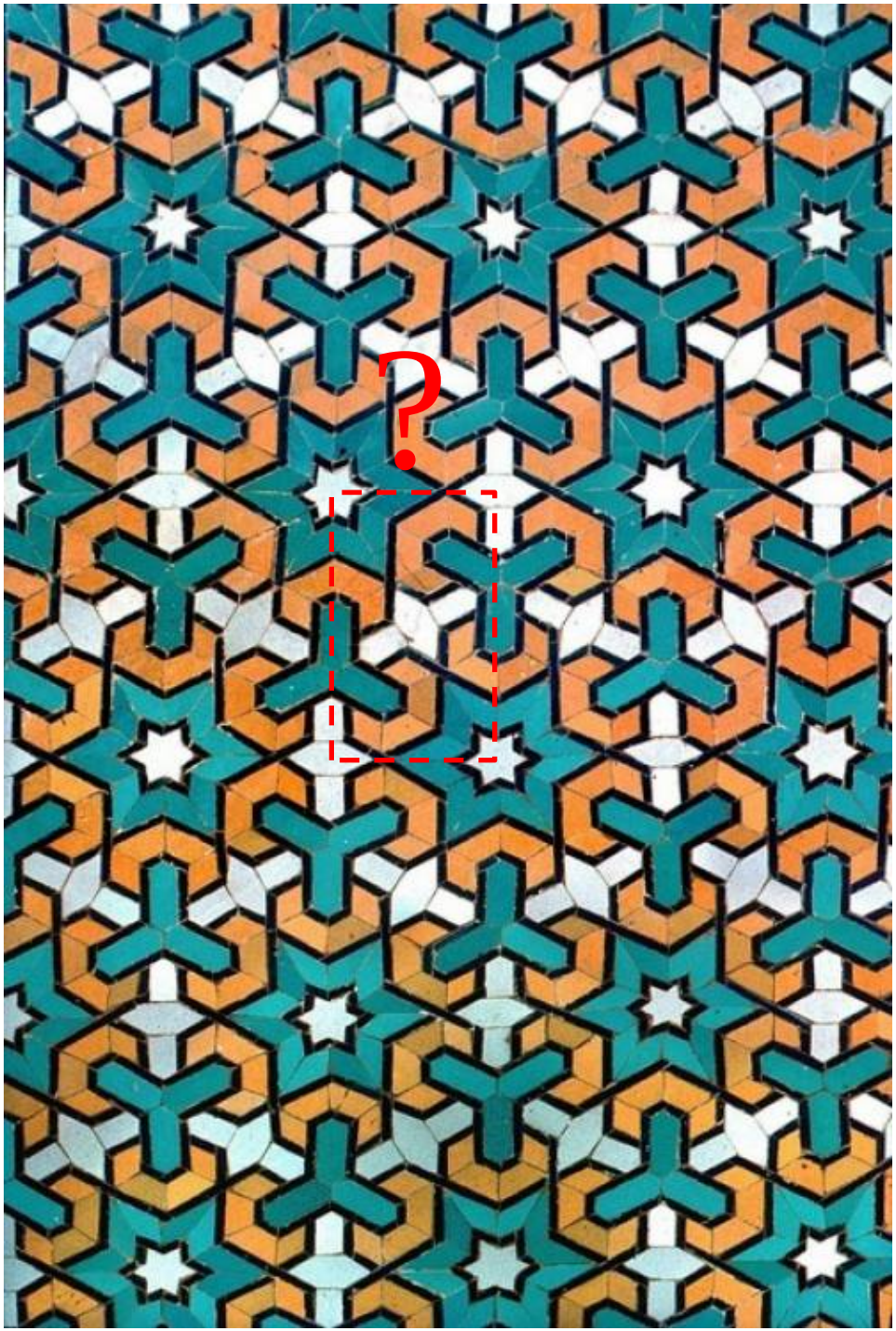
Draw the “Unit Cell”

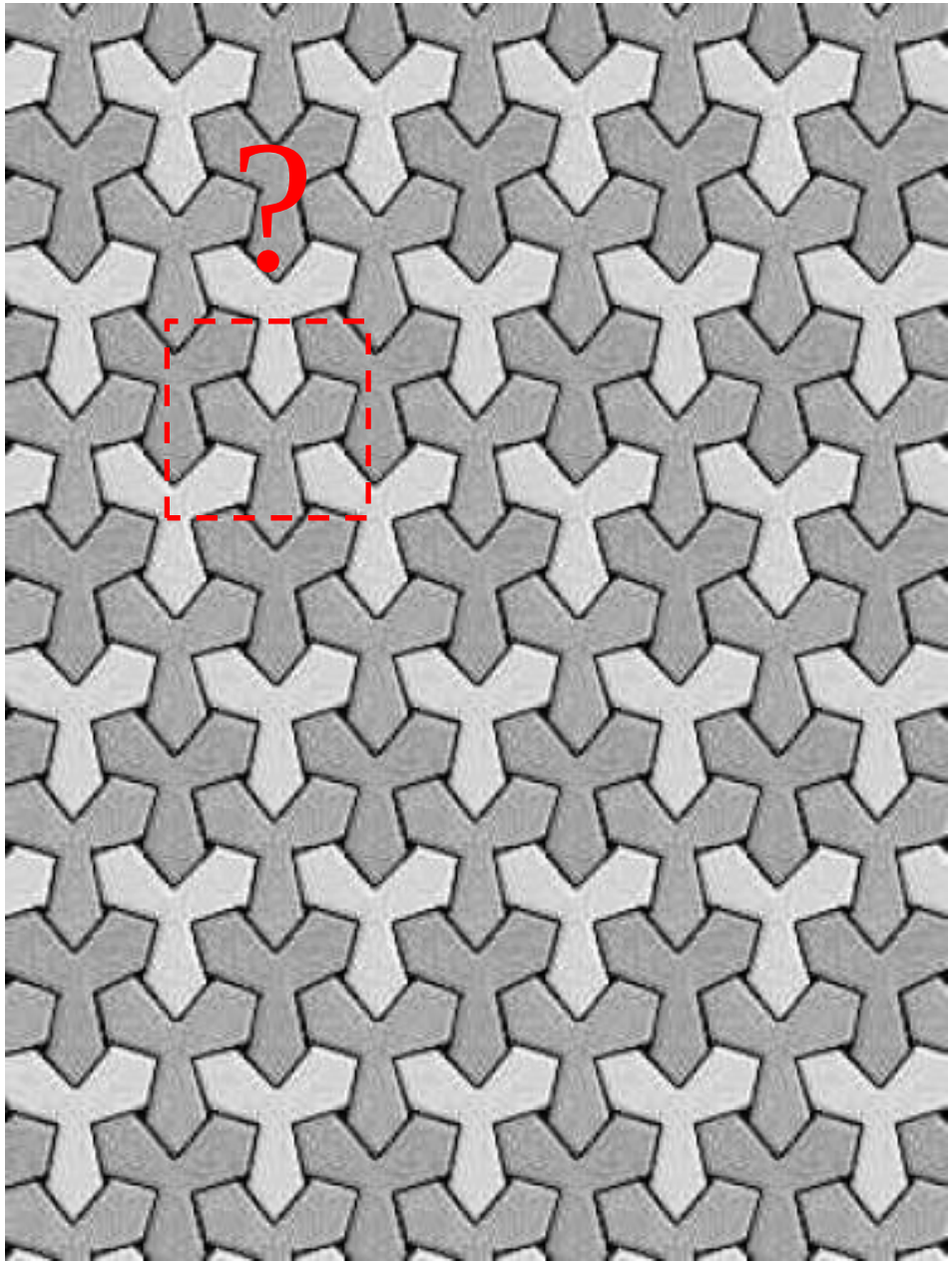


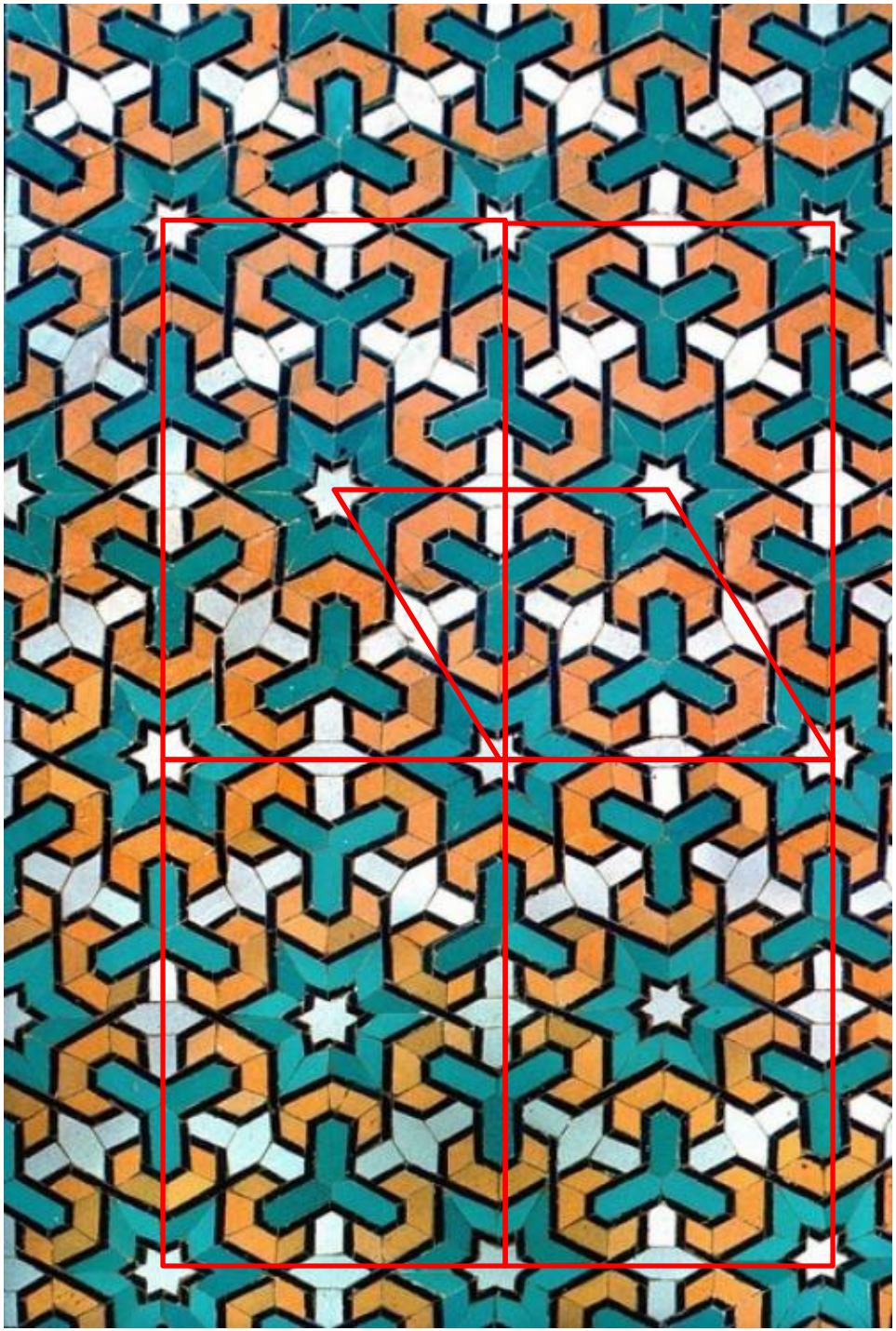
Celtic knot

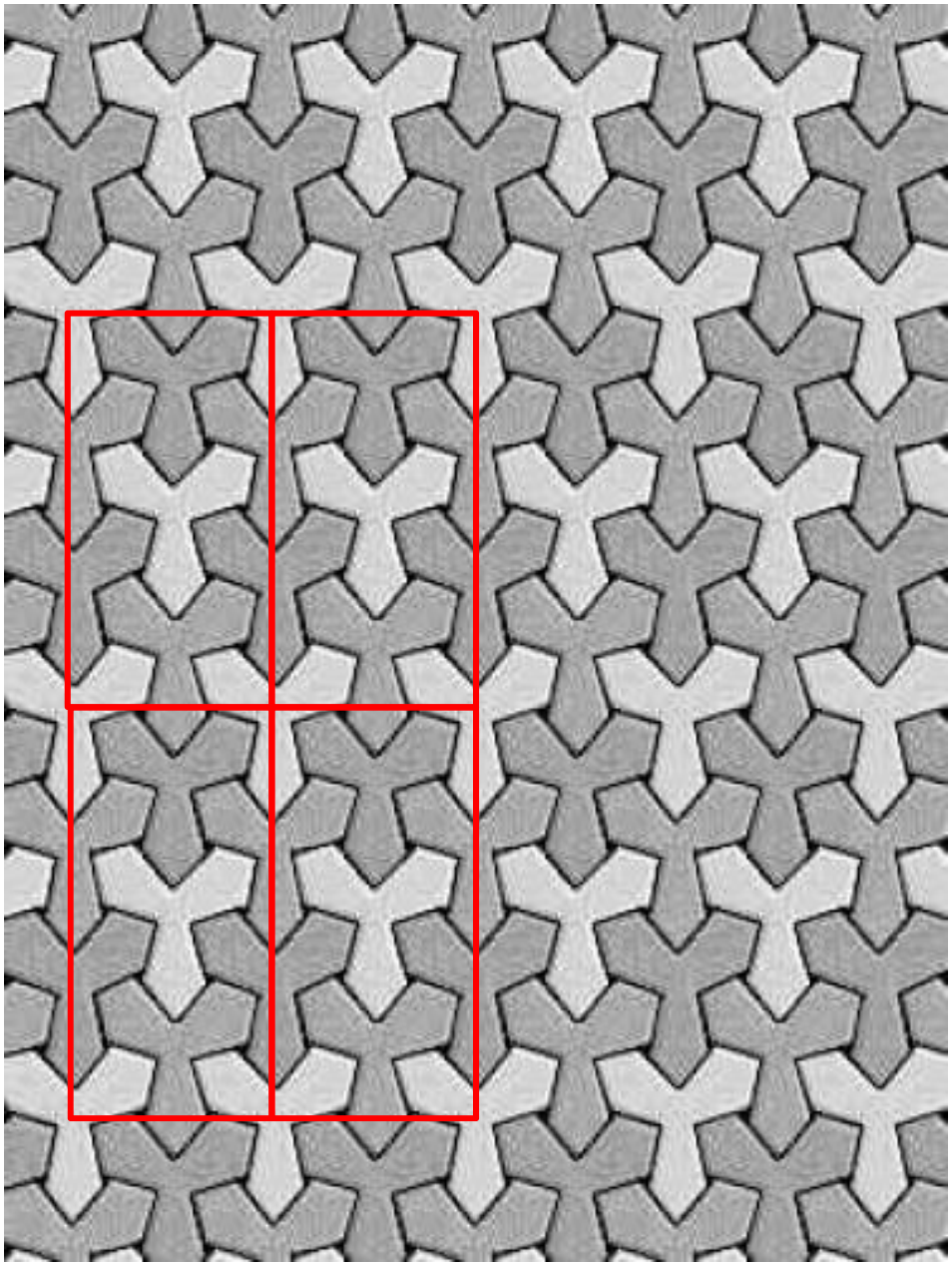


Protein/DNA

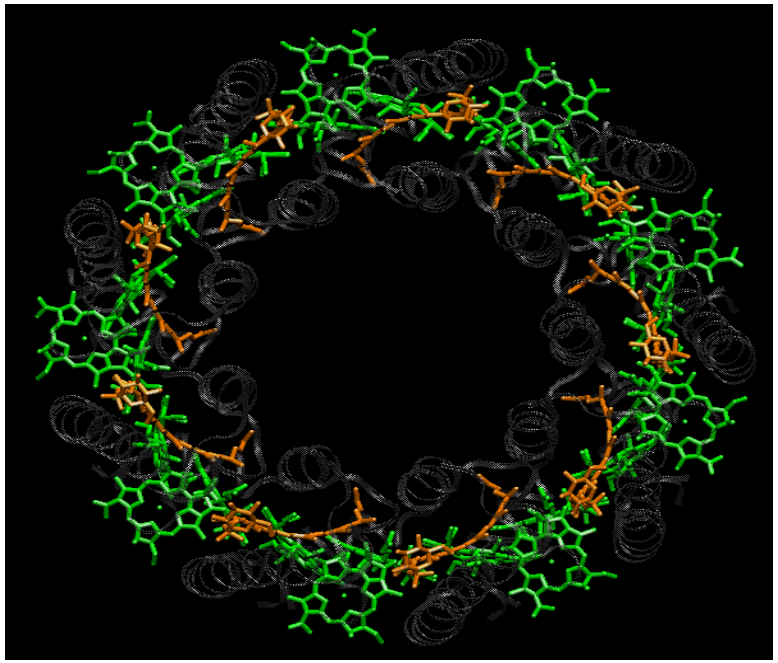


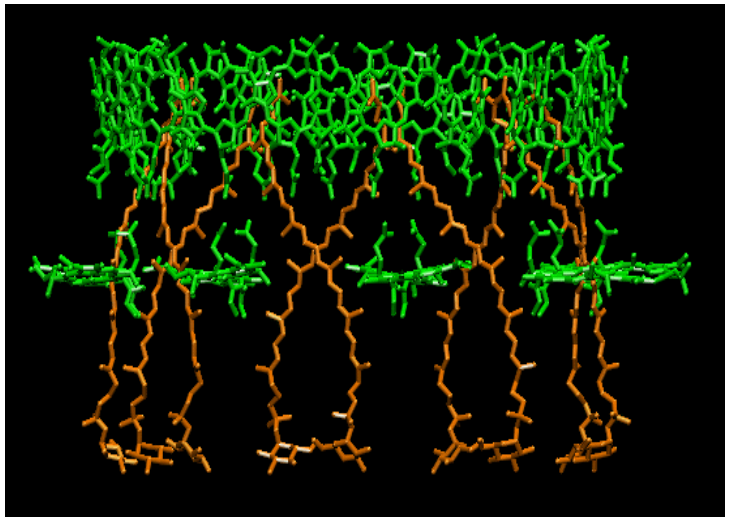




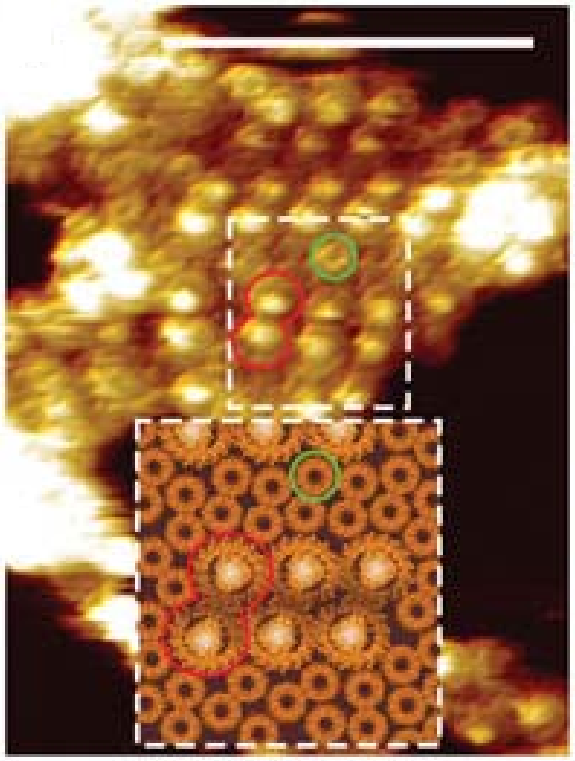


PERIODIC SYSTEM IN BIOLOGY:
Light Harvesting Complex II

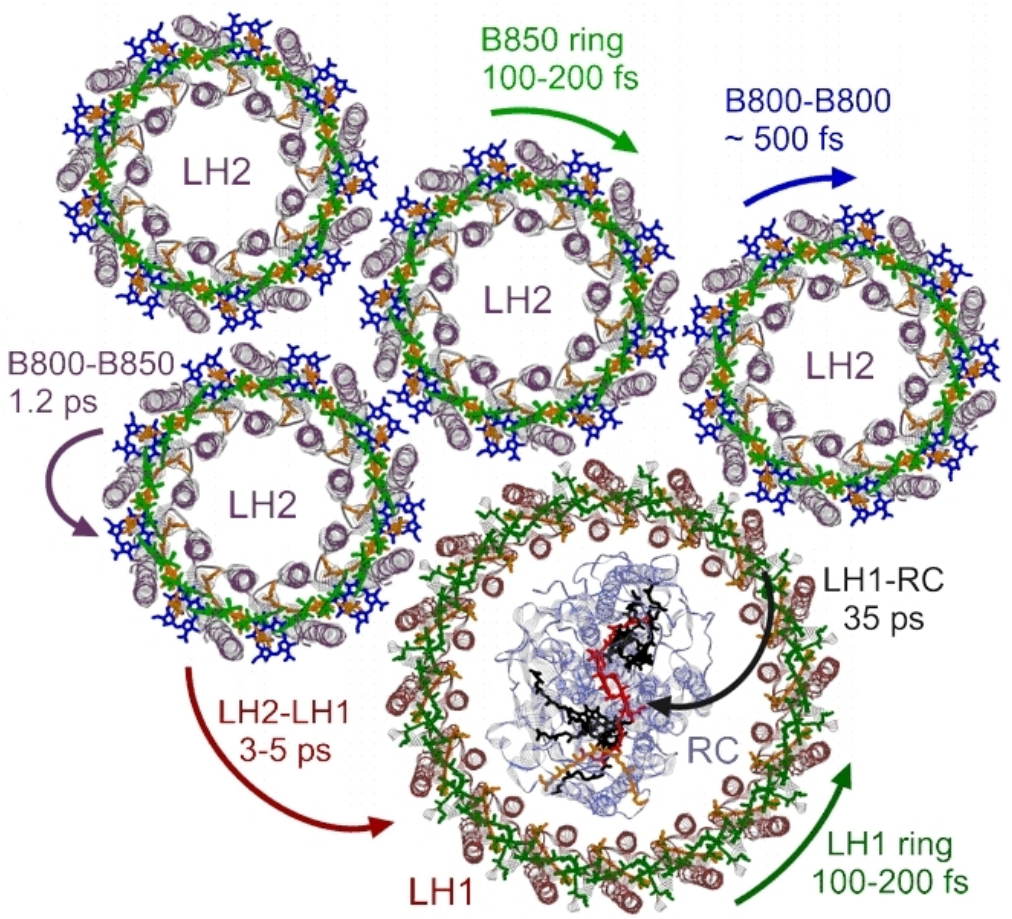




Bacterial Light Harvesting



Bahatyrova, et al.
Nature (2004) **430** 1058



Hu, et al.
J. Phys. Chem. B (1997) **101** 3854