

Phys 507B - Solid State Physics II

Assignment 1: Introduction to group theory. *Due Feb. 8th*

1. *Symmetries of a rectangle.*

- (a) List the symmetries of a general rectangle. Work out the multiplication table, and divide the elements into classes.
- (b) Which group does it correspond to in the Schönflies notation? Write down its character table and basis functions; you don't need to derive it yourself, you can just find it in the literature (e.g., Appendix B of Tinkham's *Group theory and quantum mechanics* book).

2. *Irreps. of D_4 .*

- (a) Find the unitary matrices for all the irreducible representations of D_4 . *Hint: Consider the transformation properties of the coordinates x and y in the plane of the square.*
- (b) How could you now obtain the matrices for all irreducible representations of D_{4h} ? *Hint: $D_{4h} = D_4 \times i$, where i is the group containing only the inversion and the identity.*

3. *Cubic molecule.*

- (a) Find the basis state of the Γ_2^- irreducible representation for the cubic molecule shown in Fig. 6.5 of Snoke's book (Find this state as a linear superposition of the atomic states).
- (b) Construct an explicit representation for the Γ_5^+ irrep., and use this to find one of the basis states in terms of the original atomic states.