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Exercises for Computational Methods in Solid State Theory  
SS 2012

**Exercise Set 9**

(Due date: Monday, July 2, 2012)

**Exercise 9 (Lanczos method for exact diagonalization)** (10 points)

Consider once more the single-band Hubbard model on a triangular lattice as given in Exercise 8. We focus again on six sites with  $\frac{1}{3}$ ,  $\frac{2}{3}$  and half-filling for  $t = t' = 1.0$  and  $U/t = 6.0$ .

- Calculate the tridiagonal matrix  $T_{mn}$  of the Hamiltonian using the Lanczos method.
- Calculate the lowest eigenvalue and eigenvector of the tridiagonal matrix  $T_{mn}$  using the QR algorithm and compare these results with those obtained from Mathematica in Exercise 8.
- Determine an approximation to the zero temperature retarded Greens function  $G_{ij\sigma}(\omega) = \langle\langle c_{i\sigma}; c_{j\sigma}^\dagger \rangle\rangle$  based on your tridiagonal Hamiltonian matrix.