Superconductivity and Nematic Fluctuations in a model of FeSe monolayers: A Determinant Quantum Monte Carlo Study [arxiv:1512.08523]
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Experiments

- Bulk FeSe
  - nematic (Tc ~90K) but no magnetic order
  - Low temperature superconductor (Tc ~30K).
- Monolayer of FeSe on STO
  - nematic order suppressed
  - High Tc superconductor (Matsen effect at 66K [Ref 1])

Summary of Results

- K surface doped FeSe
  - Also high Tc superconductor (50-20 K) [Ref 1]
  - Intrinsic electronic effect - not STO phonon
  [Refs. 2,3,4,5]

Microscopic Model

\[ \mathcal{L} = \mathcal{L}^{(2)}_{\text{F}} + \mathcal{L}^{(4)}_{\text{F}} + \frac{g^2}{2} \mathcal{L}^{(6)}_{\text{F}} \]

Determinant Monte Carlo

- Spin Symmetry avoids Fermion Sign Problem
- Technical improvement - parallel tempering to improve convergence.
- Lattice sizes < 2 x 12 x 12
- Temperature > 1/8 hopping

Summary of Approach

- Idea: Enhanced nematic fluctuations lead to Superconductivity
- Minimal model with orbital band structure of FeSe + Nematic Fluctuations
- 2 band model dxz, dyz orbitals:

\[ H_{\text{lat}} = -\sum (\overline{n}_{i,s} n_{i+s})^2 \]
- Sign Problem Free
- Solve Exactly with determinant Quantum Monte Carlo (DQMC)

Conclusions & Open Issues

- A case study
- Superconductivity established in a multi-orbital nematic model with enhanced nematic fluctuations
- Does Sc arise from nematic fluctuations?
  - Anisotropic pairing on hole fermi surface?
  - Role of onsite Coulomb

Superconductivity from nematic fluctuations?

- Arguments from field theory [7-9] but not all nematic models show Sc [9]
- Other explanations for Sc in the model?
  - Negative U’ intra-orbital attraction?
  - However - mean field decouplings do not give superconductivity in observed range.
  - Ellabib with nematic states see enhanced Sc in same model [9]
  - Nematic fluctuations enhanced near Sc.
  - Electron doping enhances Sc, also stronger nematic couplings.

References