Motivation

Who is the driver of the nematicity: magnetism or orbital fluctuations?

Parquet RG equations and the flow

At the bare level

\[ U_1 = U_2 = U_3 = U_4 = U_5 = U \]
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But running couplings under RG cannot be absorbed into running \( U, U', J, J' \), i.e., non-local interactions emerge

Parquet RG equations (\( u_i = U_i A_i/(4 \pi) \), \( A_i \) are combinations of masses)

\[ \delta_i = \delta_i^0 + \frac{i}{C} \delta_i^0 \]
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Only one stable solution: \( \delta_4,5 \rightarrow 0 \), \( u_4 \rightarrow u_4^0 \)

Fixed trajectory

\[ \text{Fixed trajectory:} \]
\[ u_2 = u_2^0 = \gamma_2 \hat{u}_1, \quad u_3 = u_3^0 = \gamma_3 \hat{u}_1, \quad u_4 = u_4^0 = \gamma_4 \hat{u}_1, \quad u_5 = u_5^0 = \gamma_5 \hat{u}_1 \]

\[ \gamma_1 = \frac{1}{(L \alpha - L) \sqrt{L \alpha - L}}, \quad \gamma_2 = \frac{1}{(L \alpha - L) \sqrt{L \alpha - L}}, \quad \gamma_3 = \frac{1}{(L \alpha - L) \sqrt{L \alpha - L}}, \quad \gamma_4 = \frac{1}{(L \alpha - L) \sqrt{L \alpha - L}}, \quad \gamma_5 = \frac{1}{(L \alpha - L) \sqrt{L \alpha - L}} \]

The exponent \( \alpha_{SC} < 1 \)

Parquet RG for the model w. orbital content

Fixed trajectory

The role of the Fermi energy

Pomeranchuk channel wins if the largest of Fermi energies, \( E_p \), is small enough such that the instability develops at \( T > T_s \). This is the case of FeSe, where \( E_F < 10 \text{ meV} \) and \( T_s \approx 80 \text{K} \). In this system, nematicity well may be a spontaneous orbital order if \( E_F \) is larger and no instability develops down to \( T_s \approx 10 \text{ meV} \). Then either SC or SDW becomes the first instability.

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In such systems (most of Fe-pnictides), nematicity likely is a vestigial magnetic order.

While earlier RG studies concluded...

The largest exponent of divergent susceptibility is in the Pomeranchuk channel, \( s^+ \) SC channel is second, no SDW

\[ \text{The exponent } \alpha_{SC} < 1 \]

We argue: one has to solve another set of RG eqs. for \( \Gamma_{\alpha} \), obtain susceptibilities, check divergences, and compare the exponents

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Second level RG: vertices and susceptibilities

If we just compare \( \Gamma_{\alpha} \), assume \( \Gamma_i = \Gamma_1, (1 + u' \nu^2 + \ldots) \), i.e., SC, Pomeranchuk...

SDW and SC channels: \( \chi_{SDW}(L) \propto \int dU_\alpha \chi^0_{SDW}(U_\alpha), \quad \chi_{SC}^0 \propto \int dU_\alpha \chi^0_{SC}(U_\alpha) \)

and the exponents

\[ \alpha_{SDW} = 2 + \frac{\gamma_2(1 + \gamma_3 C)}{1 + \gamma_2 C^2}, \quad \alpha_{SC} = 2 + \frac{\gamma_2(1 + \gamma_3 C)}{1 + \gamma_2 C^2} \]

Fixed trajectory: \( u_2 = u_2^0 = \gamma_2 \hat{u}_1, u_3 = u_3^0 = \gamma_3 \hat{u}_1, u_4 = u_4^0 = \gamma_4 \hat{u}_1, u_5 = u_5^0 = \gamma_5 \hat{u}_1 \)

Message: the couplings which were initially \( U \) and the ones which were initially \( U' \) or \( J,J' \), tend to the same value under parquet RG

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The exponent \( \alpha_{SC} < 1 \)

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Only one \( \chi \) diverges

For realistic \( C \), only SC develops, no SDW

The exponent \( \alpha_{SC} < 1 \)

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