

Nonstandard statistics of strongly correlated fermions near the Mott-insulator limit

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We discuss two cases of nonstandard statistics for strongly correlated spin- $\frac{1}{2}$ fermions [1–3]. The first describes a non-Fermi liquid (NFL), in which double occupation of a quasimomentum $\mathbf{k}$ -state by fermions with opposite spins is excluded. The second describes a statistical spin liquid (SSL) [2], in which the fermion spins move through the lattice and mix with holes (unoccupied states). In both cases we derive the entropy and the corresponding statistical distribution function, as well as analyze them for a two-dimensional square lattice as a function of both band filling $n \in [0, 1]$ and relative temperature $k_B T/|t|$, where $t < 0$ is the nearest-neighbor hopping integral. The distributions coincide in the dilute-gas limit, whereas the saturated total occupation is limited to unity for NFL and SSL, and compared with results for the Fermi-Dirac statistics. We are particularly interested in the situation, in which the system of itinerant fermions approaches the Mott-insulator state at the half filling ($n \rightarrow 1$). In this limit, only for SSL statistics we recover the local-moment entropy $S/N = k_B \ln 2$, whereas the NFL entropy vanishes. For comparison, the high-temperature Fermi-Dirac result is $S/N = 2k_B \ln 2$. This behavior signals a changeover from itinerant, indistinguishable fermions to localized, distinguishable spin moments near the Mott transition.

Acknowledgments *This work was supported by the Narodowe Centrum Nauki (NCN), Poland, grant No. UMO-2023/49/B/ST3/03545.*

References

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