Pauli crystals - a hidden symmetry of fermions

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Recently developed techniques allow for simultaneous measurements of the positions of all ultra cold atoms in a trap with high resolution. Each such single shot experiment detects one element of the quantum ensemble formed by the cloud of atoms. Repeated single shot measurements can be used to determine all correlations between particle positions as opposed to standard measurements that determine particle density or two-particle correlations only. We discuss the possible outcomes of such single shot measurements in case of cloud of ultra-cold non-interacting Fermi atoms. We show that the Pauli exclusion principle alone leads to correlations between particle positions that originate from unexpected spatial structures formed by the atoms, [1]. We discuss how fragile the Pauli crystals are to realistic experimental limitations. The influence of a number of single-shots pictures available to analysis, thermal fluctuations and finite efficiency of particle detection of particles considered. It is shown that experimental observation Pauli crystals is possible and conditions necessary for the detection of the geometrical arrangements of particles are identified, [2].

Example of a Pauli crystal consisting of 6 Fermi atoms is presented in the figure.

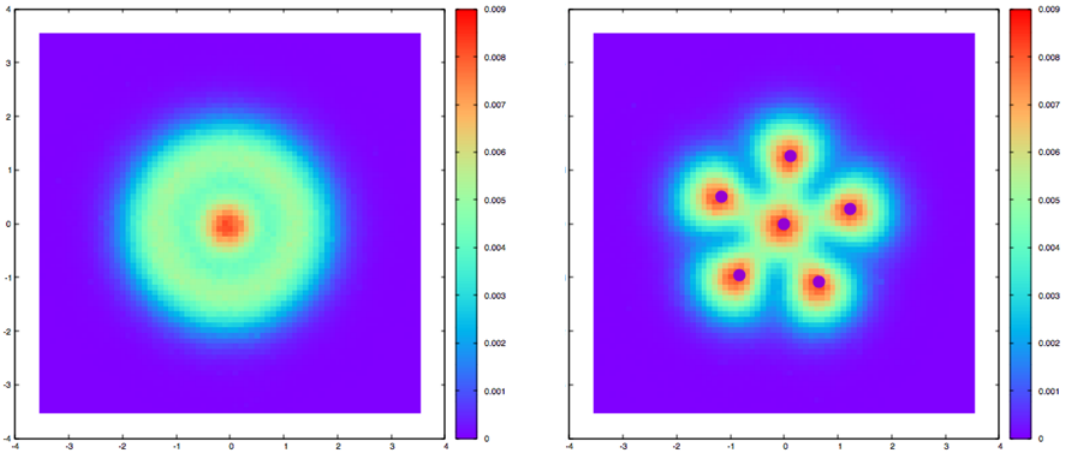

FIG. 1: One particle density function and Pauli crystal consisting of 6 fermions.

[1] M. Gajda, J. Mostowski, T. Sowiński, M. Załuska-Kotur, *Single shot imaging of trapped Fermi gas*, EPL (Europhys. Lett.) **115**, 20012 (2016).

[2] D. Rakshit, J. Mostowski, T. Sowinski, M. Załuska-Kotur, and M. Gajda. *On the observability of Pauli crystals in experiments with ultracold trapped Fermi gases*, Scientific Reports **7**, 15004 (2017).