Phase transition between the FFLO phase and the normal phase using metric spaces

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The so-called FFLO (Fulde-Ferrel-Larkin-Ovchinnikov) phase is an intriguing phenomenon in which superconductivity and magnetism coexist in the same material. This is expected to appear for example in attractive fermionic systems with spin imbalanced populations, due to the internal polarization produced by the imbalance. The transition between FFLO phase (superconducting phase) and the normal phase (non-superconducting) and their thresholds have been a subject of discussion for the past years. To study systems with that level of complexity, where superconductivity coexist with magnetism, simplified models and numerical method are required. We consider the Hubbard model in the attractive regime for which the Density Matrix Renormalization Group (DMRG) calculation allows us to obtain an exact result for the density function of the system. The analysis of these densities can be done by an almost unexplored property of the Hilbert space: the metric space property, where you can define a distance for a pair of elements. It is expected that systems that are physically similars have smaller density distance than systems that present a different physical behavior. To study these distances we have to set a reference system, so we first test several reference systems to find those that are able to indicate the phase transition. We found that, with respect to a central referential in polarization, systems without FFLO present a very symmetric behavior, while systems with FFLO are asymmetric.