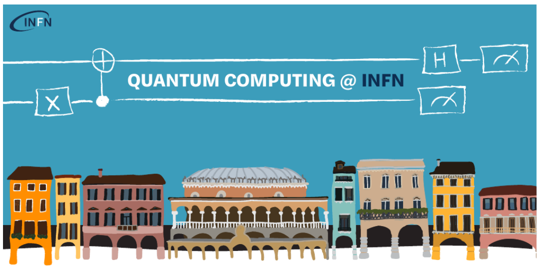

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Solving the homogeneous Bethe-Salpeter equation with a quantum annealer

Wednesday, 30 October 2024 17:05 (20 minutes)

The homogeneous Bethe-Salpeter equation (hBSE) [1], which models a bound system within a fully relativistic quantum field theory, has been solved for the first time using a D-Wave quantum annealer [2]. Following standard discretization methods, the hBSE in the ladder approximation can be reformulated as a generalized eigenvalue problem (GEVP) involving two square matrices, one symmetric and the other non-symmetric (see Ref. [3] for details). This problem is of significant interest in various scientific fields, making the results broadly impactful. The non-symmetric matrix presents a challenge for a formal approach to solving the GEVP on a quantum annealer, as it needs to be converted into a quadratic unconstrained binary optimization (QUBO) problem. We have developed a hybrid algorithm. First, we reduce the non-symmetric GEVP to a standard eigenvalue problem classically. Then, we employ the QA to solve the variational problem. Drawing inspiration from approaches for symmetric matrices [4], we generalize the algorithm to accommodate the non-symmetric case, which involves complex eigenvalues (see Ref. [5] for details). A thorough numerical evaluation of the proposed algorithms, applied to matrices of up to 64 dimensions, was conducted using the proprietary simulated annealing package and the D-Wave Advantage 4.1 system thanks to the D-Wave-CINECA agreement[6], as part of an international project approved by Q@TN (INFN-UNITN-FBK-CNR)[7]. The results show excellent agreement with classical algorithms and reveal promising scalability properties.

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Sessione

Studi fondazionali

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