The primary aim of this study is to investigate the application of spectroscopic techniques for ultracold atoms in detecting kinetically induced magnetic polarons within weakly doped Mott insulators characterized by frustrated triangular geometries.

The authors examine fermionic and bosonic Hubbard systems of spin-½ particles moving in a triangular lattice. They employ the Density Matrix Renormalization Group (DMRG) method to compute the dynamical spin structure factor, accessible through a two-photon Raman excitation.

The manuscript is well-crafted. The proposed strategy for detecting various many-body bound states of holes and magnons is original and supported by a combination of controlled approaches, including exact solutions of three and two-body bound states, along with DMRG calculations. The authors meticulously address details of their numerical results, providing a clear justification for understanding them in simple terms.

Additionally, the manuscript delves into experimental considerations, where the authors assert the realism of their proposal.

Given these considerations, I recommend the publication of this manuscript in Sci Post, contingent upon the authors considering the optional suggestions outlined below.

Abstract:

"In triangular-type lattices for large U/t, magnetism gets enhanced by doping away from n = 1 because kinetic energy of dopants can be lowered through developing magnetic correlations."

Note that this is true only for one type of doping (electrons or holes) depending on the sign of the hopping integral. Since this statement appears in the abstract, the authors may consider clarifying this point for general readers.

The prediction of magnetic polarons in the triangular lattice is rooted in the work referenced as [69] in the manuscript. This reference dates back to 2018, predating the three works cited in the abstract, which were published within the last two years. While I recognize that the cited works provide experimental confirmation of the prediction, it appears fitting to include a citation to the pioneering work that initially foresaw the phenomenon in the abstract. Incidentally, the formation of a bound state between two holes and a magnon (bipolaron) was also predicted in Ref. [69].

Section 5.1.2

The method described in section 5.1.2 (applying the Lanczos method to a target state to compute dynamical correlation functions) was originally introduced in 1988 (Phys. Rev. B 38, 11766 – Published 1 December 1988). The reference [86] cited by the authors is from 2012.

Caption of Figure 1

"Dashed line corresponds to the free ↑-fermion dispersion relation." It is more appropriate to say that the dashed line is the free magnon dispersion (magnons are bosonic modes). The "free ↑-fermion dispersion relation" is the one obtained by diagonalizing the kinetic energy term of Eq. (1).

Right above section 6.1

"However, the total quasi-momentum Q = km − kh of the hole-magnon bound state is not a good quantum number for a system with more than a single hole." This sentence is a bit confusing because the total momentum of the state is still a good quantum number. The authors indicate that the two states are mixed because of the presence of a second hole. What is the symmetry that protects the crossing of the two bands at Q=pi,0 in the exact solution of the two-body problem?

Eq. (15)

J_{\perp} should be equal to – 4t^2/U_{\up \down} because of the bosonic character of the spin 1/2 particles.

Eq. (15)

The last term of the Hamiltonian violates the conservation of N_{up}-N_{dw} (I guess that the spin of the annihilation operator should be \bar{\sigma} instead of \sigma).

5th line below Eq. (15)

There is a typo in the sentence: "The first one allows to holes to hop…"

Conclusions and Outlook

There is a typo near the end:

"We envision that the spectroscopic approached proposed…"