INTERNATIONAL SOLVAY INSTITUTES BRUSSELS

NEW HORIZONS LECTURE IN PHYSICS

Prof. Nir Navon

Yale University, USA

Many-body Physics with Fermions in an Optical Box

For the past two decades harmonically trapped ultracold atomic gases have been used with great success to study fundamental many-body physics in flexible experimental settings. However, the resulting gas density inhomogeneity in those traps makes it challenging to study paradigmatic uniform-system physics (such as critical behavior near phase transitions) or complex quantum dynamics.

The realization of homogeneous quantum gases trapped in optical boxes has marked a milestone in the quantum simulation program with ultracold atoms[1]. These textbook systems have proved to be a powerful playground by simplifying the interpretation of experimental measurements, by making more direct connections to theories of the many-body problem that generally rely on the translational symmetry of the system, and by altogether enabling previously inaccessible experiments.

I will present a set of studies with ultracold fermions trapped in a box of light. This platform is particularly suitable to study problems of Fermi-system stability, of which I will discuss two cases: the spin-1/2 Fermi gas with repulsive contact interactions[2], and the three-component Fermi gas with spin-population imbalance[3]. Both studies lead to surprising results, highlighting how spatial homogeneity not only simplifies the connection between experiments and theory, but can also unveil unexpected outcomes. Finally, I will discuss two ongoing efforts to tackle far-from-equilibrium dynamics of uniform fermions. One focuses on an impurity embedded in a Fermi bath and strongly driven between internal states; the second one aims at understanding the nonlinear density-density response of the weakly and strongly interacting Fermi gases.

[1] N. Navon, R.P. Smith, Z. Hadzibabic, Nature Phys. 17, 1334 (2021)
[2] Y. Ji et al., Phys. Lev. Lett 129, 203402 (2022)
[3] G.L. Schumacher et al., arXiv:2301.02237

Monday 20 March 2023 at 4:00 P.M.

COFFEE AND TEA WILL BE SERVED AT 3:45 P.M IN FRONT OF THE SOLVAY ROOM

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Meetings of the Belgian Quantum Physics Initiative

Prof. Nir Navon

Yale University, USA

Quantum Gases in Optical Boxes

Optical boxes have had a transformative impact on experiments with ultracold atoms[1].

They have allowed inter alia the creation of homogeneous-density quantum gases, a milestone in quantum many-body physics with ultracold atoms. These uniform gases have since opened many new research avenues by simplifying the interpretation of complex measurements and by enabling previously inaccessible experiments.

In this short course, I will give a selected overview of exciting recent results on this topic, ranging from the thermodynamics of strongly correlated systems, to collective excitations across normal-superfluid transitions, to far-from-equilibrium dynamics.

[1] N. Navon, R.P. Smith, Z. Hadzibabic, Nature Phys. 17, 1334 (2021)

Thursday 23 March 2023 at 2:00 P.M.

1:30 P.M.: Welcome coffee
2:00 P.M.: Lecture (part one)
3:00 P.M.: Coffee break and discussions
4:00 P.M.: Lecture (part two)

Salle Félicien Cattier
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