Joint CQSE and CASTS Seminar

Weekly Seminar
Dec. 13, 2013 (Friday)

TIME Dec. 13, 14:30 ~ 15:30
TITLE Nondestructive Phase Shifting Imaging of Cold Atoms
SPEAKER Prof. Dian-Jiun Han
Department of physics, National Chung Cheng University
PLACE Rm716, CCMS & New Physics Building, NTU

Abstract

Nondestructive imaging of cold atoms relies on the phase shift of probe light while passing the atomic sample. The working condition is fulfilled as the probe is far off the atomic resonances where the refractive process dominates. Hence, the near-resonance photon absorption, often causing atom heating and state flipping, is strongly suppressed and much longer probing time is permitted. Nondestructive imaging thus provides tremendous advantages over the absorption method, especially when atoms are extremely cold [1].

In this talk, we describe two experimental schemes for nondestructive imaging on cold atoms. We first introduce a scheme to engage phase shifting interferometry on cold atomic samples and present the simulation results under several experimentally achievable conditions nowadays [2]. This method allows far-detuning, low power probing, and is intrinsically nondestructive. This novel detection means yields image quality superior to the conventional phase contrast imaging at certain conditions and could be experimentally realized. Furthermore, the longitudinal resolution of imaging by this manner is mainly set by optical interference and can be better than the diffraction limit. This scheme also provides special advantages to diagnose the surface-trapped clouds, with which phase imaging on the fabricated wires and atoms altogether is possible as well.

We also show another lens-free nondestructive imaging scheme using a divergent Gaussian beam and accompanying with phase shifting interferometry for cold atomic cloud [3]. The aberration-free phase image can be digitally reconstructed from the recorded interference patterns with which no mechanical focusing is needed. Particularly, image magnification is automatically provided in the proposed lensless configuration. We examine this novel scheme for the typical cold atomic clouds under the experimentally achievable conditions too. Our simulation results demonstrate this lens-free imaging means could reach spatial resolution close to the diffraction limit.

References

[1] M. R. Andrews, M.-O. Mewes, N. J. van Druten, D. S. Durfee, D. M. Kurn, and W. Ketterle, "Direct, Nondestructive Observation of a Bose Condensate," Science **273**, 84 (1996).

[2] Tzu-Ping Ku, Chi-Yuan Huang, Bor-Wen Shiau, and Dian-Jiun Han, "Phase shifting interferometry of cold atoms," Opt. Express **19**, 3730 (2011).

[3] Chih-Yuan Huang, Hung-Shiue Chen, Chih-Yuan Liu, Chin-Han Chen, and D.J. Han, "Lensless Phase-Shifting Imaging of Cold Atoms," accepted for publication in JOSA B.