Test of the universality of free fall with atoms in different spin Orientations

Xiao-Bing Deng[1], Xiao-Chun Duan[1], Min-Kang Zhou[1], Hui-Bin Yao[1], Cheng-Gang Shao[1], and Zhong-Kun Hu[1]

[1]*MOE Key Laboratory of Fundamental Physical Quantities Measurement, School of physics, Huazhong university of Science and technology, Wuhan 430074, China*

Presenting Author: xiaobingdeng@hust.edu.cn

We present our recent work on test of the universality of free fall (UFF) with atoms in different spin orientations (Figure 1), namely, the ^{87}Rb atoms in $m_F = +1$ and $m_F = -1$. A Mach-Zehnder-type atom interferometer is exploited to sequentially measure the free fall accelerations of the atoms in the two sublevels. The spin-orientation related Eötvös parameter η_s is obtained by comparing the measured gravity accelerations, correspondingly, and the preliminary result is $\eta_s = (-0.2 \pm 1.5) \times 10^{-5}$. Since the atoms in $m_F = +1$ and $m_F = -1$ are highly sensitive to magnetic field inhomogeneity, which mainly limits the precision of our UFF test, three steps are taken to alleviate the influence of the magnetic field inhomogeneity. Firstly, a relative homogeneous magnetic field space is selected for the interfering to take place, and an anti-Helmholtz coil is added to compensate the magnetic field gradient in vertical direction, ulteriorly. Secondly, the direction of the effective Raman laser wave number $\boldsymbol{k}_{\text{eff}}$ is reversed to make a differential measurement for each m_F. The influence which is independent of $\boldsymbol{k}_{\text{eff}}$ can be canceled. However, with the Raman lasers configured in $+k_{\text{eff}}$ versus $-k_{\text{eff}}$, the directions of the recoil velocities are opposite. This induces a tiny difference between the atoms' trajectories, and consequently causes a residual influence in the differential measurement result. The third step is to correct this residuum using the common mode result for the two interfering configurations of $\boldsymbol{k}_{\text{eff}}$.

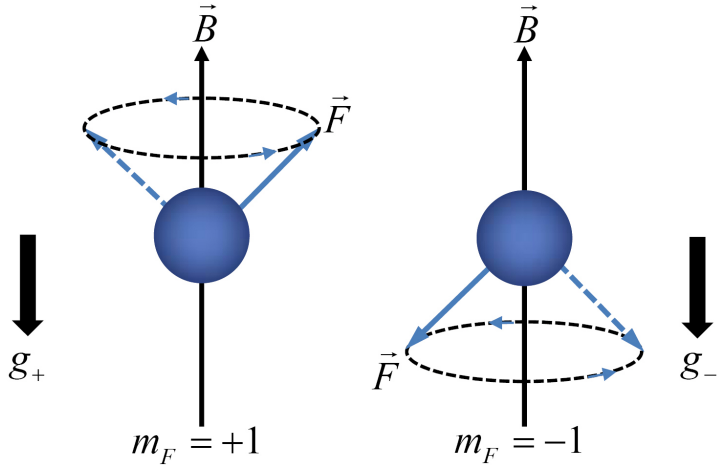

Figure 1: *Schematic of the spin orientations for ^{87}Rb atoms in $m_F = +1$ and $m_F = -1$.*

References

[1] Xiao-Chun Duan, Min-Kang Zhou, Xiao-Bing Deng, Hui-Bin Yao, Cheng-Gang Shao, Jun Luo, and Zhong-Kun Hu, arXiv: 1503.00433v1.