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Testing the universality of free fall with atoms in different quantum states ZHONG-KUN HU, XIAO-CHUN DUAN, MIN-KANG ZHOU, LU-SHUAI CAO, MOE Key Laboratory of Fundamental Physical Quantities Measurement, School of physics, Huazhong university of Science and technology — We present tests of the universality of free fall by comparing the gravity acceleration of the ^{87}Rb atoms in m_F =1 versus those in $m_F = -1$, of which the corresponding spin orientations are opposite. A Mach-Zehnder-type atom interferometer is exploited to alternately measure the free fall acceleration of the atoms in these two magnetic sublevels, and the resultant Etvs ratio is η =(0.21.2) 10^{-7}. This also gives an upper limit of 5.4 10^{-6} m^{-2} for a possible gradient field of the spacetime torsion. The interferometer using atoms in m_F =1 is highly sensitive to the magnetic field inhomogeneity. A double differential measurement method is developed to alleviate the inhomogeneity influence, of which the effectiveness is validated by a magnetic field modulating experiment. Other quantum tests of the universality of free fall with atoms in magnetic-insensitive states by employing larger enclosed spacetime area atom interferometer are discussed. **References** [1] Xiao-Chun Duan, Xiao-Bing Deng, Min-Kang Zhou, Ke Zhang, Wen-Jie Xu, Feng Xiong, Yao-Yao Xu, Cheng-Gang Shao, Jun Luo, and Zhong-Kun Hu*, Physical Review Letters, 117, 023001(2016); [2] Min-Kang Zhou, Le-Le Chen, Qin Luo, Ke Zhang, Xiao-Chun Duan, and Zhong-Kun Hu*, Physical Review A, 93, 053615(2016).

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