Testing the Universality of Free Fall with Bragg atom interferometer

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The validity of universality of free fall (UFF), as one of the fundamental postulations of General Relativity (GR), has excited a huge amount of experiments under various circumstances to search for the sign of the extended GR theory. We have performed a precision atomic interferometry experiment on testing the UFF considering atoms' spin degree of freedom. Our experiment employs the Bragg atom interferometer with ^{87}Rb atoms in different spin states of $|F=1,m_F=0\rangle$ and $|F=2,m_F=0\rangle$, and both the wave packets in these two states are diffracted in one pair of Bragg beams, which can help suppress the common-mode systematic errors. We have obtained an Eötvös ratio $\eta=(-2.8\pm4.2)\times10^{-9}$, and set a new record on the precision with a nearly 30 times improvement. Our experiment gives stronger restrictions on the possible UFF breaking mechanism. The new scheme also possesses a potential to improve various quantum tests of the UFF, e.g. with different species and search for possible spin-gravity couplings.

References

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