Gravitational redshift in quantum-clock interferometry

Roura Albert
ULM University

Remarkable advances in atom interferometry have enabled the creation of macroscopically delocalized quantum superpositions with atomic wave packets separated up to half a meter. Nevertheless, in all cases realized so far the differences in the dynamics of the two wave packets of the superposition can be entirely described in terms of Newtonian mechanics. Therefore, the creation of delocalized coherent superpositions of quantum systems experiencing different relativistic effects is an important milestone in future research at the interface of gravity and quantum mechanics. This could be achieved by generating a superposition of quantum clocks that follow paths with different gravitational time dilation and investigating the consequences on the interference signal when they are eventually recombined. After explaining the major challenges that quantum-clock interferometry based on light-pulse atom interferometers is confronted with (including their insensitivity to gravitational redshift in a uniform field), I will present a promising scheme capable of measuring the effects of gravitational time dilation in interfering quantum clocks. Its experimental implementation should be within reach of the 10-meter atomic fountains of Sr and Yb atoms that will soon become available in Stanford and HITec (Hanover) respectively.