A proposal on the test of general relativity by clock transportation experiments

W.B.Shen, J.Ning, D.Chao, J.Liu

Department of Geophysics, Wuhan university. (wbshen@sgg.whu.edu.cn)

Internationally, the accuracy of the actual atom clock (especially the cooled-atom clock) has achieved femtosecond or better. The portable atom clock with the same accuracy could be realized in the next few years. In China, a portable atom clock with the accuracy level of several femtoseconds might be realized in the near future. All of these provide a good opportunity to test general relativity by an approach of clock transportation. Based on general relativity, the clock located at a higher geopotential (gravitational potential plus centrifugal potential) runs faster than the clock located at a lower geopotential.

Choose two stations P and Q that are not far from each other, and the geopotential difference between them is around 1000 potential units, which correspond to the height difference around 100 meters. The geopotential difference can be determined by gravimetry and levelling, with the accuracy better than 0.5 potential unit (or 5 cm). Two clocks A and B are fixed at stations P and Q respectively, which are synchronized at beginning by a portable clock C in a short time interval. The portable clock C could be transported between P and Q in any time period. Then, after quite a long time, e.g., several weeks or 15 days, the clock C is transported between P and Q, comparing the records of time by clocks A and B, respectively. By this way, it could be expected that general relativity could be tested with a higher accuracy than before. Suppose the clocks A, B, C have the same accuracy level of several femtoseconds. In the present case, if general relativity is correct, after 15 days, the difference of the time records between the clocks A and B should be around 13 nanoseconds, which could be easily detected.