Advanced LIGO technologies may be partly used to verify a redshift mechanism

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Abstract. In the model of low-energy quantum gravity by the author, the redshift of light is caused by interactions of photons with gravitons. The quantum gravitational nature of redshifts may be verified in a ground-based laser experiment. Parameters of some parts of advanced LIGO detectors permit to use them to carry out this verification with relatively non-expensive additional equipment.

The model of low-energy quantum gravity by the author is based on the conjecture about an existence of the background of super-strong interacting gravitons [1]. The cosmological redshift of light is caused in the model by interactions of photons with gravitons. Redshifts of remote objects and the dimming of supernovae 1a may be interpreted here without any expansion of the Universe and without dark energy. The two-parametric theoretical luminosity distance of the model fits observations with high confidence levels (100% for the SCP Union 2.1 and JLA compilations and 99.81% for long GRBs). These parameters are computable in the model.

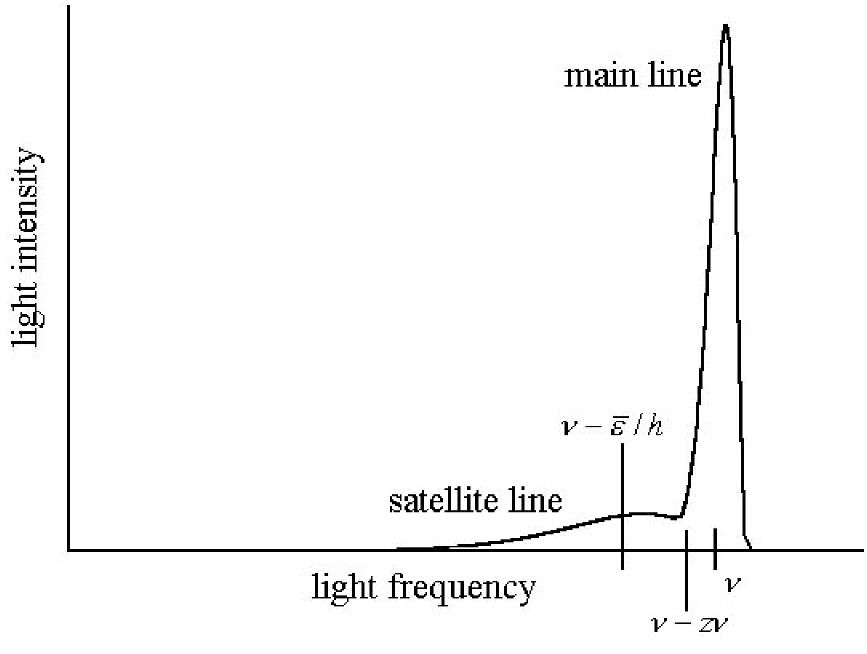

Figure 1. The main line and the expected red-shifted satellite line of a stable laser radiation spectrum after a vacuum tube.

The main conjecture of this approach about the quantum gravitational nature of redshifts may be verified in a ground-based laser experiment. To do it, one should compare spectra of laser radiation before and after passing some distance l in a high-vacuum tube [2]. The temperature T of the graviton background coincides in the model with the one of CMB. Assuming T=2.7 K, we have for the average graviton energy: ε=8.98 eV. Because of the quantum nature of redshift, the satellite of main laser line of frequency ν would appear after passing the tube with a redshift of $\sim 10^{-3}$ eV/h and its position should be fixed (see Fig. 1, z is a redshift). It will be caused by the fact that on a very small way in the tube only a small part of photons may collide with gravitons of the background. The rest of them will have unchanged energies. The center-of-mass of laser radiation spectrum should be shifted proportionally to a photon path. Due to the quantum nature of shifting process, the ratio of satellite's intensity to main line's intensity should have the order: $h\nu H_0 l/c\varepsilon$, where H_0 is the Hubble constant. The theoretical value of H_0 in the model is: $H_0 = 2.14 \cdot 10^{-18}$ s^{-1}. An instability of a laser must be only $<<10^{-3}$ if a photon energy is equal to ~1 eV. Given a very low signal photon number frequency, one could use a single photon counter to measure an intensity of the satellite line after a narrow-band filter with filter transmittance k. If q is a quantum output of a photomultiplier cathode, f_n is a frequency of its noise pulses, and n is a desired signal-to-noise ratio, then an evaluated time duration t of data acquisition would be equal to: $t=(\varepsilon cn)^2 f_n/(H_0 qkPl)^2$, where P is a laser power. Assuming for example: n=10, $f_n=10^3$ s^{-1}, q=0.3, k=0.1, P=200 W, l=300 km, we have the estimate: $t \approx 3 \cdot 10^3$ s. Such the value of l may be achieved if one forces a laser beam to whipsaw many times between mirrors in the vacuum tube with a length of a few kilometres.

The advanced LIGO detectors [3], which were used to observe the gravitational-wave event GW150914, have many technological achievements needed to do the described experiment: stable powerful lasers and input optics, high-vacuum tubes with optical resonator that multiplies the physical length by the number of round-trips of the light, mirror suspension systems with actuators. Some parameters of LIGO systems are of the same order as in the considered example. If one constructs the future LIGO detector with some additional equipment, the verification of the redshift mechanism may be performed in parallel with the main task or during a calibration stage of the detector.

References

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[3] Abbott B P et al. 2016 arXiv:1602.03838 [gr-qc]