Hawking radiation from true and analog black holes

= Grasping physics intuitively and
thinking about analog black hole experiments with ultra-intense lasers =

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I started my new research regarding the quantum field theory in curved space-time [1] here at LeCosPa, NTU, Taiwan in January. It is to verify Hawking radiation from black holes using accelerating plasma mirror induced by ultra-intense laser as analog black holes proposed by Chen and Mourou [2,3]. This project is called "AnaBHEL" (Analog Black Hole Evaporation via Lasers). The Hawking radiation is generated via excitation of quantum vacuum fluctuation due to an extremely strong gravitational force at the event horizon of black holes [4]. This is also regarded as the phase transition of vacuum, which is a core concept of creation of particles (matters) in the big bang cosmology [5]. This concept is also related to dynamical Casmir effect (DCE) and has been already applied to nano-technology devices [6].

Based on the equivalence principle, the inertial force to a frame being accelerated with acceleration α works as an effective gravity. If we can accelerate the flying plasma mirror with extremely large α, the vacuum is excited in this flying frame to be full of Hawing radiation. Vacuum excitation in an accelerating frame is called Unruh radiation [7]. AnaBHEL project aims at detecting this infrared Planckian radiation by separating a lot of plasma noise radiation in laboratory. The anticipated radiation noise is also evaluated theoretically. We assume that a statistical analysis is demanded with accumulation of more than 1000 shots data.

In my talk, I would like to explain all physics intuitively mainly with use of the uncertain principle. I would like to give the image on why the vacuum is excited and energy is created in the curved space-time. In general, Hawking radiation has been derived by use of complicated mathematics as Hawking showed [8], while I derive Hawking radiation temperature intuitively as analogy of the vacuum breakdown and pair creation by Schwinger field [9]. I use only *classical and quantum mechanics of undergraduate level* in my talk.

Finally, I would like to discuss why analog Hawking radiation can be detected and how we can verify the vacuum phase transition in laboratory. Before my talk, I recommend you to watch 16 min. video on Hawking radiation at YouTube [10], which was very useful for me to obtain the image of physics. Enjoy a very fundamental physics with me.

References

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