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From Acceleration Radiation to Black Hole Entropy: A Quantum Optical Perspective

Acceleration radiation is caused by virtual processes in which an atom jumps from the ground state to an excited state, together with the emission of a photon. If an atom is accelerated away from the original point of virtual emission then there is a small probability that the virtual photon will "get away". When ground-state atoms are accelerated through a high Q microwave cavity, radiation is produced with an intensity which can exceed the intensity of acceleration radiation in free space by many orders of magnitude (see Fig. 1a,b at http://iqse.tamu.edu/figure/Figure.pdf). The reason is a strong nonadiabatic effect at cavity boundaries [1]. By formulating acceleration radiation as a flat space quantum optics problem one can obtain the entropy of a black hole (BH). Using this approach we find the famous Bekenstein-Hawking BH entropy formula via a simple "laser-like" density matrix analysis (see Fig. 1c at http://iqse.tamu.edu/figure/Figure.pdf). In this way we calculate the entropy of the radiation emitted by a cloud of infalling atoms without introducing the BH temperature [2].

[1]. M.O. Scully, V.V. Kocharovsky, A. Belyanin, E. Fry and F. Capasso, Phys. Rev. Lett. 91, 243004 (2003).

[2]. M.O. Scully, D. Lee, W. Schleich and A.A. Svidzinsky, Black hole acceleration radiation: from a quantum optical perspective, to be published.

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Summary

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