

# Quantum Phenomena at the High Intensity Frontier

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## Abstract:

There has been a growing interest in high power laser systems throughout the globe driven by the scientific and economic incentives. In this talk, I will present a view from the fundamental physics perspective. I will talk about Schwinger mechanism [1–4], and several other phenomena that we expect to see in the collisions between intense lasers and energetic beams [5, 6].

These phenomena include nonlinear Breit-Wheeler pair production and nonlinear Compton scattering, which show distinct scaling behavior at the high intensity regime, compared with respect to the famous SLAC-E144 parameters [7,8]. I will present an outlook on the subject by briefly discussing few research prospects. Time permitting, I will briefly go over Hawking radiation, the phenomenon of black hole evaporation [9, 10].

[1] J. Schwinger, “On gauge invariance and vacuum polarization”, Phys. Rev. 82, 664 (1951)

[2] Cesim K. Dumlu and Gerald V. Dunne, Stokes Phenomenon and Schwinger Vacuum Pair Production in Time Dependent Laser Pulses, Phys. Rev. Lett. 104, 250402 (2010), [arXiv:1004.2509]

[3] Cesim K. Dumlu and Gerald V. Dunne, Complex Worldline Instantons and Quantum Interference in Vacuum Pair Production, Phys. Rev. D 84, 125023 (2011), [arXiv:1110.1657]

[4] Cesim K. Dumlu, Multidimensional Quantum Tunneling in the Schwinger Effect, Phys. Rev. D 93, 065045 (2016), [arXiv:1507.07005]

[5] A. Fedotov, A. Ilderton, F. Karbstein, B. King, D. Seipt, H. Taya, and G. Torgrimsson, Advances in QED with intense background fields, (2022), [arXiv:2203.00019 [hep-ph]].

[6] Cesim K. Dumlu, Yoshihide Nakamiya and Kazuo A. Tanaka, QED vacuum nonlinearity in Laguerre-Gauss Beams, Phys. Rev. D 106, 116001 (2022), [arXiv:2208.04736]

[7] D. L. Burke et al., Positron Production in multiphoton light-by-light scattering Phys. Rev. Lett. 79, 1626 (1997)

[8] A. I. Nikishov and V. I. Ritus, Quantum processes in the field of a plane electromagnetic wave and in a constant field I, Sov. Phys. JETP 19, 529 (1964)

[9] Stephen W. Hawking Particle creation by black holes, Commun. Math.

Phys. 43, 199 (1975). [10] Cesim K. Dumlu, Stokes Phenomenon and Hawking Radiation, Phys. Rev. D 102, 125006 (2020), [arXiv:2009.09851]