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Undulator-like radiation and cooperative phenomena in semiconductor microstructures with grating

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In this work the cooperative N^2 - effect is considered, that is the radiation whose power is $\sim N^2$, where N is the number of emitters which in this case is equal to the number of nonlinear coupled oscillators which model the electrons in a bunch. We consider two different models: in first case the predicted effect is the result of combining two others, namely Gunn-effect in GaAs and undulator-like radiation which can be produced by means of microstructure with grating (microundulator). In the second case, suggested effect is in a sense similar to Dicke superradiance, however it is not the spontaneous phase coherence arising in the ensemble of two-level atoms interacting via the emitted electromagnetic field, but rather, the result of interplay of another two effects. The first one is the 'pumping wave' acting on the electrons and which is the result of undulator field, while the second is the backward effect of radiation which is produced by electrons moving within such microundulator. As a result, the specific phase coherence ('synchronization') develops in the ensemble of emitters and they start to generate as a single oscillating charge Ne , while the power of emitted radiation becomes $\sim N^2$. It is very probable, that the effect can be used for the developing of a new semiconductor-based room temperature source of the GHz and THz-radiation.

Biography

Igor Tralle is a Physics Professor at the Faculty of Mathematics and Natural Sciences, University of Rzeszów. His research interests are concentrated around Solid State and Semiconductor Physics, charge carrier transport in low-dimensional and quantum structures, linear and nonlinear Optics, quantum cascade lasers as well as Mathematical Physics. During the last couple of years his research interests are moving also towards THz detection and generation and metamaterials. He is an author or co-author of about 100 research papers published in high-rank peer reviewed scientific journals.

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