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The theory of structure formation of electron-hole liquid in dichalcogenides under optical pumping

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We consider formation of EHL in a transition metal dichalcogenide monolayer in a stochastic approach. The theoretical foundations were formulated in [A.A. Chernyuk et al., Physics Letters A 384, 126185 (2020)] for studying exciton liquid formation in semi-conductor quantum wells. In this work, an exciton gas is created in dichalcogenide plane by pumping. The exciton flux through the island boundary is determined by difference between excitons entering the island and electron-hole pairs leaving it. The prob-ability of structure appearance and their configurations is estimated from the distribution function. The kinetic equation for particles number in an island is solved together with the exciton diffusion equation, taking into account the pumping. The interaction between islands occurs through diffusion fields of free excitons.

We obtained that the sizes of EHL islands are tens of microns in monolayers of MoS2 and MoTe2, and the distance between them is hundreds of microns, which is sig-nificantly larger than the corresponding EHL sizes in semiconductor structures with quantum wells.

In case of uniform strip-shaped pumping, the EHL islands are located equidistantly along the strip line, if the strip width is small. If the pumping is performed with a thick strip, then the optimal arrangement of island rows becomes like “checkerboard pattern”, and the distance between islands in a row decreases with growing pumping intensity. The number of island rows enlarges with increasing pumping strip thickness.

The arrangement of EHL islands in dichalcogenide layer is an example of macro-scopic lattice in a 2D structure.

Type of presence

Presence at Taras Shevchenko National University

Primary author: Dr CHERNYUK, Andriy (Institute for Nuclear Research, NAS of Ukraine)

Presenter: Dr CHERNYUK, Andriy (Institute for Nuclear Research, NAS of Ukraine)

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