Contribution ID: **9** Type: **Oral**

Localized waves and resonance effects in layered superconductors

Monday, 23 December 2019 10:55 (20 minutes)

High-temperature superconductors with layered structure, such as $YBa_2Cu_3O_{7-\delta}$,$Bi_2Sr_2CaCu_2O_{8+\delta}$, $La_{2-\delta}Sr_\delta CuO_4$ are anisotropic and strongly nonlinear Josephson plasma media. Such layered superconductors favor propagation of electromagnetic waves in the THz frequency range which is promising for various applications. In close analogy to nonlinear optics, these materials exhibit numerous remarkable features, including the self-focusing effects, slowing down of light, stimulated transparency etc. Furthermore, layered superconductors possess anisotropy with simultaneously different signs of the permittivity tensor components in a certain frequency range, providing a possibility of negative index of refraction and hyperbolic dispersion law [1].
In this work, a series of recent theoretical studies of the propagation of localized Josephson plasma waves (JPW) in layered superconductors is discussed. In particular, the propagation of JPWs along the boundaries of semi-infinite samples and along a plate of finite thickness are studied. We show that when the layers are perpendicular to the plate boundaries, the anomalous dispersion of the localized waves is predicted for layered superconductors in a certain range of frequencies and wave numbers [2]. In addition, due to nonlinearity one can control the anomalous dispersion of the spectrum by the wave amplitude [3].
We also present new results on excitation and propagation of localized Josephson plasma waves in a plate of layered superconductor in the presence of an external static magnetic field. For this case, the dispersion equations for localized waves in the plate of layered superconductor are obtained. It turns out that even relatively weak static magnetic field can significantly change the conditions for the waves propagation [4]. Also, we study THz transmission through layers and show that the resonance transmission of JPWs can be flexibly tuned by the DC magnetic field in a wide range of the parameters. The studied resonant phenomenon opens wide prospects for possible applications, such as THz waves filtering or tuning the emission and receive frequency from THz sources.
The publication contains the results of studies conducted by Presidents of Ukraine grant for competitive projects (F82/233-2019), which support we gratefully acknowledge.

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Session Classification: Condensed Matter Physics

Track Classification: Condensed Matter Physics