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Collective modes of vortex lattices in two-component Bose-Einstein condensates TAKUMI YOSHINO, SHO HIGASHIKAWA, SHUNSUKE FURUKAWA, University of Tokyo, MASAHITO UEDA, University of Tokyo, RIKEN CEMS — There has been an ever-growing interest in artificial gauge fields in ultracold atomic gases, which are induced by rotating gases or by optically dressing atoms. When the gas is composed of two components, the former (latter) method induces mutually parallel (antiparallel) synthetic magnetic fields in the two components. Within the mean-field theory, two-component Bose-Einstein condensates (BECs) in parallel and antiparallel fields show the same vortex-lattice phase diagram with five phases determined by the ratio of the intercomponent interaction $g_{\uparrow\downarrow}$ to the intracomponent one g. It is interesting to ask whether and how the difference between the cases of parallel and antiparallel fields occurs. Here we study the collective modes of the vortex lattices in two-component BECs by applying the Bogoliubov theory and an effective field theory. We find that two modes with linear and quadratic dispersion relations appear in both the cases. For negative $g_{\uparrow\downarrow}$, while the excitation spectra are significantly different between the two cases, their low-energy parts are found to coincide by a simple rescaling. This relation is violated for positive $g_{\uparrow\downarrow}$ with increasing degree of violation for larger $g_{\uparrow\downarrow}$.

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