

Supplemental Information for

**Valley-dependent topologically protected elastic waves using
continuous graphene membranes on patterned substrates**

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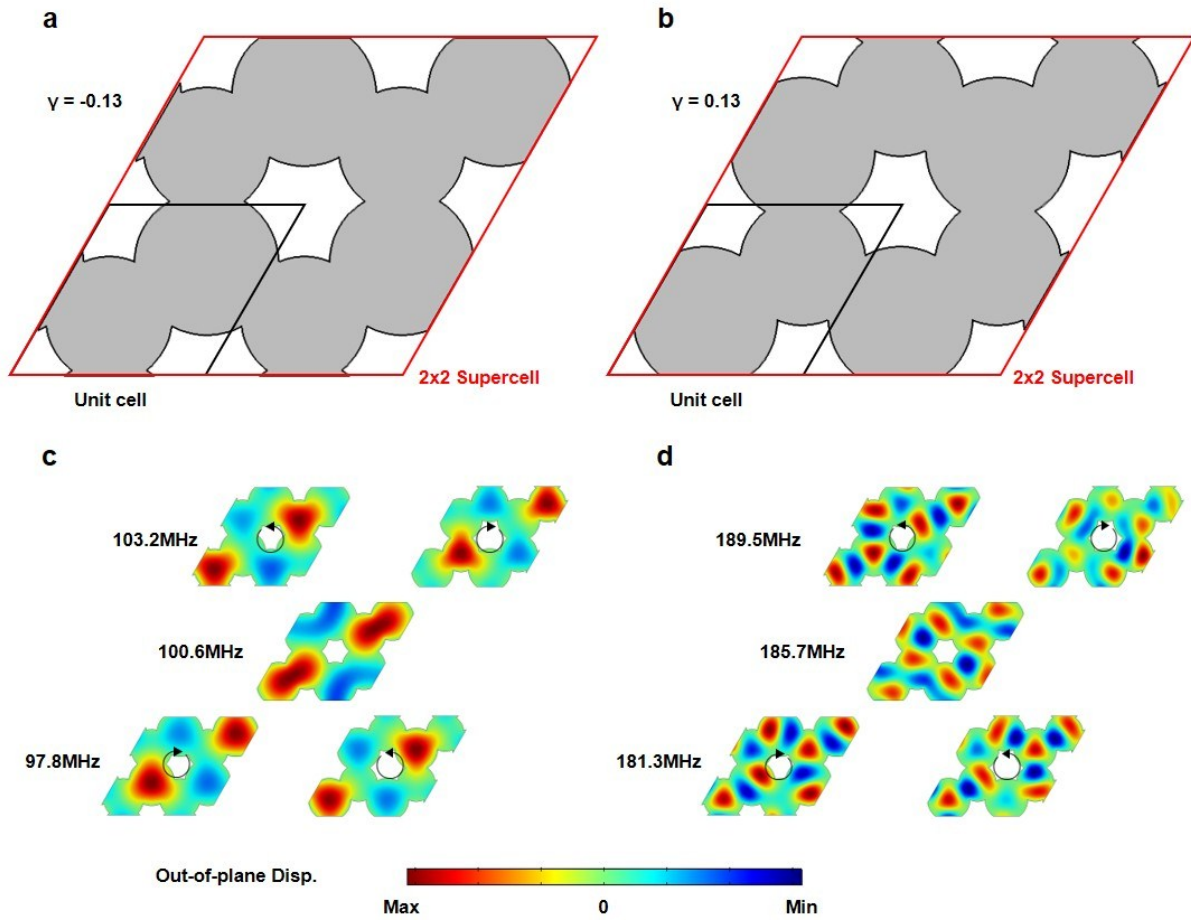


Fig. S1. Supercell and polarized modes in wave propagation. 2×2 supercell configuration for (a) $\gamma = -0.13$ and (b) $\gamma = 0.13$. Wave propagation mode with pseudospin-like polarization: symmetry case, $\gamma = 0$ (Center), asymmetric case, $\gamma = -0.13$ (Left), and $\gamma = 0.13$ (Right) for (c) first bandgap region from 97.8MHz to 103.2MHz (d) second bandgap region from 181.3MHz to 189.5MHz.

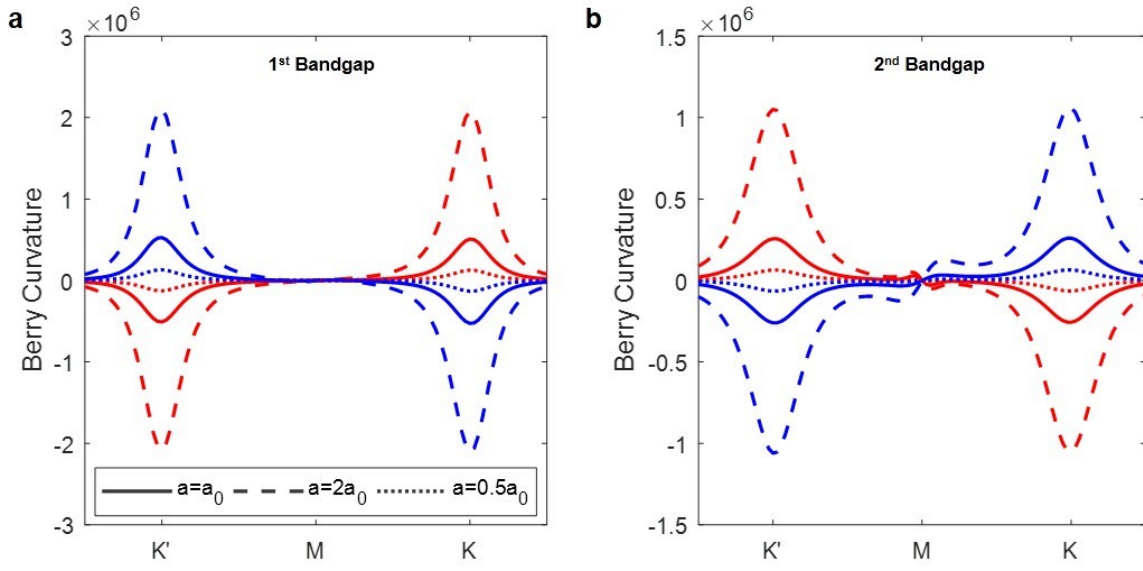


Fig. S2. Change in Berry curvature. Variation of valley-dependent Berry curvature with respect to change in lattice parameter for (a) first bandgap region and (b) second bandgap region.

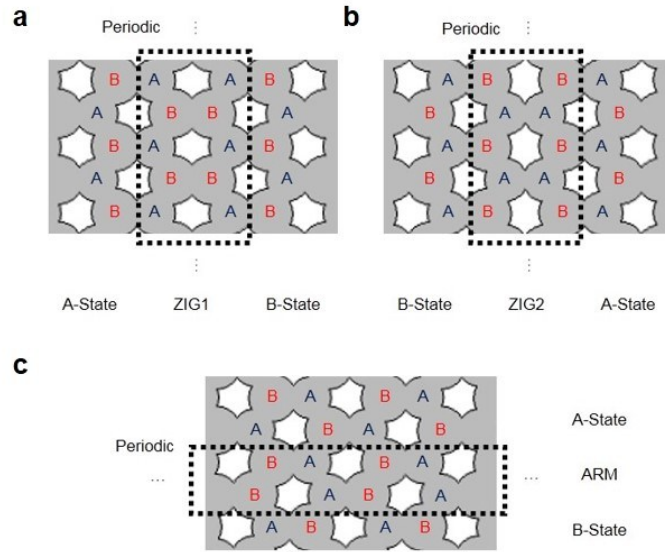


Fig. S3. Edge state structure. Possible edge state structures in the hexagonal lattice array. (a) ZIG1 edge type connecting A-B state, (b) ZIG2 edge type connecting B-A state, and (c) ARM edge type connecting A-B and B-A type identically.

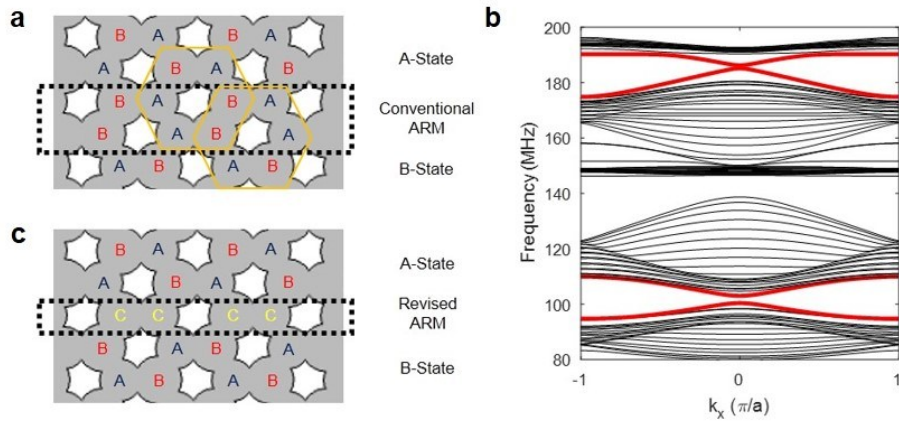


Fig. S4. Revised ARM edge states. (a) Intrinsic ARM edge state formation that breaks C_3 symmetry (orange marked). (b) Frequency dispersion curve for intrinsic ARM edge that has extant bandgap at first bandgap region. (c) Revised ARM edge state formation that insert R_0 type (symmetry) drum in order to improve symmetry.

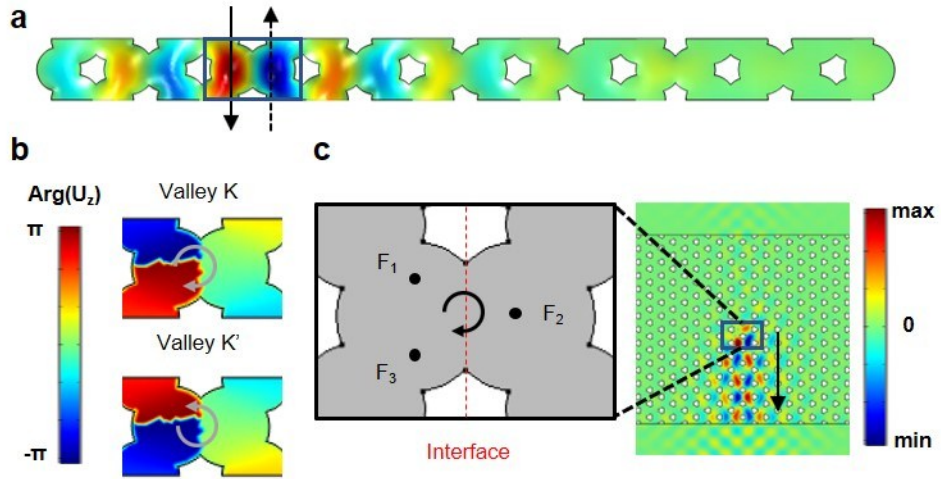


Fig. S5. (a) Edge state for ZIG1 edge in the first bandgap region; (b) phase distribution at the ZIG1 interface edge (c) full domain analysis for phased excitation based on phase distribution at valley K in ZIG1 edge.