Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally Mandal, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Giant field-free transverse Josephson diode effect in altermagnets

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The simultaneous breaking of time-reversal and inversion symmetries in a Josephson junction leads to an asymmetric current-phase relation, characterized by unequal magnitudes of critical currents, known as the Josephson diode effect (JDE). We predict that altermagnets (AMs) with Rashba spin-orbit coupling (SOC) can exhibit transverse Josephson diode effect (TJDE) without any external magnetic field. AMs break time reversal symmetry without exhibiting net magnetization and their combination with SOC breaks the inversion symmetry. We propose a four-terminal Josephson junction where a longitudinal phase bias applied between two opposite terminals induces transverse supercurrents in the unbiased terminals. These transverse currents display diode-like nonreciprocity accompanied by a finite anomalous phase shift, signifying the emergence of transverse anomalous Josephson effect. For certain parameter choices, transverse supercurrent is unidirectional, and the TJDE efficiency exceeds 3000%, demonstrating exceptionally strong diode behavior. The longitudinal supercurrent also exhibits both the Josephson diode effect and anomalous Josephson effect. Both these effects can be tuned by varying the Néel vector orientation. We further show that these effects remain robust against moderate disorder and imperfect interfaces. Furthermore, we investigate the influence of finite temperature on these effects and demonstrate that these effects persist up to the superconducting transition temperature. Our results establish altermagnets as a versatile platform for engineering field-free non-reciprocal superconducting transport in multiterminal devices.

Friday, Aug 7th 2026

11:30 Hrs (Tea / Coffee 11:15 Hrs)

Seminar Hall, TIFRH