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## Constraints on Electromagnetic and Neutral Current Couplings of Dark Vector Boson to Standard Model Fermions by SN1987A

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We study SN1987A constraints on the interactions between Standard Model fermions and dark vector boson. We consider a more general scenario that the dark boson mixes with Standard Model (SM) gauge bosons through both kinetic and mass mixing terms in the Lagrangian. Hence dark boson couples to SM fermions via vector and axial-vector couplings. Such couplings induce reactions  $N + N \rightarrow N + N + Z_d$  inside the supernova (SN) neutrino-sphere and consequently affect the SN core-collapse dynamics. The emissivity resulting from the above production is calculated and the re-absorption process  $N + N + Z_d \rightarrow N + N$ , and decays  $Z_d \rightarrow l^+ l^-$ ,  $\nu \bar{\nu}$  are also considered. It is shown that the axial-vector couplings between  $Z_d$  and nucleons give dominant contributions to the emission and re-absorption processes of  $Z_d$  compared to the contributions by vector couplings, assuming that the vector and axial-vector  $Z_d - N - N$  couplings are comparable in magnitudes. The constraints on such couplings are obtained using SN1987A observations. We compare our constraints to those obtained from fixed target experiments, atomic parity violation, and the measurement on coherent elastic neutrino nucleus scattering.

**Authors:** Mr LAI, Wei-Hao (Institute of Physics, National Chiao-Tung University, Taiwan); Prof. LIN, Guey-Lin (Institute of Physics, National Chiao-Tung University, Taiwan); Dr TSAI, Yue-Lin Sming (Institute of Physics, Academia Sinica, Taiwan); Dr WU, Meng-Ru (Institute of Physics, Academia Sinica, Taiwan)

**Presenter:** Prof. LIN, Guey-Lin (Institute of Physics, National Chiao-Tung University, Taiwan)

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