W50a Late Engine Activity in Neutron Star Mergers As An Alternative Scenario for the Blue Kilonova

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Follow-up observations of short gamma-ray bursts (sGRBs) have continuously unveiled late extended/plateau emissions, attributed to jet launch due to late engine activity, the nature of which remains enigmatic. Observations of GW170817 confirmed that sGRBs are linked to neutron star (NS) mergers, and discovered a kilonova (KN) transient. Nevertheless, the origin of the early blue KN in GW170817 remains unclear. Here, we investigate the propagation of late jets in the merger ejecta. Our results reveal that late jets generate significantly brighter cocoons compared to prompt jets, primarily due to reduced energy loss by adiabatic cooling. Notably, with typical late jets, emission from the cocoon trapped inside the ejecta can reproduce the blue KN emission. We estimate that the forthcoming Einstein Probe mission will detect the early cocoon emission with a rate of a few events per year, and that optical/UV follow-ups in the LIGO-VIRGO-KAGRA O5 run will be able to detect about one cocoon emission events. As an electromagnetic counterpart, this emission provides an independent tool to probe NS mergers in the Universe, complementing insights from sGRBs and gravitational waves.