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High-energy neutrinos and gamma-rays from the AGN-driven wind and torus in NGC 1068

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Powerful, broadly collimated winds, likely driven by accretion disks around supermassive black holes (BHs), are observed in the majority of active galactic nuclei (AGN) and can play a crucial role in the evolution of AGN and their host galaxies. If some of the wind power is dissipated by shocks near the BH, protons can be thereby accelerated and undergo $p\gamma$ interactions with the AGN radiation, leading to emission of high-energy neutrinos, as well as broadband electromagnetic cascade emission triggered by $\gamma\gamma$ interactions. The TeV-range neutrinos tentatively detected by IceCube from the nearby, obscured Seyfert galaxy NGC 1068 can be interpreted consistently if the velocity of the shock is $\sim$1000 km/s, similar to that measured for its wind through IR to UV emission lines. While the $p\gamma$ cascade emission is heavily attenuated in the GeV-TeV bands, the observed GeV-range gamma rays from NGC 1068 may arise mainly as pp gamma rays from an external shock where the wind interacts with the obscuring torus, in addition to an underlying starburst component. Further multi-messenger observations of NGC 1068 and other AGN to test this scenario are discussed.

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