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Recent progress in neutrino - astrophysics connections

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Of all the constituents within the standard model of particle physics our understanding of the neutrino has benefited the most from the interaction of astrophysics and 'terraphysics.' Much has been learned about the properties of the neutrino from each: experiments here on Earth temper our appreciation of the role that neutrinos play in the cosmos while astrophysics can provide the densities and temperatures in which the neutrinos do more than simply flee. But the reluctance of neutrinos to interact means that it is not until we venture into the most extreme environments of astrophysics that we observe neutrinos 'pushing back' as hard as they are being 'pushed'. We review two sites where this occurs: the early Universe and the accretion disk 'engines' of gamma ray bursts. Neutrinos play an important role in the evolution of the early Universe with a particular focus upon the electron neutrino in determining the primordial elemental composition via its participation in the most important reaction at that time. Within gamma ray burst accretion disks we again see the electron neutrinos at work in the nuclear reactions and through their function as the 'coolant' for the disk. Removal of the disk energy, and its deposition into the remnants of the massive star surrounding the disk, may lead to the formation of highly relativistic jets that will later be observed as the burst. We show what has been learned so far about the neutrino and its properties from the study of such environments.