Astrophysics > High Energy Astrophysical Phenomena

Neutrinos from Decaying Muons, Pions, Kaons and Neutrons in Gamma Ray Bursts

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In the internal shock model of gamma ray bursts ultrahigh energy muons, pions, neutrons and kaons are likely to be produced in the interactions of shock accelerated relativistic protons with low energy photons (KeV-MeV). These particles subsequently decay to high energy neutrinos/antineutrinos and other secondaries.
In the high internal magnetic fields of gamma ray bursts, the ultrahigh energy charged particles (μ^+, π^+, K^+) lose energy significantly due to synchrotron radiations before decaying into secondary high energy neutrinos and antineutrinos. The relativistic neutrons decay to high energy antineutrinos, protons and electrons. We have calculated the total neutrino flux (neutrino and antineutrino) considering the decay channels of ultrahigh energy muons, pions, neutrons and kaons. We have shown that the total neutrino flux generated in neutron decay can be higher than that produced in μ^+ and π^+ decay. The charged kaons being heavier than pions, lose energy slowly and their secondary total neutrino flux is more than that from muons and pions at very high energy. Our detailed calculations on secondary particle production in $p\gamma$ interactions give the total neutrino fluxes and their flavour ratios expected on earth. Depending on the values of the parameters (luminosity, Lorentz factor, variability time, spectral indices and break energy in the photon spectrum) of a gamma ray burst the contributions to the total neutrino flux from the decay of different particles (muon, pion, neutron and kaon) may vary and they would also be reflected on the neutrino flavour ratios.

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