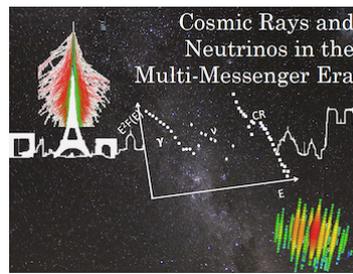


## Cosmic Rays and Neutrinos in the Multi-Messenger Era



ID de Contribution: 98

Type: Non spécifié

### Generation of Z bosons in emission processes by neutrinos in early universe

Production of Z bosons in emission processes by neutrinos in the expanding de Sitter universe is studied. We use perturbative methods to investigate emission processes that are forbidden in flat space-time electro-weak theory by the energy and momentum conservation. The amplitude and probability for the spontaneous emission of a Z boson by a neutrino or an antineutrino are computed analytically, then we perform a graphical analysis in terms of the expansion parameter. Our results prove that this process is possible only for large expansion conditions of the early Universe. The total probability of the process is analyzed and we explore the physical consequences of our results proving that in the Minkowski limit there is no emission of Z bosons by neutrinos. The limit of large space expansion when the expansion parameter is much more larger than the mass of the Z boson is also obtained and the results prove that in this limit the emission probability increase.

#### Related session

Particle physics with neutrinos

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