Investigating the physics of ultrahigh energy neutrinos in neutrino telescope experiments

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Abstract
We compute the corresponding number of events for PeV energy neutrinos for typical neutrino telescopes as the IceCube experiment. We consider different parametrisations for the s.v cross section, including predictions from the geometric scaling phenomenology. The theoretical uncertainty for the number of events is investigated.

Introduction
One important property of the nonlinear perturbative QCD approaches for high energy deep inelastic ψp scattering is the prediction of the geometric scaling (GS) [2]. Namely, the total σp→A cross section at large energies is not a function of the two independent variables x and Q2, but is rather a function of the single variable x = Q2/(2xpE). As usual, Q2 is the photon virtuality and x the Bjorken variable. The saturation momentum Qs2 = (2mpE)/(1−xA) is connected with the momentum of gluon saturation. It is expected that the rise of the gluon distribution function at small values of Bjorken x is naturally saturated by gluon radiation and is connected with the subsequent quark picture of unquarkization. Some years ago, the high energy jet-lepton-photon-proton-nucleus and nucleus-nucleus collisions have been related through GS (see Ref. [2]).

Within the color dipole picture and making use of a rescaling of the impact parameter of the ψp cross section in terms of hadron target radius Rt, the nuclei dependence of the cross section is absorbed in the A-dependence of the saturation scale via GS. The relation reads as [2]:

$$\sigma_{tot}^A[(x, Q^2)] = \frac{\lambda_A^{2s} e^{2} R^2 t}{\sqrt{s}} e^{-\frac{Q^2}{4s}}$$

Figure 1: (Left) Theoretical predictions for number of events, N', for astrophysical UHE neutrinos computed to IceCube data in terms of the core energy. Eν is in units of TeV. Atmospheric neutrino background is also shown.

Table: Theoretical predictions for number of events, N', for astrophysical UHE neutrinos computed to IceCube data in terms of the core energy. Eν is in units of TeV. Atmospheric neutrino background is also shown.

<table>
<thead>
<tr>
<th>Eν (TeV)</th>
<th>N' (events)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
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<tr>
<td>30</td>
<td>150</td>
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References