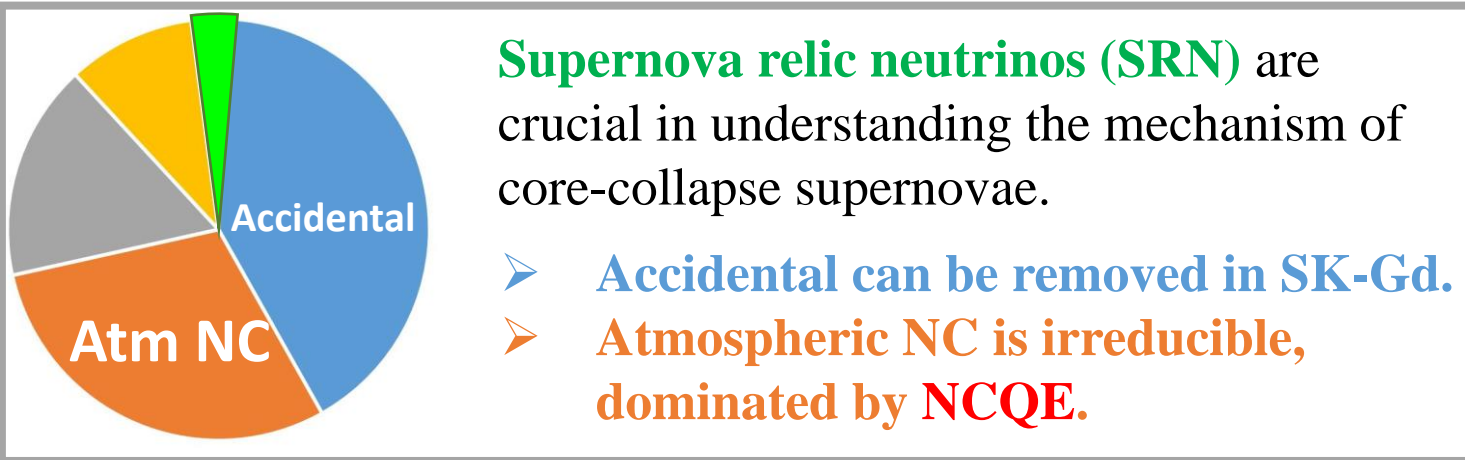


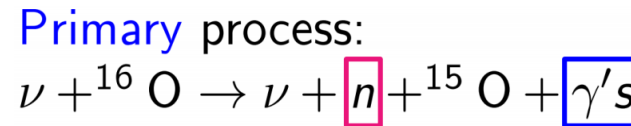
Atmospheric neutrino **NCQE** interaction at Super-Kamiokande



WAN, Linyan (Tsinghua University)
on behalf of the Super-Kamiokande collaboration

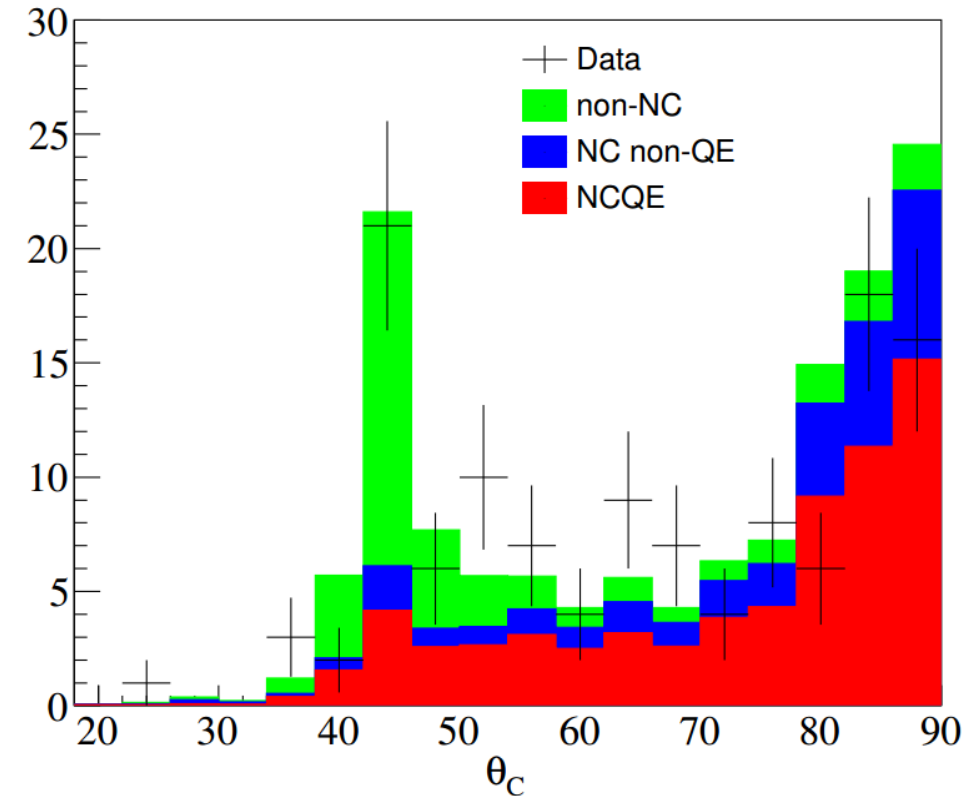


Neutral Current
Quasi-Elastic

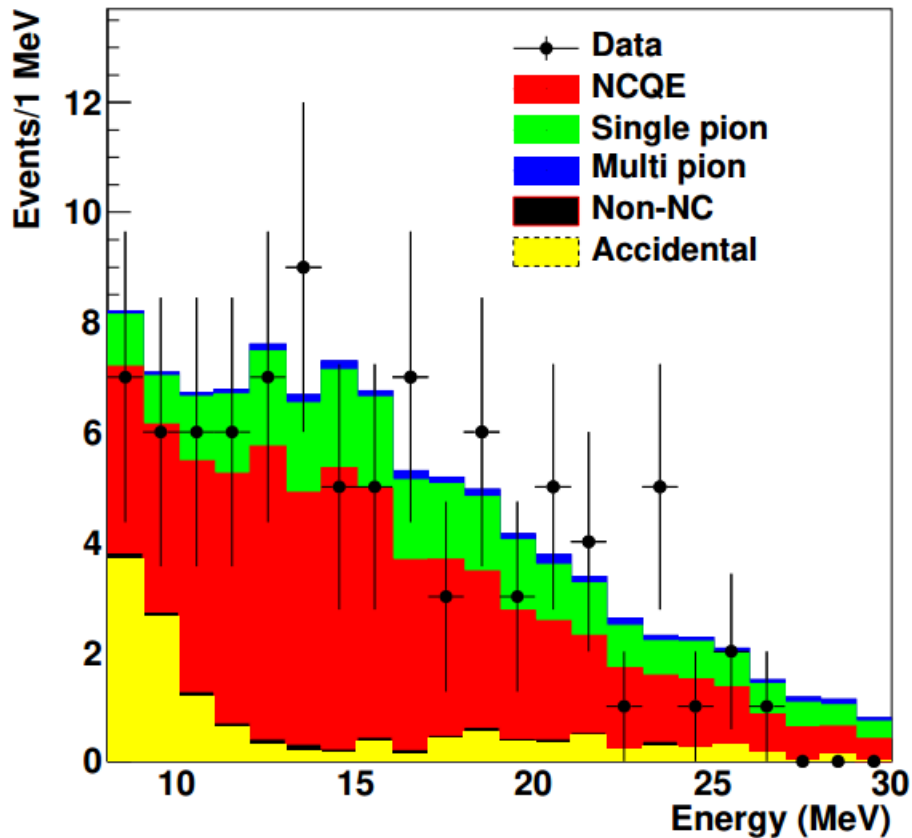


Features:

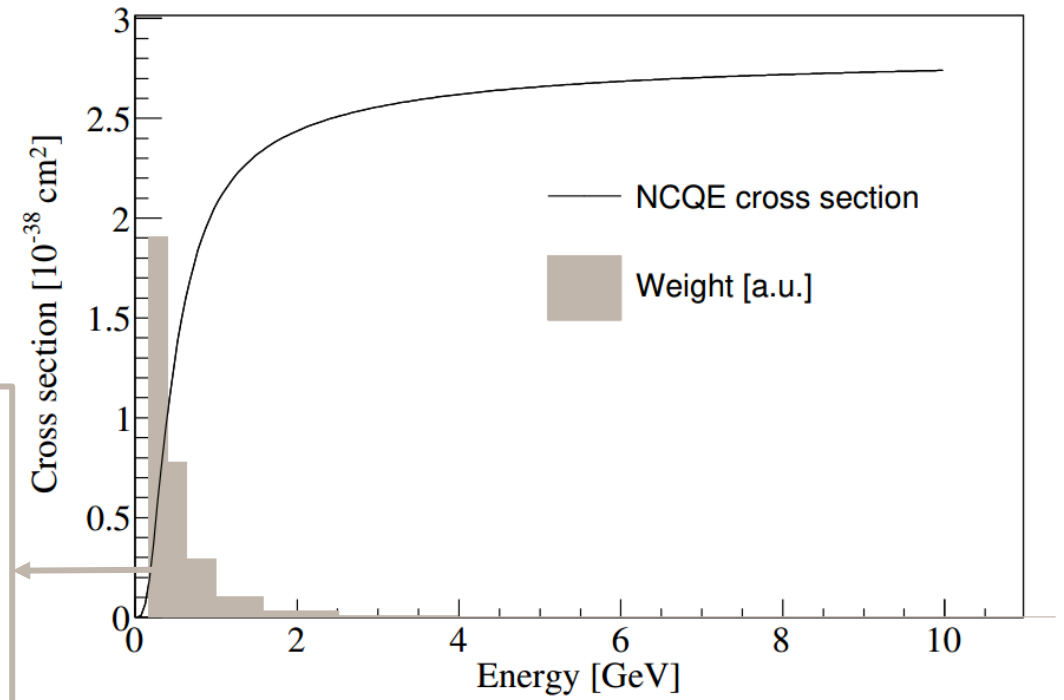
1. **De-excitation $\gamma's$** in 1-10 MeV (isotropic Cherenkov light)
2. Accompanied by **neutrons** in many cases



- After a strict data reduction and neutron tagging, **89 events** are observed, against **98.5 expected** from MC, within 1σ statistical fluctuation.
- The null hypothesis of no NCQE observation is rejected by 4σ .



Using atmospheric neutrino flux as the weight to calculate average cross-section.



$$\begin{aligned}
 \langle \sigma_{\text{NCQE}}^{\text{theory}} \rangle &= \frac{\int_{160 \text{ MeV}}^{10 \text{ GeV}} \sum_{i=\nu, \bar{\nu}} \phi_i(E_\nu) \times \sigma_i(E_\nu)_{\text{NCQE}}^{\text{theory}} dE_\nu}{\int_{160 \text{ MeV}}^{10 \text{ GeV}} \sum_{i=\nu, \bar{\nu}} \phi_i(E_\nu) dE_\nu} \\
 &= 1.14 \times 10^{-38} \text{ cm}^2
 \end{aligned}$$

- The average NCQE cross-section from atmospheric neutrinos on oxygen is measured to be **$(0.95 \pm 0.12 \text{ (stat.)}_{-0.32}^{+0.49} \text{ (sys.)}) \times 10^{-38} \text{ cm}^2$** .