

Le temps de GARGAMELLE

A (*very*) short history of a glorious bubble chamber

En l'honneur de

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GARGAMELLE (GGM *for friends*)



GARGAMELLE, a new large bubble chamber

À la recherche du temps passé

GARGAMELLE

Conceived by A. Lagarrigue et A. Rousset , P. Musset

(inspired by first results on ν interactions in bubble chamber (Siena 1963))

Constructed under the responsibility of CEA , ready to be installed
at CERN in 1970 , cosmics tests end of 1970

Works with heavy liquid so that: reasonable statistics

MAIN GOALS *(to start with....)*

To study neutrino interactions with the CERN-PS neutrino beams.

Starts in january 1971 (filled with freon) .

Priorities on measurements of charged currents (CC) cross-sections



The discovery of the weak Neutral Currents

Neutral currents (NC) are postulated by GSW in the **1960's**.

In 1971 t'Hooft et Veltman demonstrate that the Yang-Mills theory is renormalizable, and the gauge bosons acquire a mass, and cross sections are finite

The priorities of physics of the Gargamelle collaboration are set on NC in 1972

Look for

$\nu_\mu (\nu_e) + e^- \rightarrow \nu_\mu (\nu_e) + e^-$ the best being: $\bar{\nu}_\mu + e^- \rightarrow \bar{\nu}_\mu + e^-$
 \longrightarrow *extremely small background*

and for

$\nu_\mu (\nu_e) + N \rightarrow \nu_\mu (\nu_e) + \text{hadrons}$ \longrightarrow *severe background*

In 1973 the announcement of the discovery: one of the most important (and least recognized) in particle physics

Implications: the existence of Z^0 well established, the measurement of $\cos\theta_W = M_W/M_Z$ guided the direct observation of W and Z years later (1983)

The study of the properties of neutral currents

Then it came a serie of beautiful measurements studying the basic properties of the recently discovered weak Neutral Currents

GARGAMELLE filled with propane (C_3H_8) : another chapter of the glorious history of this chamber (The Gargamelle Neutrino Propane collaboration)

Many important fundamental studies and results came out from this phase:

detailed studies of NC properties:

the Lorentz structure of neutral currents

strange particles production by NC

comparison of single π^0 production by NC and CC

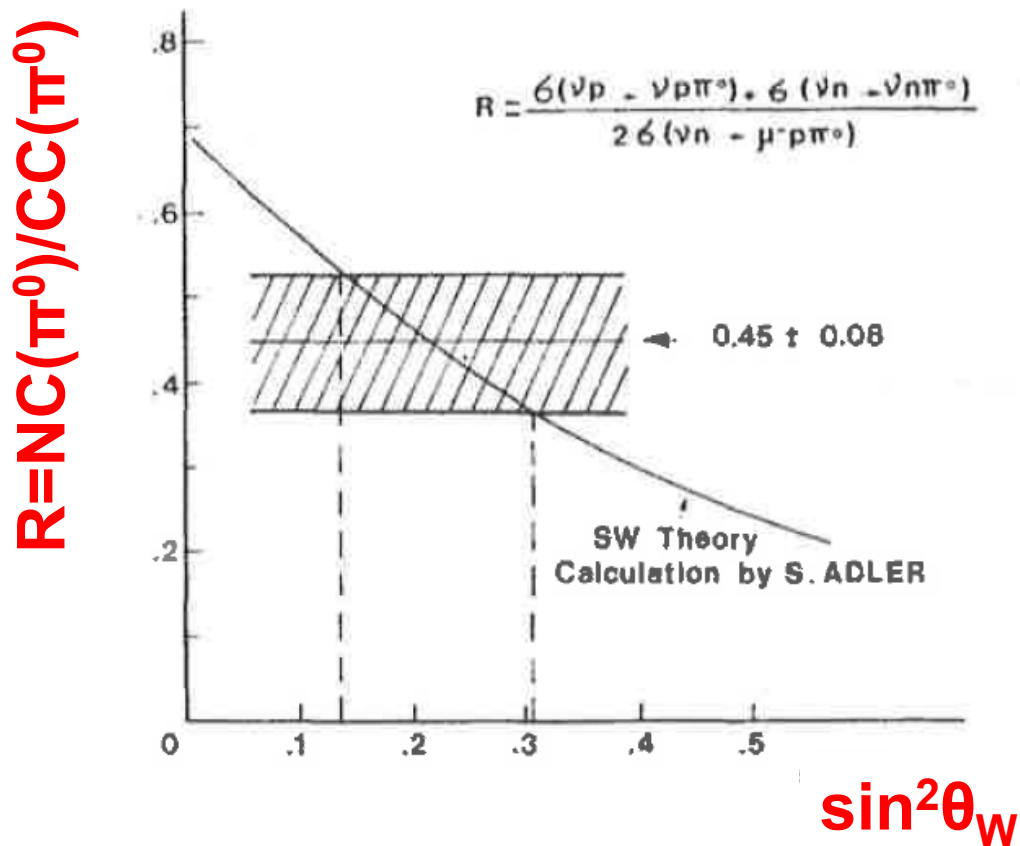
single π^0 production by ν and $\bar{\nu}$ NC

exclusive single π production

In **1977** the **SPS neutrino beam** ($E_{\nu} = 10-200$ GeV) became operational:

refined high statistics study of $\nu_{\mu} + e^{-} \rightarrow \nu_{\mu} + e^{-}$
and value of $\sin^2 \theta_w$ in a final paper in 1978

The study of the properties of neutral currents



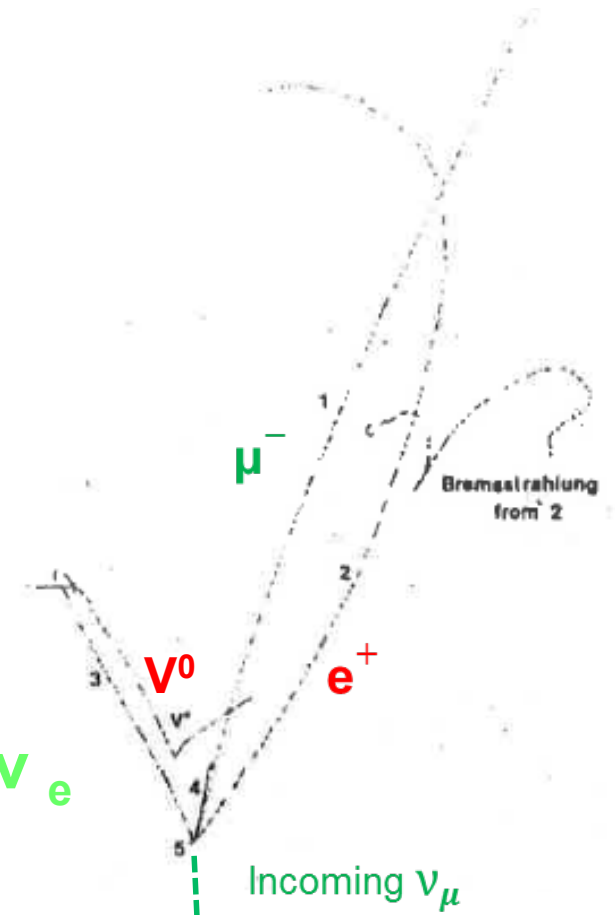
The observation of open charmed particles

In 1970, the suppression of the strangeness changing neutral currents was explained by Glashow, Iliopoulos, Maiani with the existence of a new quark: the 'charm'

The charm was discovered experimentally in 1974 at Brookhaven and SLAC as constituents of a new resonance: $J/\Psi(c\bar{c})$ and its family

GGM observes in 1975, in a dedicated CF_3Br run, open charm particles in events with two leptons $\mu^- e^+$ correlated to strange particles.

The observation of this new hadron containing a c quark plus a light quark was published in 1976, confirming the observation of dimuon events in Fermilab



The study of nucleon structure functions and the properties of quarks

Tests of the quark model (comparing neutrino with electron Deep Inelastic Scattering) (in CF_3Br and C_3H_8)

Measurements of neutrino cross sections and structure functions **$F_2(x)$ and $xF_3(x)$** show that:

- ★ quarks are pointlike
- ★ there are 3 valence quarks in a nucleon
- ★ quarks have fractional charge
- ★ only $\approx 50\%$ of the momentum in valence quarks
 $\approx 50\%$ is ascribed to the neutral, isospin 0 gluons

Many other physics topics in GARGAMELLE

GARGAMELLE filled with propane

- ★ The inverse muon decay process $\nu_{\mu} + e^{-} \longrightarrow \mu^{-} + \nu_e$
 - ★ Detailed study of ν_e ($\bar{\nu}_e$) interactions and ν oscillations
 - ★ Limits on neutrino lifetime
 - ★ Beam dump to search for new penetrating particles
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Bernard et GARGAMELLE

All the results I mentioned have all received the contributions from Bernard's skill, dedication, and his scientific formation

Je suis tres heureuse d' avoir pu le rencontrer et travailler ensemble pendant toutes ces annees là.

Sa gentillesse, sa modestie, n'ont jamais caché sa grande valeur et expertise scientifique

C'est un grand plaisir de temoigner ici de ses qualités.

**Merci Bernard,
et congratulations pour un prix bien merité**