CLAUDE ITZYKSON

The early years

Graduated from Ecole Polytech-
nique + Corps des Mines

joined Service de Physique Thorique on a CEA position in 1962-3

The senior members of SPhT at the time

Head Claude Bloch

with a nuclear physics group (Gillet Raynal Ripka,$\cdots$)

Quantum many body problem :

De Dominicis, Balian

High energy physics :

Froissart, Stora, Jacob

Maurice Jacob era

1.
DECAY OF THE OMEGA-AND ETA-MESONS
By: ITZYKSON, C; JACOB, M; PHAM, F; et al.
PHYSICS LETTERS Volume: 1 Issue: 3 Pages: 96-97 Published: 1962
Full Text from Publisher
Times Cited: 7
(from All Databases)
2.
1-PARTICLE EXCHANGE IN ANTIPROTON COLLISIONS IN FLIGHT
By: BESSIS, D; JACOB, M; ITZYKSON, C
NUOVO CIMENTO Volume: 27 Issue: 2 Pages: 376-+ Published: 1963
Full Text from Publisher
Times Cited: 19
(from All Databases)
3.
POLARIZATION EFFECTS IN PROTON-PROTON HIGH-ENERGY SCATTERING
By: ITZYKSON, C; JACOB, M
NUOVO CIMENTO Volume: 28 Issue: 2 Pages: 250-+ Published: 1963
Full Text from Publisher
Times Cited: 9
(from All Databases)
4.
A POSSIBLE DETERMINATION OF THE SPIN AND RELATIVE PARITY OF THE HYPERON ISOBARS
By: ITZYKSON, C; JACOB, M
PHYSICS LETTERS Volume: 3 Issue: 4 Pages: 153-155 Published: 1963
Full Text from Publisher
Times Cited: 5
(from All Databases)
5.
PHENOMENOLOGICAL APPROACH TO HIGH-ENERGY LEPTON-NUCLEON SCATTERING
By: ITZYKSON, C; JACOB, M; CHAN, CH
NUOVO CIMENTO Volume: 32 Issue: 1 Pages: 71-+ Published: 1964
Full Text from Publisher

Axiomatic field theory

Représentations intégrales de fonctions analytiques et formule de Jost-Lehman-Dyson

J.Bros, C.Itzykson, F.Pham

Annales de l'Institut Henri Poincaré
1966

Back from Stanford

in 1967

Non leptonic K decays

(with Jacob and Mahoux)

Non leptonic hyperon decays

(with Jacob)

High energy 2-body reactions in quark model

(with Jacob)

The Stanford days

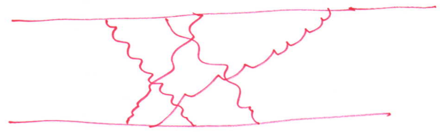
UNITARY GROUPS - REPRESENTATIONS AND DECOMPOSITIONS
By: ITZYKSON, C; NAUENBER.M
REVIEWS OF MODERN PHYSICS Volume: 38 Issue: 1 Pages: 95-& Published: 1966 .
GROUP THEORY AND HYDROGEN ATOM .1.
By: BANDER, M; ITZYKSON, C
REVIEWS OF MODERN PHYSICS Volume: 38 Issue: 2 Pages: 330-& Published: 1966
GROUP THEORY AND HYDROGEN ATOM .2.
By: BANDER, M; ITZYKSON, C
REVIEWS OF MODERN PHYSICS Volume: 38 Issue: 2 Pages: 346-& Published: 1966
MASSLESS PARTICLES AND FIELDS
By: FRISHMAN, Y; ITZYKSON, C
PHYSICAL REVIEW Volume: 180 Issue: 5 Pages: 1556-& Published: 1969

Stanford to Princeton

Relativistic Eikonal Expansion

Henry D. I. Abarbanel and Claude Itzykson

Phys. Rev. Lett. 23, 53 (1969)

$\sum$ 

$$= e^{\int \frac{\delta}{\delta A_1(x_1)} D(x_1 - x_2) \frac{\delta}{\delta A_2(x_2)}} \, G(A_1) \otimes G(A_2)$$

A relativistic Balmer formula including recoil effects

Phys. Rev. D1, 2349 (1970)

E.B., C.Itzykson, J.Zinn-Justin

$$s = m_1^2 + m_2^2 + \frac{2m_1m_2}{[1 + Z^2\alpha^2/(n - \epsilon_j)^2]^{1/2}}$$

includes recoil effects, gives positronium singlet up to order α^4.

Itzykson C., Kadyshevsky V.G., Todorov, I.T., Phys. Rev. D1, 2823-2831 (1970)

Three-dimensional formulation of the relativistic two-body problem and infinite-component wave-equations

Non-linearities in QED

Phys. Rev. D 2, 1191-1199 (1970)
Pair production in vacuum by an alternating field

Phys. Rev. D 3, 618-621 (1971)
Polarization phenomena in vacuum nonlinear electrodynamics

(EB and Claude)

Schwinger field : non-linear QED for strong electric fields

$$eE_s\frac{\hbar}{mc} = mc^2$$

$E_s \simeq 10^{16} V/cm$ still out of reach. Pair production out of vacuum by a static electric field (the equivalent of a dielectric breakdown) : a tunneling effect with potential barrier $2mc^2$.

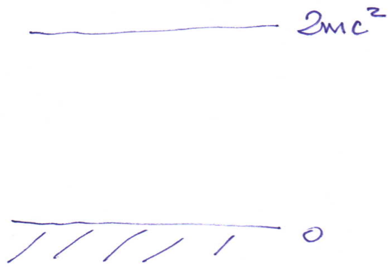
Schwinger's result the probability is proportional to

$$w \simeq e^{-E_s/E}$$

But what could one say if

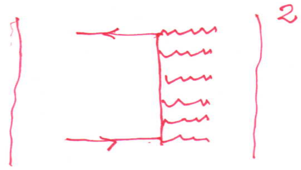
$$\frac{\hbar\omega}{mc^2} \neq 0$$

It is similar to multi photon ionization



Multiphoton ionization

$$n\hbar\omega \geq 2mc^2$$



$$\left| \cdots \right|^2 \propto \alpha^n$$

We derived an interpolating formula for $\frac{\hbar\omega}{mc^2} \neq 0$. The dimensionless parameter

$$\gamma = \frac{E_s}{E}\frac{\hbar\omega}{mc^2}$$

governs the crossover.

For $\gamma \ll 1$ one recovers Schwinger.

For γ large the multionization result

$$w \simeq (\frac{eE}{2m\omega})^{4mc^2/\hbar\omega}$$

but in practice up to now one is still closed to the Schwinger's limit.

Balian, Drouffe, Itzykson

Phys. Rev. D 10, 3376-3395 (1974)

Gauge fields on a lattice. I. General outlook

Phys. Rev. D 11, 2098-2103 (1975)

Gauge fields on a lattice. II. Gauge invariant Ising model

Phys. Rev. D 11, 2104-2119 (1975)

Gauge fields on a lattice. III. Strong coupling expansions and transition points

The 2D Ising model

Itzykson C., Zuber J.-B., Phys. Rev. D15, 2875-2884 (1977)

Quantum field theory and the two-dimensional Ising model

Bander M., Itzykson C., Phys. Rev. D 15, 463-469 (1977)

Quantum-field-theory calculation of the two-dimensional Ising model correlation function

Itzykson C., Nucl. Phys. B210 [FS6], 448-476 (1982)
Ising fermions. I - Two dimensions
Nucl. Phys. B210 [FS6], 477-498 (1982)
Ising fermions. II - Three dimensions

Itzykson C., Pearson R.B., Zuber J.-B.
Nucl. Phys. B220 [FS8], 415-433 (1983)
Distribution of zeros in Ising and gauge models

Itzykson C., Zuber J.-B., McGraw-Hill, 1980, 705 p.

Quantum Field Theory

Large orders in perturbation theory

Itzykson C., Parisi G., Zuber J.-B., Phys. Rev. Lett. 38, 306-310 (1977)
Asymptotic estimates in scalar electrodynamics Itzykson C., Parisi G., Zuber J.-B., Phys. Rev. D 16, 996-1013 (1977),
Asymptotic estimates in quantum electrodynamics - I.
Balian R., Itzykson C., Parisi G., Zuber J.-B., Phys. Rev. D 17, 1041-1052 (1978),
Asymptotic estimates in quantum electrodynamics - II.

In a simple theory, such as ϕ^4 all diagrams of order n have the same sign, and the number of diagrams of that order grows like $n!$.

Parisi had pointed out that in a theory with fermions, such as a Yukawa Lagrangian, there are sign cancellations at a given order related to closed fermion loops. Consequently the asymptotic large order behavior is reduced to an effective $\sqrt{n!}$

The question naturally arose for QED.... but all this had to be reconsidered at the light of 't Hooft's *renormalons*

Large N

In 1972 K. Wilson realized that in a theory such as $g/N(\sum_{a=1}^{N} \phi_a^2)^2$, only "bubble" diagrams survived in the large N limit, leading to an elementary explicit solution.

I remember a blackboard discussion at coffee with Jean, Claude, maybe Jean-Bernard, where we looked at Yang-Mills $SU(N)$ and convinced ourselves that the simplest non-bubble graph was not negligible in the large N limit. (We were not the only ones : I discussed it in 73 with Ken who said *I have tried also, it doesn't work*).

None of us had had the idea of drawing a non-planar graph, but of course 't Hooft did.

So, how does one sum planar diagrams?

EB., C.Itzykson, G.Parisi, J.-B. Zuber

Commun. Math. Phys. 59, 35-51 (1978),

Planar diagrams

This article was in fact a setback to our ambition. All we succeeded to do was

(i) count how many planar diagrams there are (easily generalized to surfaces of arbitrary genus)

(ii) solve the one-dimensional large N-problem

$$\mathcal{L} = \mathrm{Tr}(\dot{\mathrm{M}}^2 - \mathrm{V}(\mathrm{M}))$$

mapped to non-interacting fermions in a well.

Itzykson C., Zuber J.-B., J. Math. Phys. 21, 411-421 (1980),

The planar approximation. II

contains the celebrated Itzyson-Zuber formula

$$\int dU \, \exp(\mathrm{TrAUBU}^\dagger) = \frac{\det\left(\exp a_i b_j\right)}{\Delta(A)\Delta(B)}$$

a *localization* formula (i.e. WKB exact) which has been used repeatedly in thousand of articles on matrix models.

EB, D.J. Gross, C. Itzykson

Nucl. Phys. B 235 [FS11], 24-44 (1984)

Density of states in the presence of a strong magnetic field and random impurities in 2D

Electrons in a strong external magnetic field with random potential

$$H = (p - eA)^2 + V(r)$$

For large $B = \nabla \wedge A$, all the electrons lie in the lowest Landau level. Their wave function is then

$$\psi(x, y) = e^{-\frac{1}{4}\kappa^2|z|^2} u(z)$$

with holomorphic $u(z)$

The resolvent is given by

$$\langle r_1|(E-H+i0)^{-1}|r_2\rangle = -\int D\phi D\theta \phi(r_1)\phi^\star i(r_2)$$

$$\times \exp(i\int[\phi^\star(E-H_0)\phi+\bar{\theta}(E-H_0)\theta]dr - i\int V(r)[\phi^\star\phi+\bar{\theta}\theta]dr)$$

in which ϕ and θ belong to the $n = 0$ holomorphic subspace. Using holomorphic superfield one gets an exact dimensional reduction from dimension 2 to zero dimension. The density of states follows, however we have never succeeded to use this to compute the (more interesting) Hall conductivity.

Itzykson C., Zuber J.-B., Nucl. Phys. B275 [FS17], 580-616 (1986)

Two-dimensional conformal invariant theories on a torus

Itzykson C., Saleur H., Zuber J.-B., Europhys. Lett. 2, 91-96 (1986)

Conformal invariance of nonunitary 2d-models

Cappelli A., Itzykson C., Zuber J.-B., Commun. Math. Phys. 113, 1-26 (1987)

The A-D-E classification of minimal and $A_I^{(1)}$ conformal invariant theories

The last years

Huge activity, many collaborations with JB, Bauer, Di Francesco

Combinatorics, algebras, Kontsevich integral, triangulations, etc

How to characterize best Claude's unique personality?

nihil humani mihi alienum est

May I add that non only was he my best friend, but that no one has influenced me more than Claude in every respect?