

A lifelong friendship with Jean-Bernard

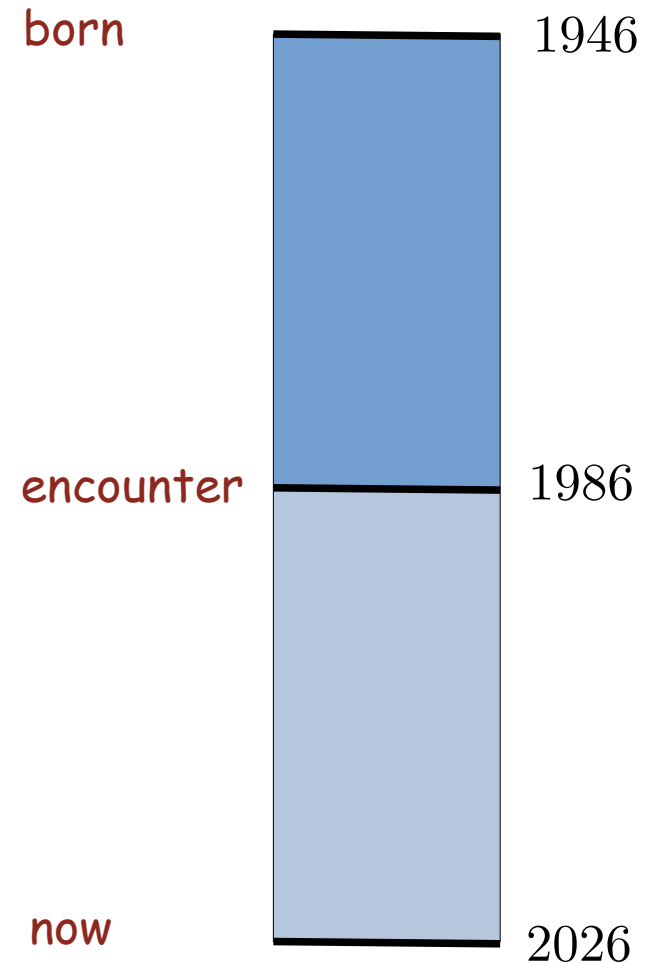
Andrea Cappelli
(INFN and Phys. Dept., Florence)

Outline

- two periods, two celebrations
- my first encounter with J-B
- being in SPTh Saclay circa 1987
- J-B & the ADE classification 40y passed

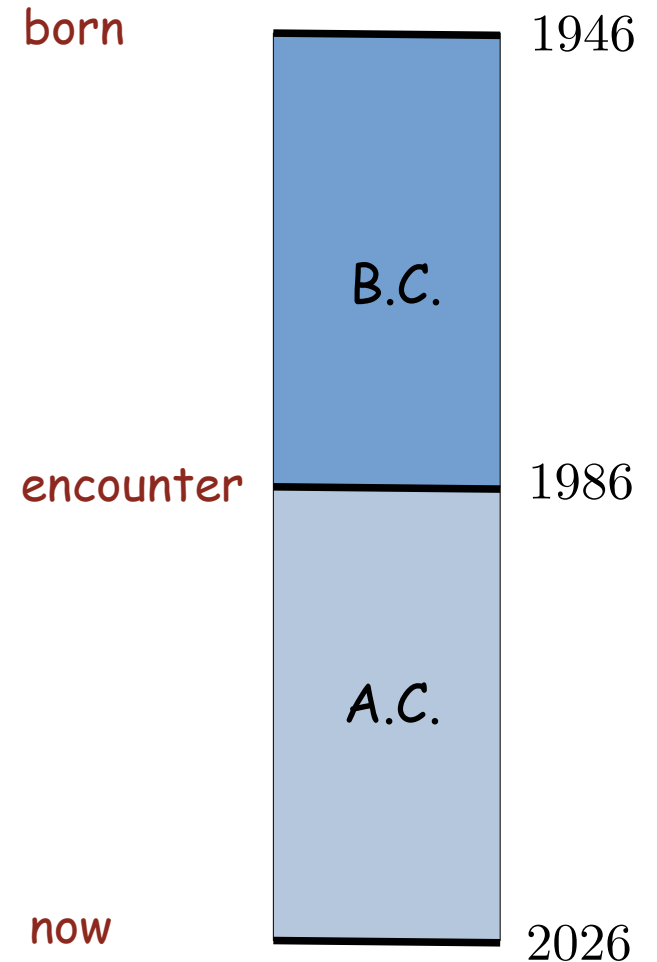
Two periods, two celebrations

- when we met I was 27, but he was young too!
- we know each other since a long time...



Two periods, two celebrations

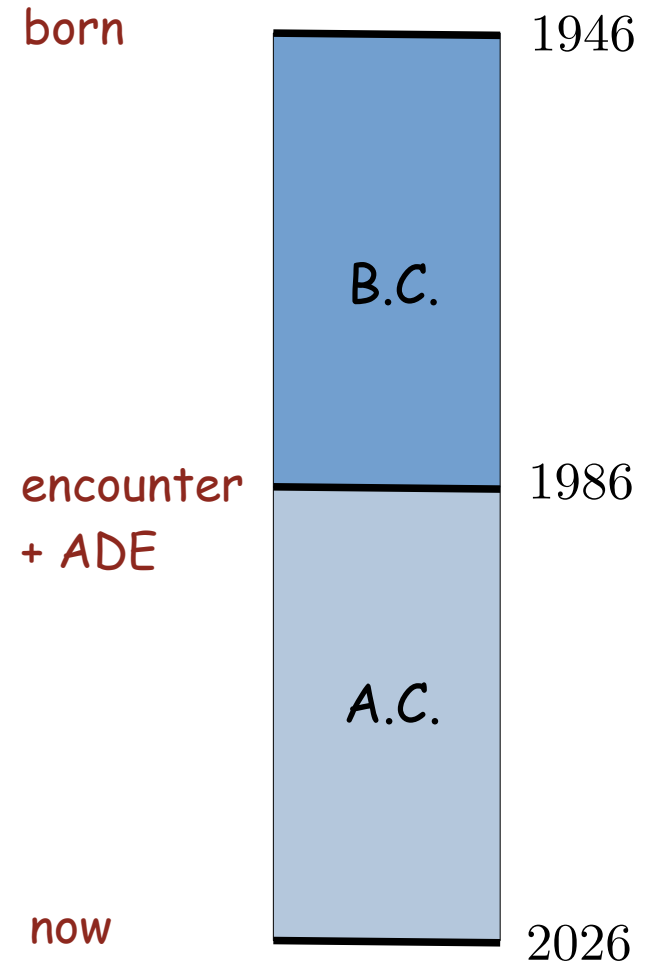
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➔ the ADE classification of CFTs has 40 years!

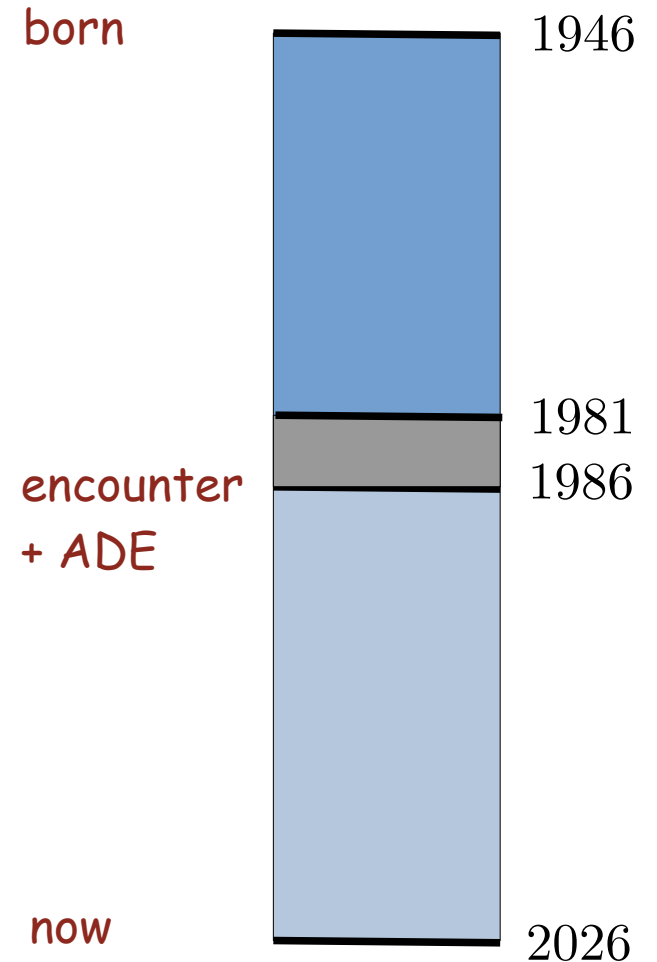


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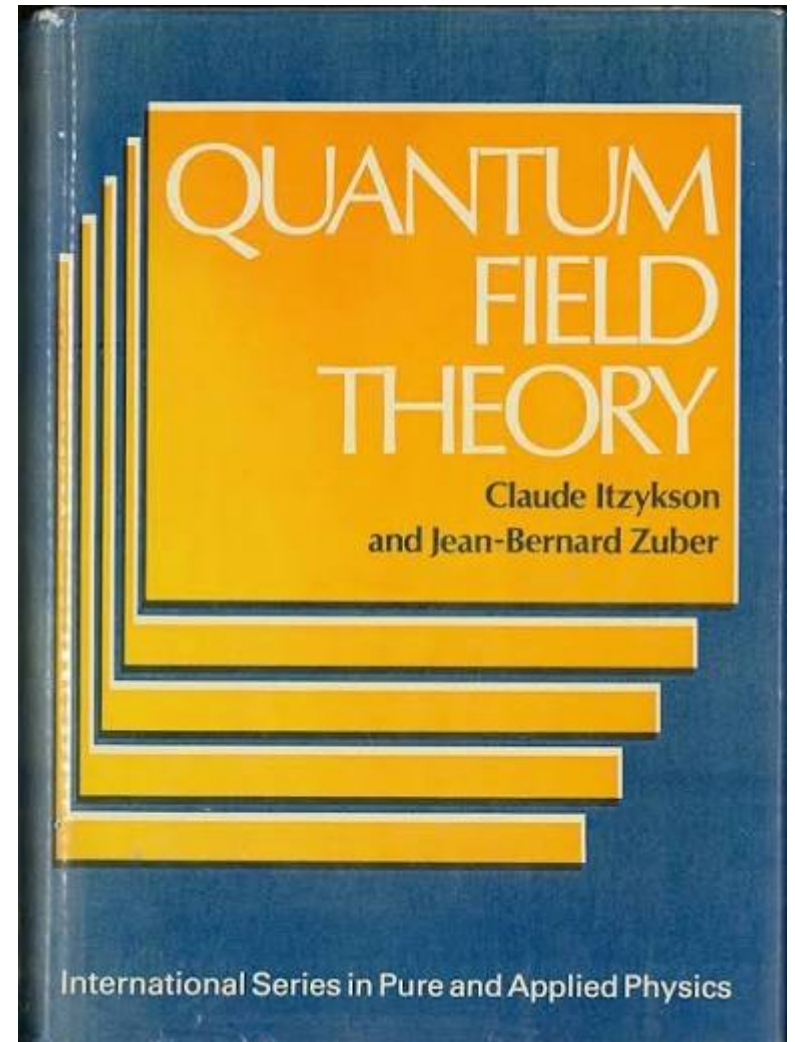
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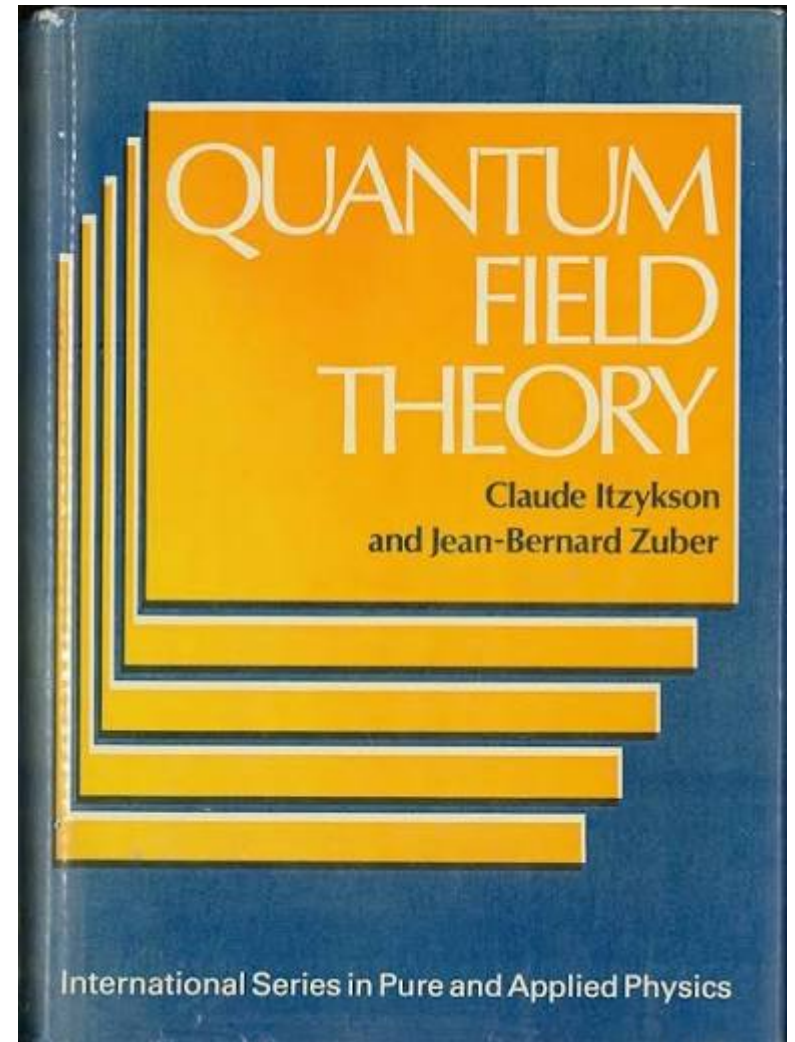
..but I had met J-B before!



- in these prehistorical times, written words were important....
- for a student of QFT, this book was very enjoyable...

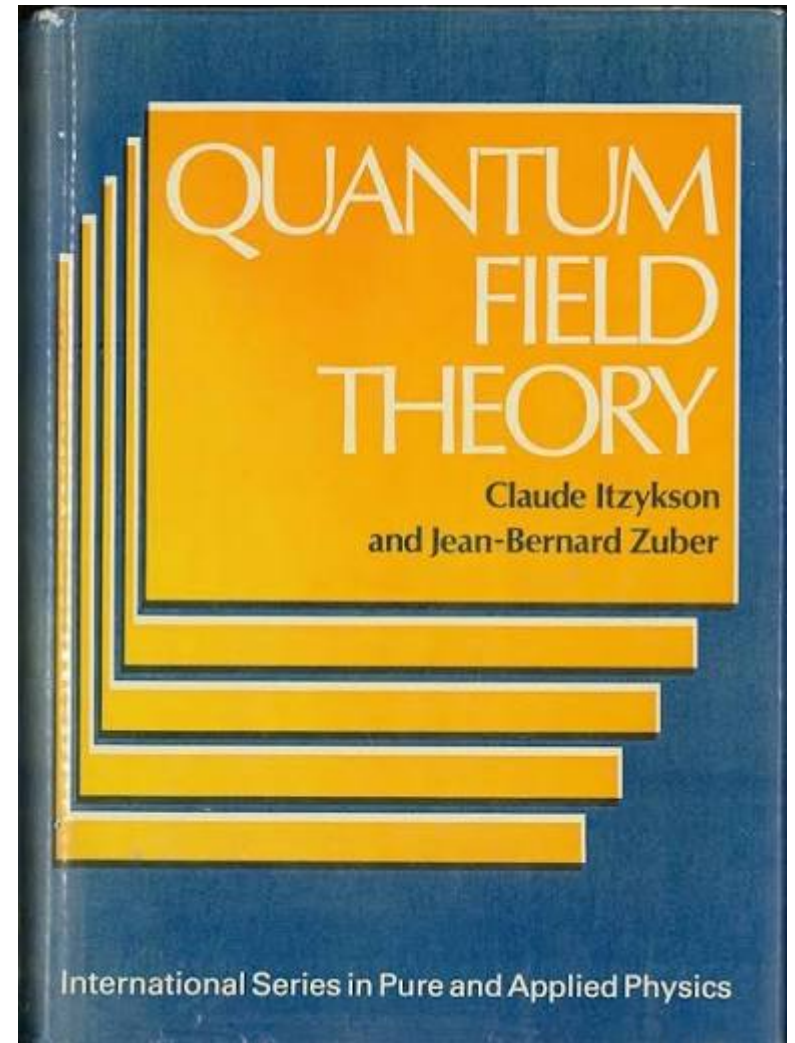


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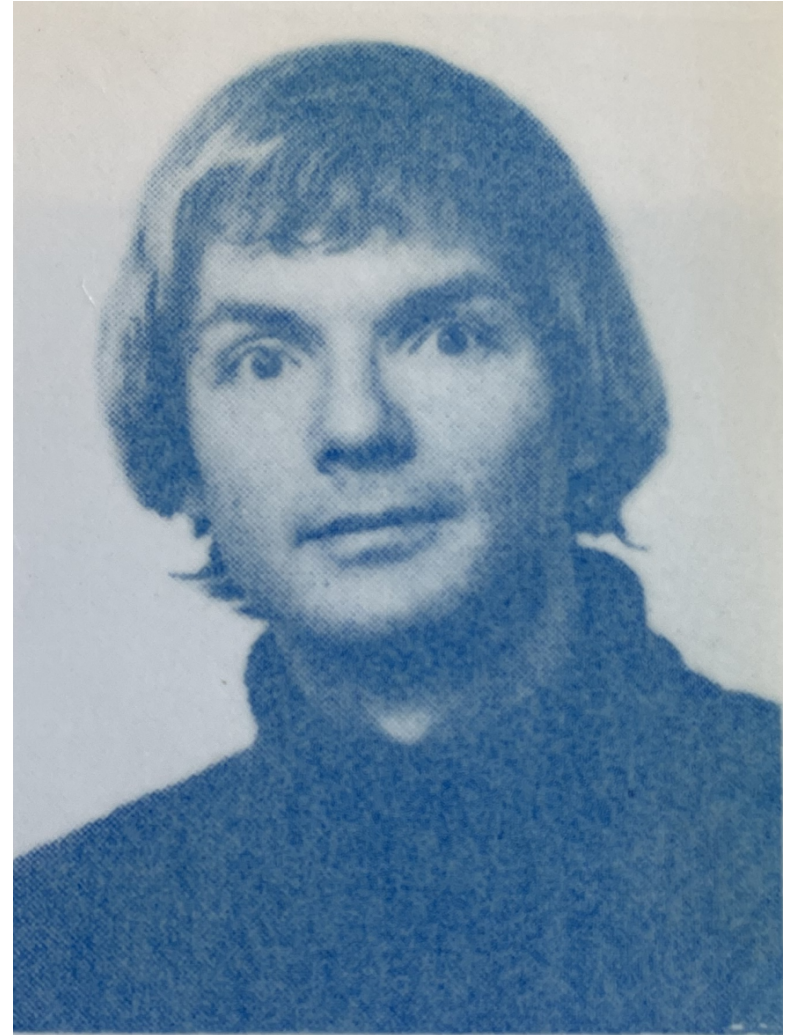


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How I met J-B?



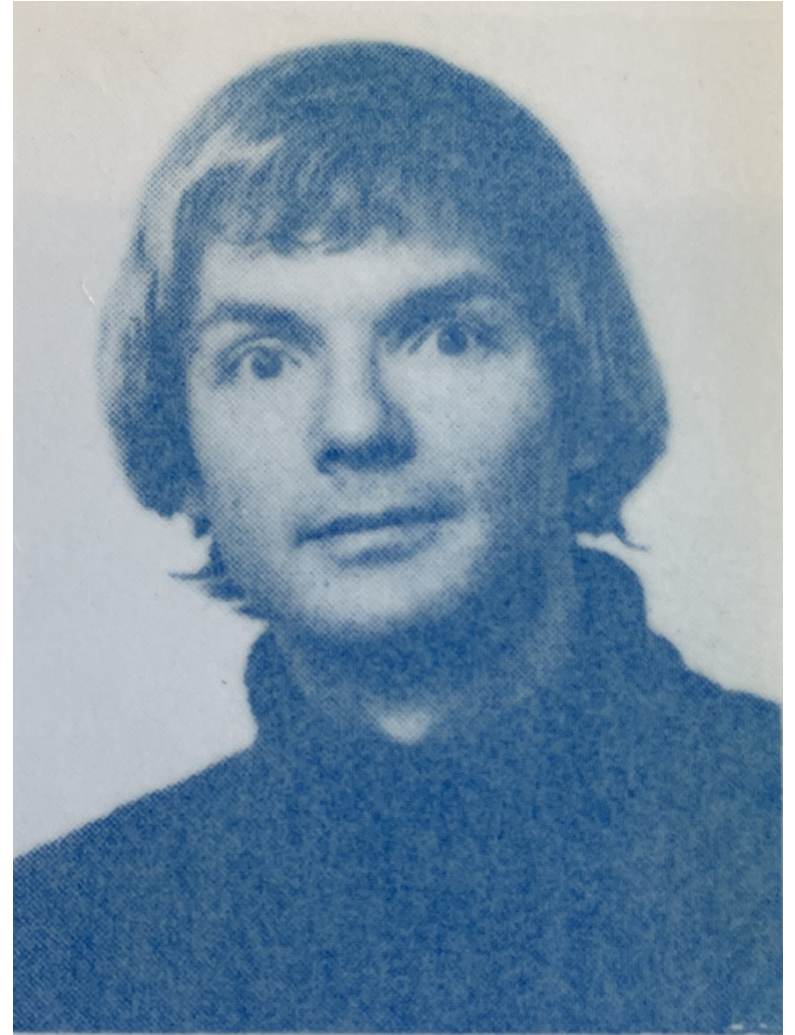
How I met J-B



How I met J-B

- This picture is "hidden", is not on internet

→ Let us ask to A.I.





ChatGPT ▾



do you know this man?

I can't determine or confirm the identity of a real person from a photo.

If you'd like, I can describe what I see:

- The image appears to be a monochrome blue-tinted reproduction of a portrait photograph.
- The person looks like a young adult.



Your first chat with Claude ▾



can you tell me who is this man?

I'm not able to identify who this person is from the photo. I can see it appears to be a **vintage portrait** (likely from the 1970s based on the style) of a young man with medium-length, bowl-cut style hair, wearing what looks like a turtleneck sweater. The image has a distinctive **blue monochrome/cyanotype** quality, suggesting it may be from an old yearbook, ID card, or printed publication.

If you could tell me who this is, I'd be happy to share any information I might know about them!





do you know this man?



Based on the visual characteristics, this is a portrait of **Gennady Bachinsky** (Геннадий Бачинский).

He was a very well-known Russian radio and television host, as well as a producer. He is most famous for co-hosting the highly popular radio shows "*Smotryashchie vniz*" (Looking Down) and "*Dva v odnom*" (Two in One) on the radio station "*Maximum*" with Sergey Stillavin in the late 1990s and early 2000s.

The specific hairstyle (shaggy bowl cut), the high-necked sweater, and the halftone blue printing style in this photo are strongly associated with his younger years during that era of his career.



do you know this man?

Yes, that is a well-known historical photo of **Jeffrey Dahmer**, a notorious American serial killer. ←

This specific monochrome blue image is an early photograph of him, often associated with his youth, high school years, or early adulthood in the 1970s.



Being in SPhT Saclay circa 1987

- SPhT was a big lab, with a very friendly atmosphere
 - I met many young people like me: Denis, Hubert, Ivan, Michel, Philippe, Thierry, Vincent...
 - during lunch, Claude Itzykson was teaching us physics
 - at the coffee, I was taught physics by other members
 - learning by "osmosis"
- ➡ Jean-Bernard was the key character for building the group, in all respects
- ➡ I will be forever grateful to him...

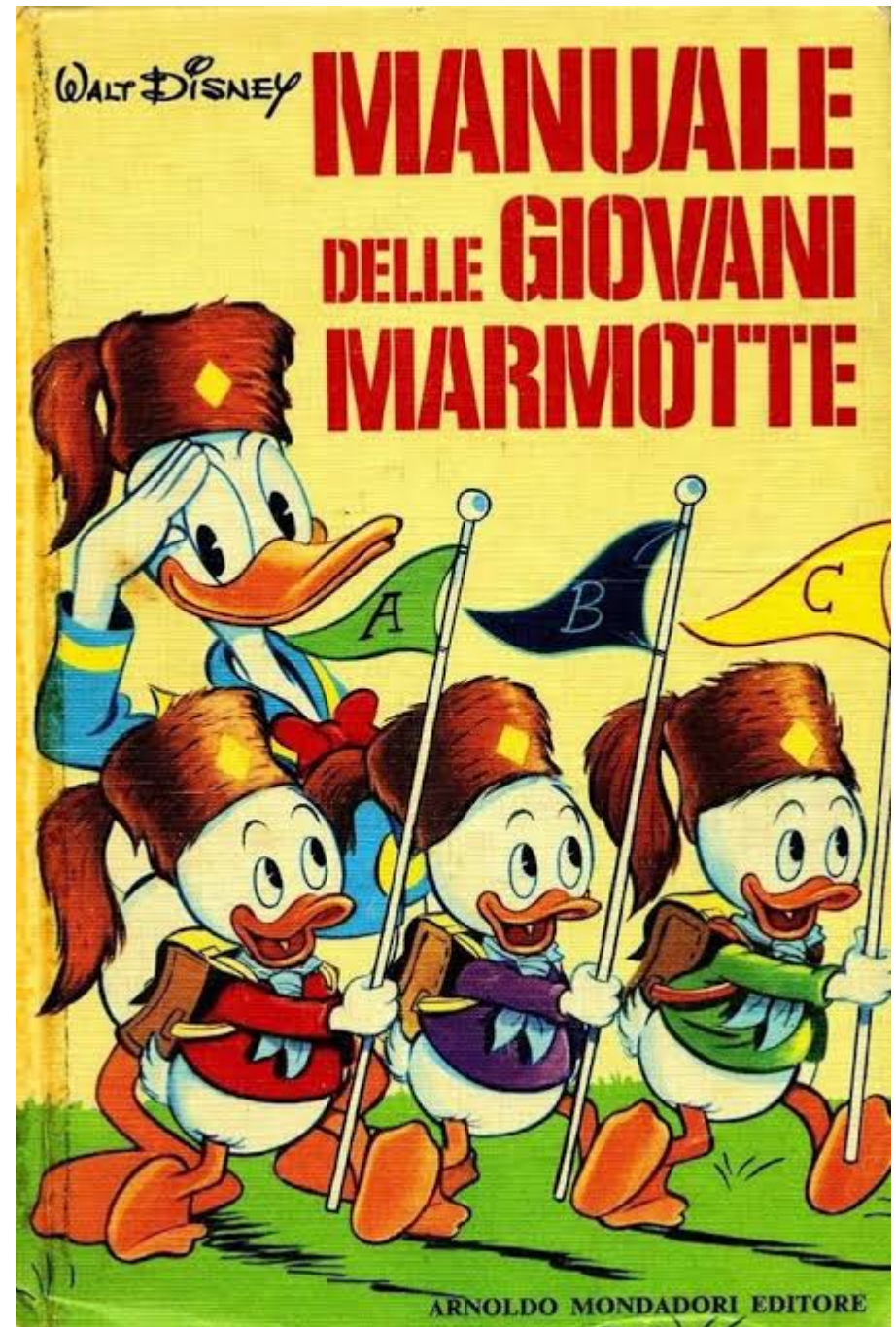
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....but let's take it lightly...

...another book of my youth....

(now 23rd ed. Italy; Manuels
des castors juniors, France)



J-B & the ADE classification 40y passed

Nuclear Physics B280 [FS 18] (1987) 445–465
North-Holland, Amsterdam

Commun. Math. Phys. 113, 1–26 (1987)

Communications in
Mathematical
Physics

MODULAR INVARIANT PARTITION FUNCTIONS IN TWO DIMENSIONS

A. CAPPELLI*, C. ITZYKSON and J.-B. ZUBER

Service de Physique Théorique, CEN-Saclay, 91191 Gif-sur-Yvette Cedex, France

Received 3 September 1986

We present a systematic study of modular invariance of partition functions, relevant both for two-dimensional minimal conformal invariant theories and for string propagation on a $SU(2)$ group manifold. We conjecture that all solutions are labelled by simply laced Lie algebras.

The A-D-E Classification of Minimal and $A_1^{(1)}$ Conformal Invariant Theories

A. Cappelli*, C. Itzykson, and J. B. Zuber

Service de Physique Théorique, CEN-Saclay, F-91191 Gif-sur-Yvette Cedex, France

Abstract. We present a detailed and complete proof of our earlier conjecture on the classification of minimal conformal invariant theories. This is based on an exhaustive construction of all modular invariant sesquilinear forms, with positive integral coefficients, in the characters of the Virasoro or of the $A_1^{(1)}$ Kac-Moody algebras, which describe the corresponding partition functions on a torus. A remarkable correspondence emerges with simply laced Lie algebras.

What is it all about?

(A.C & J-B.Z. Scholarpedia (2010), arxiv:0911.3242)

- use exact 1+1d conformal invariance & discrete reparameterization of the torus

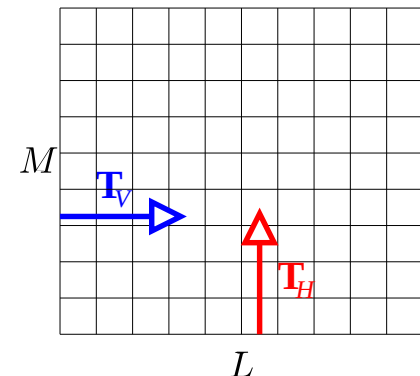
- Identity:

$$Z(L, M) = \text{Tr } \mathbf{T}_H^M = \text{Tr } \mathbf{T}_V^L$$

- can decompose Tr into known (pair of) conformal repr.

- Hilbert space $\mathcal{H} = \bigoplus_{j\bar{j} \in \mathcal{I}} N_{j\bar{j}} \mathcal{V}_j \otimes \mathcal{V}_{\bar{j}}$

- unknown integer multiplicities $N_{j\bar{j}}$

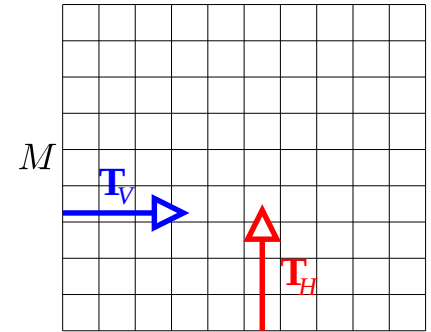


$$Z(L, M) = \text{Tr } \mathbf{T}_H^M = \text{Tr } \mathbf{T}_V^L$$

- trace in each repr. gives known character $\chi_j(q)$, $q = e^{2\pi i \tau}$
- solve integer identity for $N_{j\bar{j}}$ "bootstrap for Z"

$$SNS^\dagger = TNT^\dagger = N, \quad N \in \mathbb{N}, \quad N_{11} = 1$$

- S = exchange, T = twist of torus
- solution in remarkable connection with Dynkin diagrams A,D,E (Lie algebras)



$$\tau = iM/L$$

level	Z	diagram
$k \geq 0$	$\sum_{\lambda=1}^{k+1} \chi_\lambda ^2$	A_{k+1}
$k = 4\rho \geq 4$	$\sum_{\lambda \text{ odd}=1}^{2\rho-1} \chi_\lambda + \chi_{4\rho+2-\lambda} ^2 + 2 \chi_{2\rho+1} ^2$	$D_{2\rho+2}$
$k = 4\rho - 2 \geq 6$	$\sum_{\lambda \text{ odd}=1}^{4\rho-1} \chi_\lambda ^2 + \chi_{2\rho} ^2 + \sum_{\lambda \text{ even}=2}^{2\rho-2} (\chi_\lambda \bar{\chi}_{4\rho-\lambda} + \text{c.c.})$	$D_{2\rho+1}$
$k = 10$	$ \chi_1 + \chi_7 ^2 + \chi_4 + \chi_8 ^2 + \chi_5 + \chi_{11} ^2$	E_6
$k = 16$	$ \chi_1 + \chi_{17} ^2 + \chi_5 + \chi_{13} ^2 + \chi_7 + \chi_{11} ^2 + \chi_9 ^2 + [(\chi_3 + \chi_{15})\bar{\chi}_9 + \text{c.c.}]$	E_7
$k = 28$	$ \chi_1 + \chi_{11} + \chi_{19} + \chi_{29} ^2 + \chi_7 + \chi_{13} + \chi_{17} + \chi_{23} ^2$	E_8

simpler $SU(2)$ CFT;
extends to Virasoro
minimal models

- Why? (see: "Elements of ADE-ology" section in our review)

J-B & the ADE classification 40y passed

- it was some luck and some hard work....
- Claude Itzykson: "Andrea, why are you telling to me and J-B things that even you do not understand?"
- we both developed modular invariant Zs further (but did not make a living out of it...)

....yet, something recently happened...

Generalised twisted partition functions

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^a School of Computing and Mathematics, University of Northumbria, NE1 8ST Newcastle upon Tyne, UK

^b TH Division, CERN, CH-1211 Genève 23, Switzerland

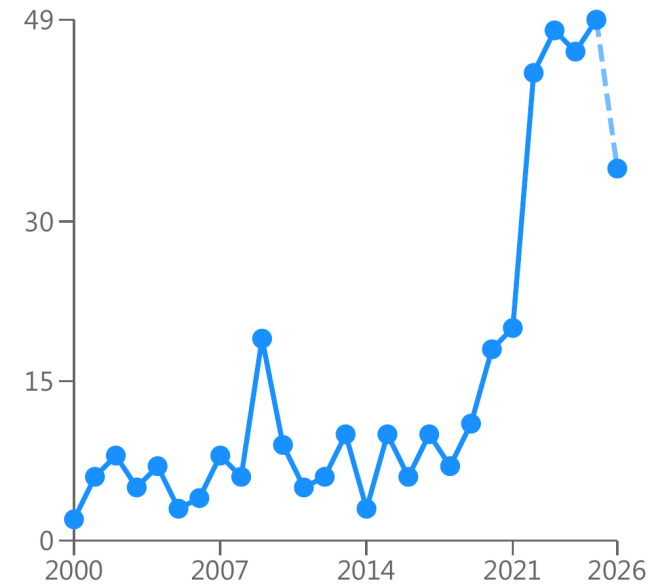
Received 6 November 2000; accepted 21 November 2000

Editor: L. Alvarez-Gaumé

Abstract

We consider the set of partition functions that result from the insertion of twist operators compatible with conformal invariance in a given 2D conformal field theory (CFT). A consistency equation, which gives a classification of twists, is written and solved in particular cases. This generalises old results on twisted torus boundary conditions, gives a physical interpretation of Ocneanu's algebraic construction, and might offer a new route to the study of properties of CFT. © 2001 Elsevier Science B.V. All rights reserved.

Citations per year



Inserting a topological defect $\mathcal{L}$ and imposing modular covariance: ex. Ising

$$\boxed{\begin{array}{|c|} \hline \rightarrow \\ \hline \end{array}} = Z^{\mathcal{L}}(\tau, \bar{\tau}) = \text{Tr}_{\mathcal{H}}[\mathcal{L} q^{L_0 - \frac{c}{24}} \bar{q}^{\bar{L}_0 - \frac{c}{24}}]$$

$$\boxed{\begin{array}{|c|} \hline \uparrow \\ \hline \end{array}} = Z_{\mathcal{L}}(\tau, \bar{\tau}) = \text{Tr}_{\mathcal{H}_{\mathcal{L}}}[q^{L_0 - \frac{c}{24}} \bar{q}^{\bar{L}_0 - \frac{c}{24}}]$$

$$Z^{\mathcal{L}}(\tau, \bar{\tau}) = Z_{\mathcal{L}}(-1/\tau, -1/\bar{\tau})$$

(from S.-H. Shao review 2308.00747, see also Behrend, Pearce, Petkova, Zuber 2000)

fusion of conformal fields $1, \varepsilon, \sigma$, vs. fusion of defects $I, \eta, \mathcal{D}$

(J-B, Petkova)

$$\varepsilon \times \varepsilon = 1,$$

$$\sigma \times \varepsilon = \varepsilon \times \sigma = \sigma,$$

$$\sigma \times \sigma = 1 + \varepsilon.$$

$$\eta^2 = I,$$

$$\eta \times \mathcal{D} = \mathcal{D} \times \eta = \mathcal{D},$$

$$\mathcal{D} \times \mathcal{D} = I + \eta.$$

most interesting is the “duality defect” $\mathcal{D}$

$$Z_{\mathcal{D}}(\tau, \bar{\tau}) = \chi_{\frac{1}{16}}(\tau) \bar{\chi}_0(\bar{\tau}) + \chi_{\frac{1}{16}}(\tau) \bar{\chi}_{\frac{1}{2}}(\bar{\tau}) + \chi_0(\tau) \bar{\chi}_{\frac{1}{16}}(\bar{\tau}) + \chi_{\frac{1}{2}}(\tau) \bar{\chi}_{\frac{1}{16}}(\bar{\tau}).$$

generalized symmetries: topological defects $\longleftrightarrow$ symmetry generators

$\mathcal{D}$ generates a non-invertible symmetry (there is no $\mathcal{D}^{-1}$)

Ising fusion rules are also called the $\mathbb{Z}_2$ Tambara-Yaganami fusion category TY_+

A lot of activity!

♥ Happy ♥
Birthday

