



# The Humble Giant of Supergravity

---

Anna Ceresole  
(INFN, Torino)

*Eugène Cremmer memorial session  
Paris, July 3rd, 2023*

ENS SUMMER INSTITUTE 2023

École normale supérieure Summer Institute 2023





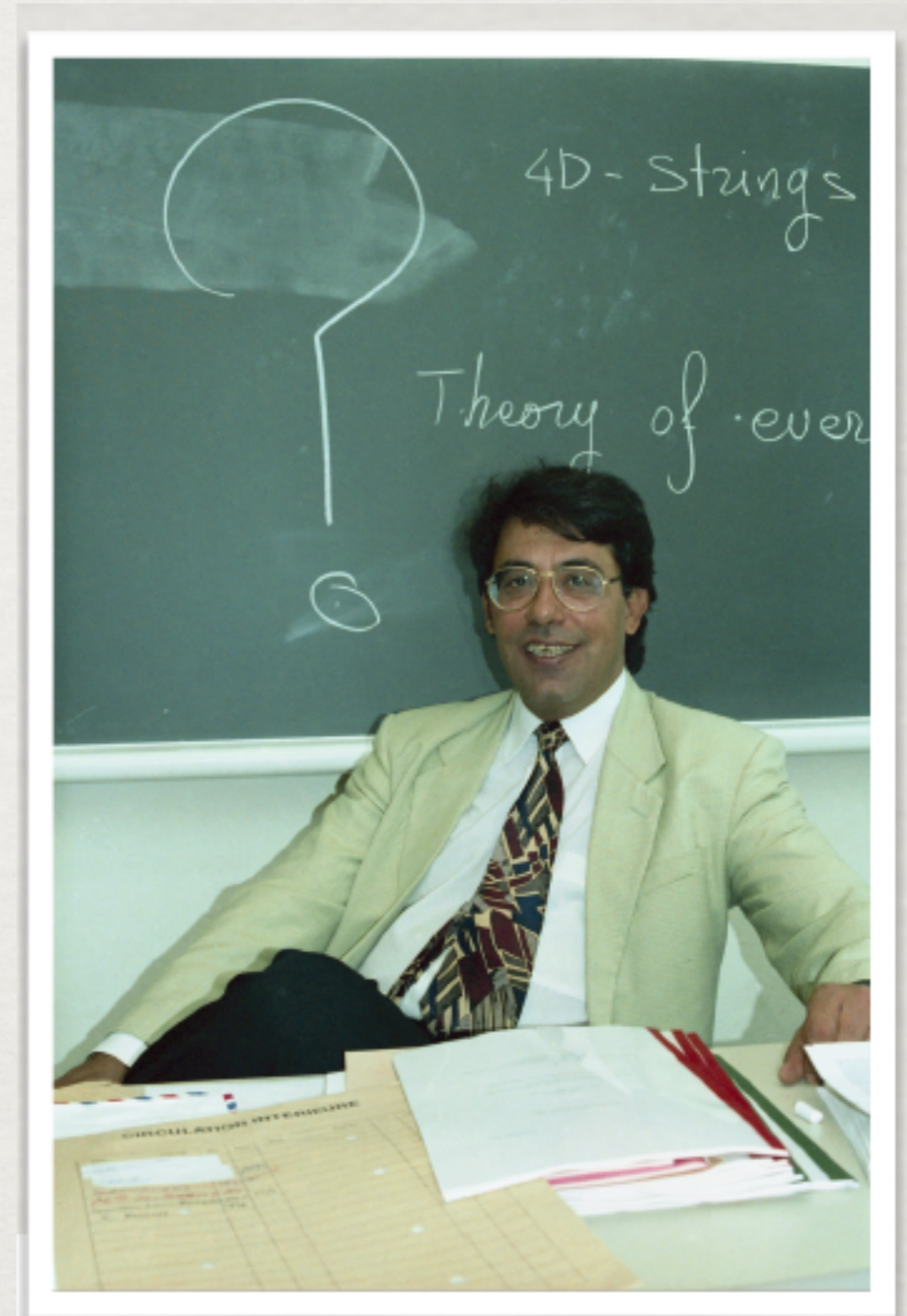
(1942—2019, 17<sup>em</sup>, Paris)

I will celebrate **Eugène Cremmer's** groundbreaking contributions, that have shaped the **supergravity and string theory** panorama for almost 50 years. Today they keep sourcing new ideas, reaching as far as the the physics of **gravitational waves**.



I will not miss to honour also my friend **Costas Kounnas** and among many of his contributions, his beautiful work with Eugène on no-scale models

The title of my talk, “**The humble giant ...**”,  
of course does not refer to Costas but to  
Eugène:  
for Costas I probably would have used  
“**The flamboyant hero of supergravity**”



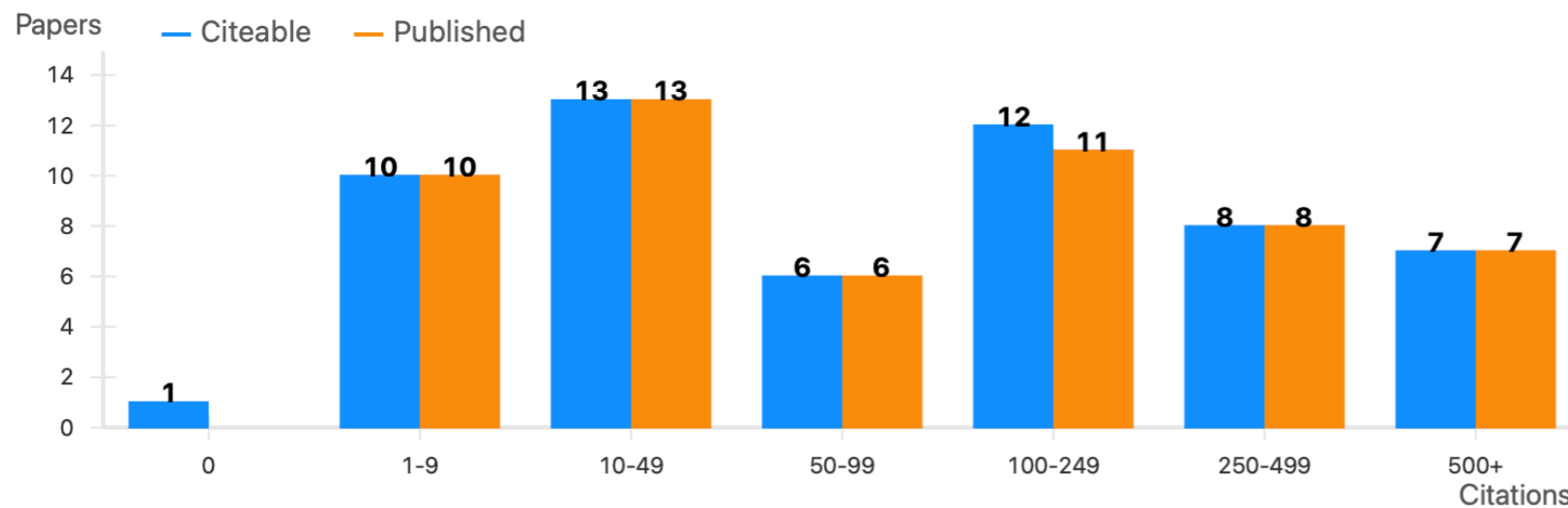
# Ask Inspire:



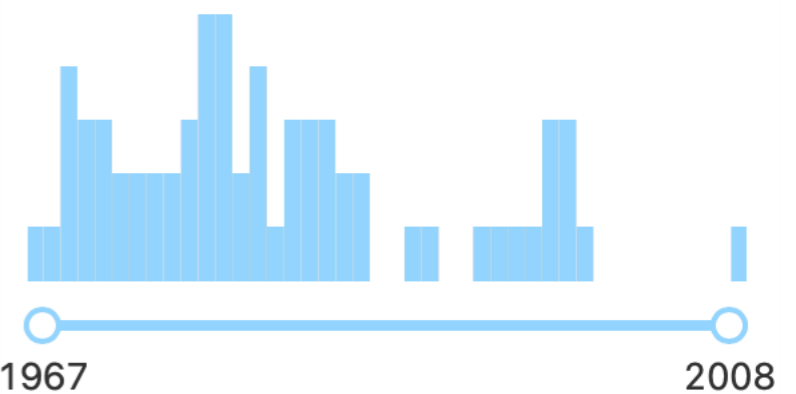
## Citation Summary

Exclude self-citations ?

	Citeable ?	Published ?
Papers	57	55
Citations	13,130	12,992
h-index ?	33	32
Citations/paper (avg)	230.4	236.2



## Date of paper



## Author

- Eugene Cremmer 67
- Joel Scherk 18
- Sergio Ferrara 12
- Jean-Loup Gervais 10
- Bernard Julia 8
- Luciano Girardello 7
- Christopher N. Pope 6
- Hong Lu 6
- Kellogg S. Stelle 4
- Antoine Van Proeyen 4
- Costas Kounnas 3
- Michel Gourdin 3

Several masterpieces:  $D=11$  &  $N=8$

# The fab 5

## #1 **Supergravity Theory in Eleven-Dimensions**

E. Cremmer(ENS), B. Julia(ENS), Joel Scherk(ENS) (Mar, 1978)  
Phys.Lett.B 76 (1978) 409-412                      1,807 citations

## #2 **The SO(8) Supergravity**

E. Cremmer(ENS), B. Julia(ENS) (Mar, 1979)  
Nucl.Phys.B 159 (1979) 141-212                      1,512 citations

## **The N=8 Supergravity Theory. I. The Lagrangian**

E. Cremmer(ENS), B. Julia(ENS) (Sep, 1978)  
Phys.Lett.B 80 (1978) 48                              728 citations

## #3 **Spontaneous Symmetry Breaking and Higgs Effect in Supergravity Without Cosmological Constant**

E. Cremmer(ENS), B. Julia(ENS), Joel Scherk(ENS), S. Ferrara(CERN), L. Girardello(Milan&INFN),  
P. Van Nieuwenhuizen (Leiden) (Sep, 1978)  
Nucl.Phys.B 147 (1979) 105                              869 citations

## #4 **Yang-Mills Theories with Local Supersymmetry: Lagrangian, Transformation Laws and SuperHiggs Effect**

E. Cremmer(ENS), S. Ferrara(CERN), L. Girardello(Milan U and INFN), Antoine Van Proeyen(CERN)  
(Jun, 1982)  
Nucl.Phys.B 212 (1983) 413                              1,266 citations

## #5 **Naturally Vanishing Cosmological Constant in N=1 Supergravity**

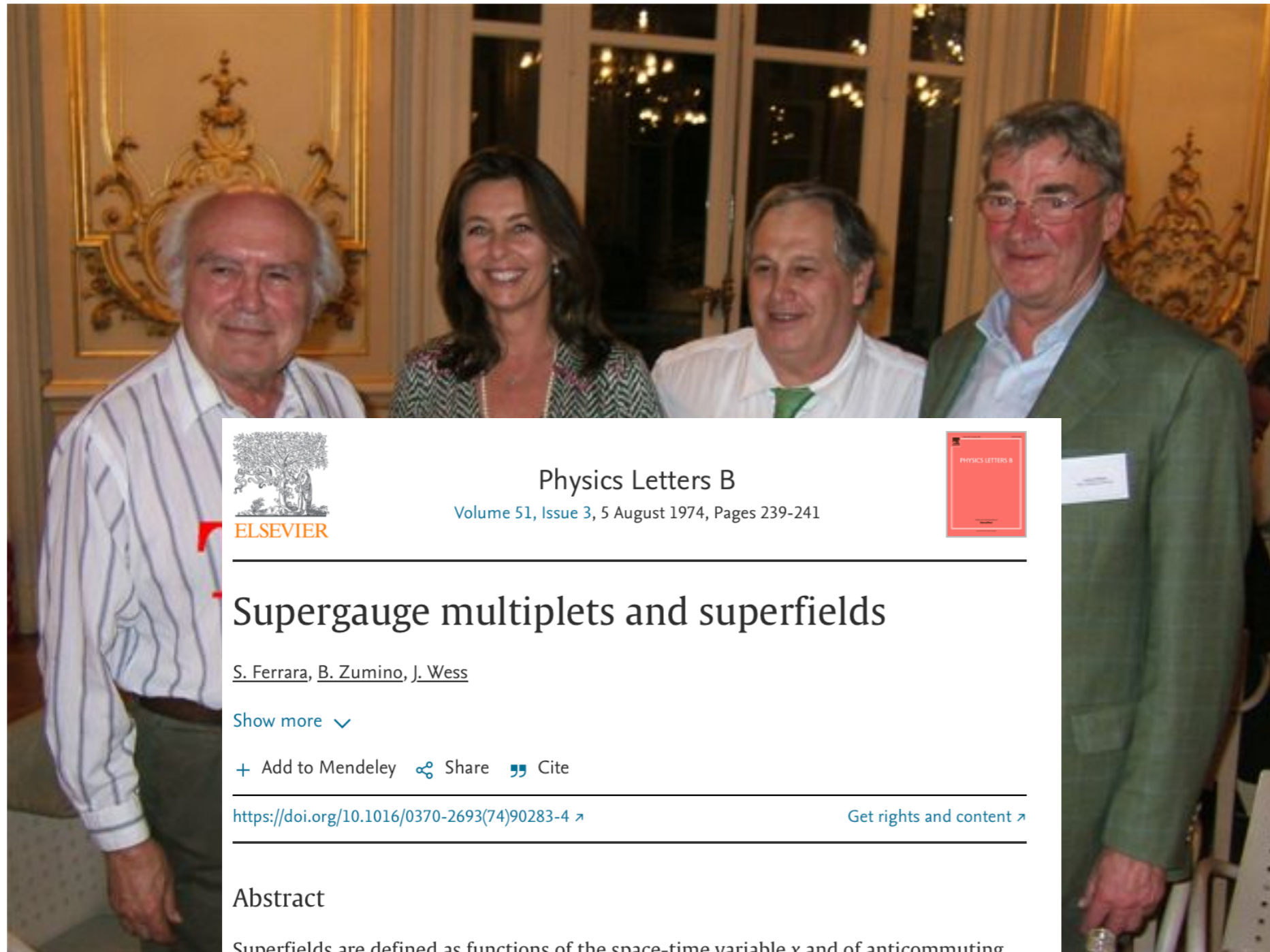
E. Cremmer(ENS), S. Ferrara(CERN), C. Kounnas(CERN), D. V. Nanopoulos(CERN) (Jul, 1983)  
Phys.Lett.B 133 (1983) 61                              863 citations

# San Francisco 1978



1st Supergravity conference

# 1974: supergauge multiplets and superfields



Physics Letters B

Volume 51, Issue 3, 5 August 1974, Pages 239-241



## Supergauge multiplets and superfields

S. Ferrara, B. Zumino, J. Wess

Show more

+ Add to Mendeley Share Cite

[https://doi.org/10.1016/0370-2693\(74\)90283-4](https://doi.org/10.1016/0370-2693(74)90283-4)

[Get rights and content](#)

### Abstract

Superfields are defined as functions of the space-time variable  $x$  and of anticommuting two-component spinors  $\theta$  and  $\bar{\theta}$ . They have definite transformation properties under supergauge transformations. Their expansion in  $\theta$  and  $\bar{\theta}$  generates a finite number of ordinary fields forming a multiplet. A number of operations are defined which allow the construction of new superfields from given ones. The corresponding set of multiplets is complete, in the sense that the product of any two can be decomposed as a sum of multiplets belonging to the same set.



# Ask a bot: ChatGPT

AN

who was Eugène Cremmer?



Eugène Cremmer was a French theoretical physicist who made significant contributions to the field of theoretical physics, particularly in the areas of quantum field theory, supergravity, and string theory. He was born on October 5, 1938, in Paris, France, and passed away on November 5, 2010. **Wrong dates!**



Cremmer is best known for his work on supersymmetry and supergravity. He played a crucial role in the development of N=8 supergravity, a highly influential theory that combines supersymmetry with gravity. Along with his collaborators, he made groundbreaking discoveries and formulated important mathematical frameworks that advanced our understanding of these fundamental physical theories.

Throughout his career, Cremmer made significant contributions to various aspects of theoretical physics, including the study of higher-dimensional theories, the investigation of black holes, and the exploration of string theory. His work greatly influenced the field and earned him recognition and numerous awards, including the Dirac Medal from the International Centre for Theoretical Physics in 1990. **Wrong prize!**

Eugène Cremmer's contributions to theoretical physics have had a lasting impact, and his research continues to shape our understanding of the fundamental laws that govern the universe.

Bernard Julia is a French theoretical physicist known for his influential contributions to theoretical physics, particularly in the field of string theory and mathematical physics. He was born on June 16, 1945, in France. **Wrong date!**

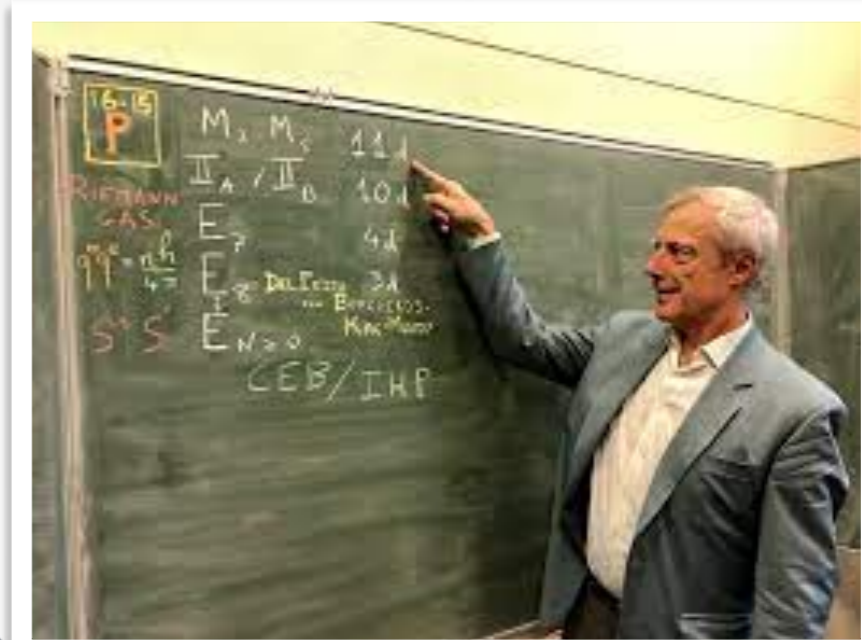


Julia has made significant contributions to various areas of theoretical physics, including supersymmetry, supergravity, and duality symmetries. He is well-known for his collaboration with Eugène Cremmer and Joël Scherk in the development of N=8 supergravity, a supersymmetric extension of gravity that incorporates eight supersymmetries.

In addition to his work on supergravity, Julia has made important contributions to the understanding of duality symmetries in string theory. He played a key role in elucidating the concept of "electric-magnetic duality" in gauge theories, which is a profound symmetry that relates different descriptions of the same physical system.

Julia has published numerous research papers and has been recognized for his contributions with various awards and honors. He was elected as a member of the French Academy of Sciences in 2001. His work has had a significant impact on the development of string theory, supergravity, and the broader field of theoretical physics.





Bernard Julia's research and insights have not only advanced our understanding of fundamental physics but have also provided deep mathematical connections between different areas of theoretical physics. His contributions continue to inspire and guide further investigations into the nature of the universe.



Ask Bernard!

# Ask a bot: ChatGPT

AN who is anna ceresole?

 I apologize, but I couldn't find any notable public figure or well-known person by the name of Anna Ceresole in my database. It's possible that the individual you're referring to may not be widely recognized or may be a private individual. If there is specific context or additional information you can provide, I may be able to assist further.   



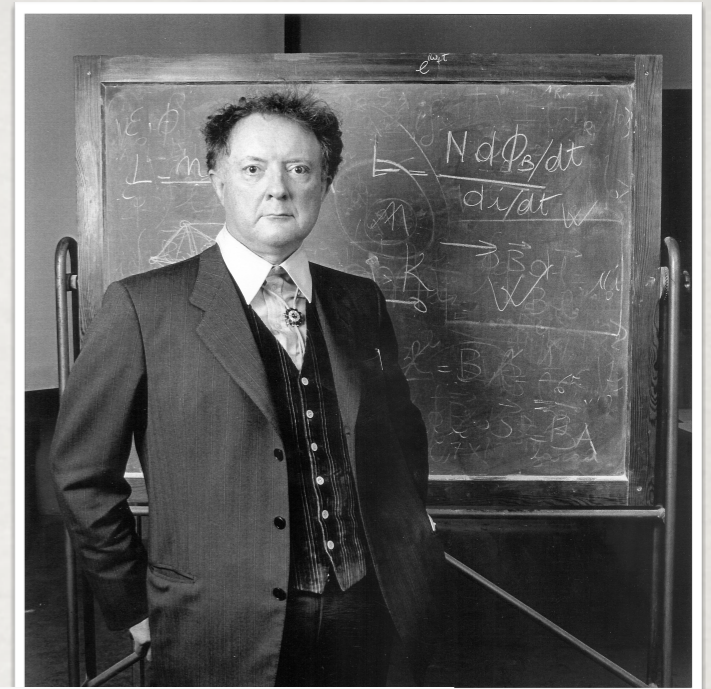
## *In Torino:*



The group manifold approach to unified gravity (Regge & Ne'eman, 1978)

The birth of String Theory (Fubini, Ademollo et al,...)

Castellani, D'Auria, Fré... (Kaluza-Klein compactifications...)



# Woodwork and Supergravity



$$e_M^A (g_{MN}) \rightarrow e_m^{\lambda} (g_{\mu\nu})$$

$$B_{\mu}^i (g_{\mu i})$$

$$e_{\nu}^j (g_{ij})$$

$$A_{MNP} \rightarrow A_{\mu\nu\rho} \text{ AUXILIARY}$$

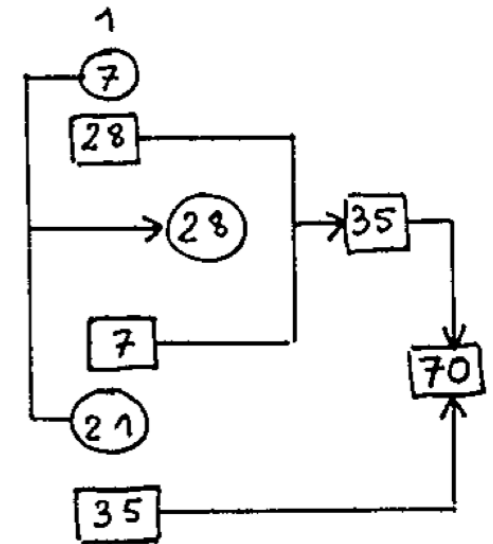
$$A_{\mu\nu i} \sim \phi^i$$

$$A_{\mu ij} \sim B_{\mu}^{ij}$$

$$A_{ijk}$$

$$\Psi_M \rightarrow \Psi_{\mu}^A$$

$$\Psi_{\mu}^A \sim \lambda_{ABC}$$



8  
56

We can now write the complete Lagrangian for the N = 8 supergravity

$$\begin{aligned} \mathcal{L} = & -\frac{e}{4} R(\omega, e) + \frac{1}{2} \varepsilon^{\mu\nu\rho\sigma} \bar{\Psi}_{\mu A} \gamma_{\rho} \gamma_{\sigma} (\delta_A^B D_{\nu}(\omega) - \phi_{\nu A}^B) \Psi_{\rho B} \\ & + \frac{e}{8} G_{\mu\nu}^{MN} H_{MN}^{\mu\nu} (B, V, \Psi, \lambda) + \frac{ie}{12} \bar{\lambda}_{ABC} \gamma^{\mu} (\delta_A^D D_{\mu}(\omega) - 3\phi_{\mu A}^D) \lambda_{BCD} \\ & + \frac{e}{24} P_{ABCD} \hat{P}^{\mu ABCD} + \frac{e}{6\sqrt{2}} \bar{\Psi}_{\mu A} \gamma^{\nu} \gamma^{\mu} (\hat{P}_{\nu}^{ABCD} + \hat{P}_{\nu}^{\wedge ABCD}) \lambda_{BCD} \\ & + \frac{e}{8\sqrt{2}} \left\{ \bar{\Psi}_{\mu A} \gamma^{\nu} \hat{F}_{AB}^{\mu\nu} \Psi_{\nu B} - \frac{i}{\sqrt{2}} \bar{\Psi}_{\mu C} \hat{F}_{AB}^{\mu\nu} \gamma^{\mu} \lambda_{ABC} \right. \\ & \quad \left. - \frac{1}{72} \varepsilon^{ABCDEFGH} \bar{\lambda}_{ABC} \hat{F}_{DE}^{\mu\nu} \lambda_{FGH} \right\} \end{aligned}$$

# N=8 Supergravity, TOE and the Maharishi

We can now write the complete Lagrangian for the N = 8 supergravity

$$\begin{aligned} \mathcal{L} = & -\frac{e}{4} R(\omega, e) + \frac{1}{2} \varepsilon^{\mu\nu\rho\sigma} \bar{\Psi}_{\mu A} \gamma_{\rho} \gamma_{\sigma} (\delta_A^B D_{\nu}(\omega) - \varphi_{\nu A}^B) \Psi_{\rho B} \\ & + \frac{e}{8} G_{\mu\nu}^{MN} \tilde{H}^{\mu\nu}(\beta, \psi, \chi, \lambda) + \frac{ie}{12} \bar{\lambda}_{ABC} \gamma^{\mu} (\delta_A^D D_{\mu}(\omega) - 3\varphi_{\mu A}^D) \lambda_{BCD} \\ & + \frac{e}{24} P_{ABCD} \hat{P}^{\mu ABCD} + \frac{e}{6\sqrt{2}} \bar{\Psi}_{\mu A} \gamma^{\nu} \gamma^{\mu} (\hat{P}_{\nu}^{ABCD} + \hat{\tilde{P}}_{\nu}^{ABCD}) \lambda_{BCD} \\ & + \frac{e}{8\sqrt{2}} \left\{ \bar{\Psi}_{\mu A} \gamma^{\nu} \hat{F}_{AB} \gamma^{\mu} \Psi_{\nu B} - \frac{i}{\sqrt{2}} \bar{\Psi}_{\mu C} \hat{F}_{AB} \gamma^{\mu} \lambda_{ABC} \right. \\ & \quad \left. - \frac{\gamma}{\sqrt{2}} \varepsilon^{ABCDEFGH} \bar{\lambda}_{ABC} \hat{F}_{DE} \lambda_{FGH} \right\} \end{aligned}$$



## Discovery of the Unified Field

Unification of the Four Fundamental Forces of Nature



Super Unification

**UNIFIED FIELD**  
OF ALL THE LAWS OF NATURE

*Total Potential of Natural Law*

..his last paper in 2008

In his personal recollections about the birth of string theory <https://arxiv.org/pdf/0812.1190.pdf> he praises the phenomenological work he did for his PhD in Orsay with Gourdin on e+e-processes:

*“These works allowed me to deepen my knowledge in particle physics as well as to learn mastering difficult calculations. However, I was more attracted by more formal research (that we would like being able to say more fundamental!) “.*

# Dual models

*The theoretical physics laboratory in Orsay was also hit by the explosion of activity which followed **the paper of Veneziano**, and a group of people began to work on dual models: Bouchiat, Gervais, Nuyts, **Amati** who was spending a sabbatical in Orsay, as well as younger researcher Neveu, Scherk and Surlas.*

***My first encounter with dual models was to rebel against this too fashionable growing activity.***

*With Jean Nuyts I asked if there could be some other example of a s-t dual amplitude with only poles in both channels [...] however this amplitude led to many unsatisfactory physical conclusions and*

***I joined the main stream.***



# CERN

*I had the chance to get a fellow position at the theory division at CERN for 2 years (1971 and 1972). This was the first chance of my career.*

*The second one was to "integrate" the dual group at CERN which was led by Daniele Amati. In this group, there was not only a very stimulating scientific atmosphere, but also a very friendly one.*

*Then arrived my third and most important chance, the venue of **Jöel Scherk** and the beginning of our collaboration.*

*As early as that stage, Jöel was a profound physicist. He was a very quiet and efficient physicist. His notes were very clear and are still readable many years later (contrary to mine!)*



# Life in eleven dimensions



ELSEVIER

Physics Letters B

Volume 76, Issue 4, 19 June 1978, Pages 409-412



## Supergravity in theory in 11 dimensions

E. Cremmer, B. Julia, J. Scherk

Show more

+ Add to Mendeley Share Cite

[https://doi.org/10.1016/0370-2693\(78\)90894-8](https://doi.org/10.1016/0370-2693(78)90894-8)

[Get rights and content](#)

### Abstract

We present the action and transformation laws of supergravity in 11 dimensions which is expected to be closely related to the  $O(8)$  theory in 4 dimensions after dimensional reduction.



...from Sergio



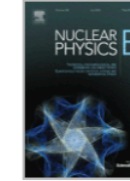
*“...obviously  $N=8$  in relation with his work with Bernard on 3-forms and branes  
—the construction of sugra coupled to matter with Luciano and myself  
—the work on no-scale models with Kounnas and Nanopoulos”*

# N=8 Supergravity



Nuclear Physics B

Volume 159, Issues 1–2, 5–12 November 1979, Pages 141–212



## The SO(8) supergravity

E. Cremmer, B. Julia

Show more

Add to Mendeley Share Cite

[https://doi.org/10.1016/0550-3213\(79\)90331-6](https://doi.org/10.1016/0550-3213(79)90331-6)

[Get rights and content](#)

### Abstract

We present the derivation of the SO(8) supergravity theory by dimensional reduction of the supergravity theory in 11 dimensions to 4 dimensions. It has been found that the equations of motion are invariant under the global non-compact group  $E_{7(+7)}$ . They can be derived from a family of Lagrangians invariant under a local compact group SU(8). The general procedure to deal with non-compact global internal symmetry without introducing ghosts is discussed in connection with the appearance of an associated compact local symmetry and the use of a non-linear realization of the non-compact group. The supersymmetry transformation rules have been partially derived by dimensional reduction; their complete form follows from the assumption of covariance with respect to  $E_7$  and SU(8). We also present briefly the  $O(N)$  supergravities  $N = 7, 6, 5$  and explain the symmetry  $SU(4) \times SU(1, 1)$  found for the  $O(4)$  supergravity.

# Supergravity couplings



Physics Letters B

Volume 116, Issue 4, 14 October 1982, Pages 231-237



## Coupling supersymmetric Yang-Mills theories to supergravity

E. Cremmer<sup>a</sup>, S. Ferrara<sup>b</sup>, L. Girardello<sup>c,d</sup>, A. Van Proeyen<sup>1,e</sup>

Show more

+ Add to Mendeley Share Cite

[https://doi.org/10.1016/0370-2693\(82\)90332-X](https://doi.org/10.1016/0370-2693(82)90332-X) ↗

[Get rights and content](#) ↗

### Abstract

We extend the technique of Cremmer et al. to couple arbitrary chiral multiplets with supersymmetric Yang-Mills interactions to  $N = 1$  supergravity. We present the general form of the lagrangian and the detailed form of the scalar potential is spelled out. In the case of  $N$  chiral multiplets, “minimally” coupled to supergravity, we derive, in the absence of gauge interactions, a model-independent mass formula Supertrace  $M^2 = \sum_J (-)^{2J} (2J + 1) m_J^2 = 2(N - 1) m_{3/2}^2$ , where  $m_{3/2}$  is the gravitino mass. A concrete example of the super Higgs effect involving  $N$  chiral multiplets is exhibited.

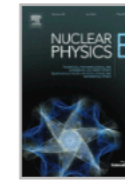
Life changing

# Supergravity couplings



Nuclear Physics B

Volume 212, Issue 3, 28 February 1983, Pages 413-442



## Yang-Mills theories with local supersymmetry: Lagrangian, transformation laws and super-Higgs effect

E. Cremmer, S. Ferrara, L. Girardello, A. Van Proeyen<sup>1</sup>

[Show more](#)

[+](#) Add to Mendeley [🔗](#) Share [🗒](#) Cite

[https://doi.org/10.1016/0550-3213\(83\)90679-X](https://doi.org/10.1016/0550-3213(83)90679-X)

[Get rights and content](#)

### Abstract

We derive the lagrangian and transformation laws of the coupled Yang-Mills-matter-supergravity system for unextended  $n = 1$  local supersymmetry. We study the super-Higgs effect and the normal Higgs effect of the Yang-Mills gauge group  $G$ . In the case of  $N$  chiral multiplets “minimally” coupled to supergravity, transforming according to some  $N$ -dimensional, generally reducible representation of  $G$ , we find a model-independent mass formula:

$$\text{Supertrace } M^2 = \sum_{J=0}^{\infty} 2(-)^{2J} (2J+1) \mathbf{m}_J^2 = (N-1)(2\mathbf{m}_{3/2}^2 - \kappa^2 D^\alpha D^\alpha) - 2\mathbf{g}_\alpha D^\alpha \text{Tr } T^\alpha$$

, where  $\mathbf{m}_{3/2}$  is the gravitino mass,  $\kappa$  and  $\mathbf{g}_\alpha$  the gravitational and gauge couplings, respectively,  $D^\alpha$  is the auxiliary component of the gauge multiplet of  $G$  and  $T^\alpha$  the generators of  $G$  in the representation of the matter chiral multiplets.

# No scale models



Physics Letters B

Volume 133, Issues 1–2, 8 December 1983, Pages 61–66



---

## Naturally vanishing cosmological constant in $N=1$ supergravity

E. Cremmer, S. Ferrara, C. Kounnas, D.V. Nanopoulos

Show more 

+ Add to Mendeley  Share  Cite

---

[https://doi.org/10.1016/0370-2693\(83\)90106-5](https://doi.org/10.1016/0370-2693(83)90106-5) ↗

[Get rights and content](#) ↗

---

### Abstract

For  $N=1$  supergravity theories we show that the choice of a particular class of Einstein spaces for the Kähler manifold of the hidden sector leads to a vanishing cosmological constant without unnatural fine tuning. The total scalar potential from the hidden and physical sector is positive definite. The resulting low energy softly broken global supersymmetry for the matter fields is thus the same as in the case of factorized superpotential models with a flat Kähler metric.

---

# The many facets of Supergravity

- ★ A quantum field theory realising local supersymmetry
- ★ A Low energy effective action for string theories
- ★ One side of the AdS/CFT correspondence
- ★ A theoretical laboratory to study black holes
- ★ A scheme for a consistent finite theory of quantum gravity
- ★ A setting for models for cosmology
- ★ A laboratory for beautiful mathematical ideas



# From eleven to five...



Physics Letters B

Volume 357, Issues 1–2, 31 August 1995, Pages 76–80



## 11-Dimensional supergravity compactified on Calabi-Yau threefolds ☆

A.C. Cadavid<sup>d a</sup>, A. Ceresole<sup>d b</sup>, R. D'Auria<sup>d b</sup>, S. Ferrara<sup>c d</sup>

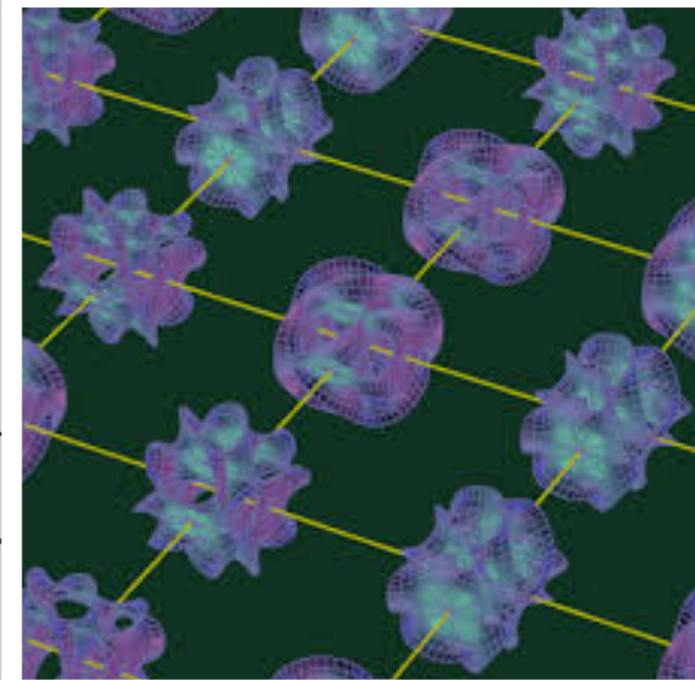
Show more ▾

+ Add to Mendeley  Share  Cite

[https://doi.org/10.1016/0370-2693\(95\)00891-N](https://doi.org/10.1016/0370-2693(95)00891-N) ↗

### Abstract

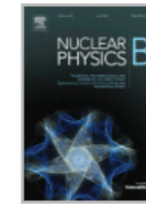
We consider generic features of eleven dimensional supergravity compactified down to five dimensions on an arbitrary Calabi-Yau threefold. The possible relation with the heterotic string compactified on  $K3 \times S_1$  is discussed.



# N=2 Supergravity couplings



Nuclear Physics B  
Volume 250, Issues 1–4, 1985, Pages 385-426



## Vector multiplets coupled to $N=2$ supergravity: Super-Higgs effect, flat potentials and geometric structure

E. Cremmer, C. Kounnas, A. Van Proeyen<sup>1</sup>, J.P. Derendinger, S. Ferrara, B. de Wit<sup>2</sup>, L. Girardello<sup>3 4</sup>

Show more 

+ Add to Mendeley  Share  Cite

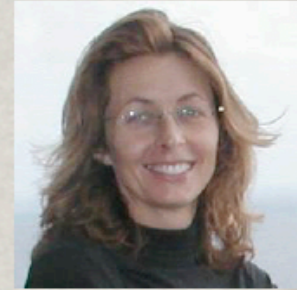
[https://doi.org/10.1016/0550-3213\(85\)90488-2](https://doi.org/10.1016/0550-3213(85)90488-2) ↗

[Get rights and content](#) ↗

### Abstract

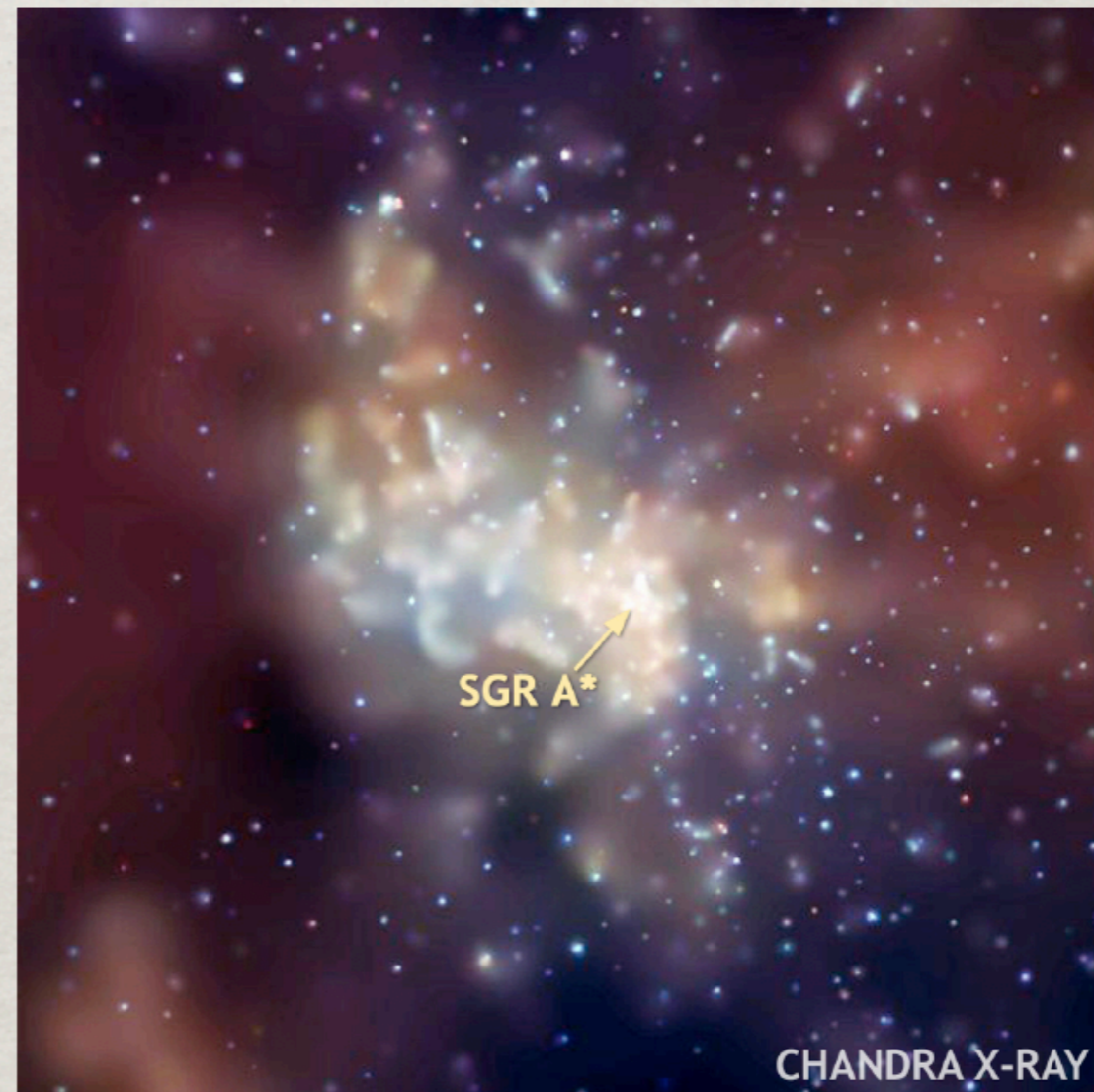
We obtain general properties of  $N=2$  gauged extended supergravity coupled to vector multiplets, which can gauge an arbitrary group. General formulas for masses and curvatures are derived. Particular attention is devoted to the scalar potential of the theory which determines the classical vacuum structure. Explicit examples are given in which the potential is identically zero, but supersymmetry is broken. It is found that these theories are symmetric under generalized duality transformations.

# Application to Black Holes in Supergravity



“The dark side of  
String Theory”  
(G. Horowitz,  
Trieste 1992)

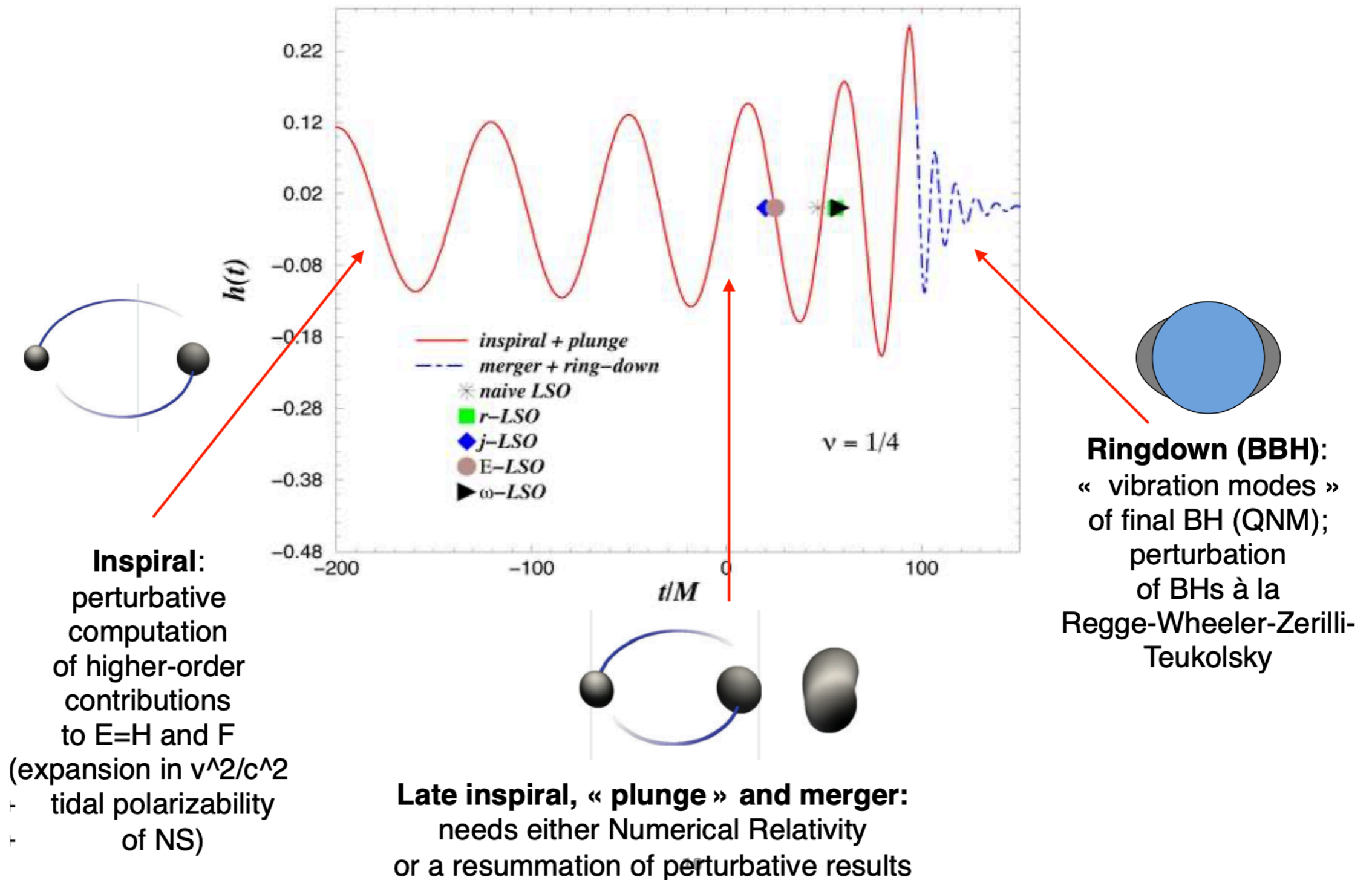
“The Hydrogen Atom  
of Quantum Gravity”,  
(J. Maldacena, 1996)



“BH’s are the Harmonic Oscillator of the 21st Century”  
(A. Strominger, 2009)

# From Supergravity to real BH

## Physics entering the GWs emitted by coalescing BHs or NSs



# Finiteness of $N=8$ & amplitude studies

- Galileo medal 2023: Bern, Dixon, Kosower  
==> quantum scattering amplitudes



# Bridging between the classical & quantum 2-body problem

- Galileo Medal 2021 : Damour  $\implies$  Effective-One-Body approach  
 $\implies$  GR 2 body problem  $\implies$  BH dynamics  
 $\implies$  waveform templates Ligo Virgo Kagra experiments and future
- “The dynamics of black hole binaries from scattering amplitudes”,  
Amati-Ciafaloni-Veneziano, Russo, Heissenberg, Di Vecchia, ...  
supergravity connection
- DUALITY: double copy, correspondence Gravity  $\iff$  YM

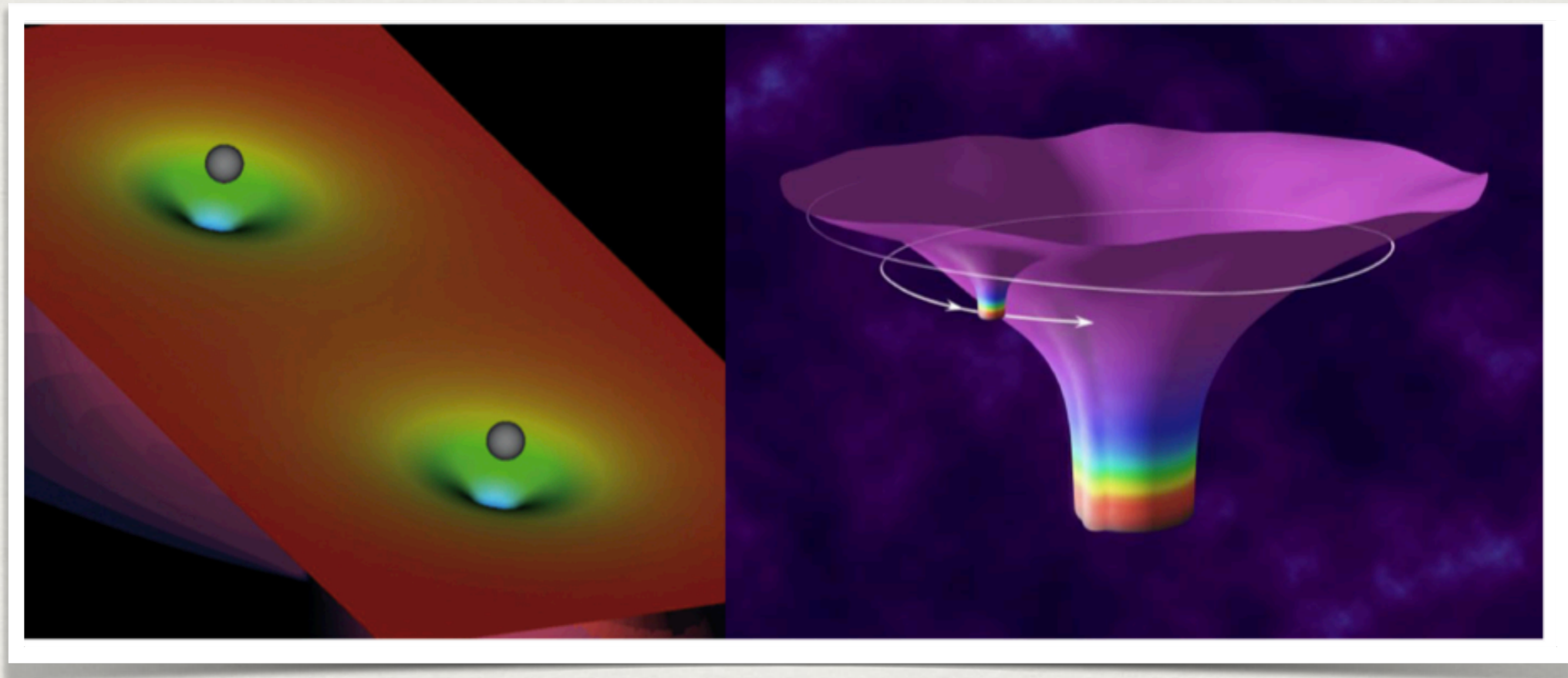


- \*The Effective One Body (EOB) formalism is an analytical approach which aims at providing an accurate description of the motion and radiation of coalescing binary black holes with arbitrary mass ratio.
- \*It provides accurate template waveforms to be used for gravitational wave data analysis purposes.

[review <https://arxiv.org/pdf/0906.1769.pdf> ]

🌐 Supergravity connection (Amati-Ciafaloni-Veneziano 1990, Bern, Parra Martinez...)

\*Resuming the dynamics of a 2-body system  $(m_1, m_2, s_1, s_2)$  in terms of a particle with mass  $\mu$  and spin  $S$  moving in some effective metric  $g(M, S)$



**Effective metric for non-spinning bodies: a nu-deformation of Schwarzschild**

$$M = m_1 + m_2 \quad \mu = \frac{m_1 m_2}{m_1 + m_2} \quad \nu = \frac{\mu}{M} = \frac{m_1 m_2}{(m_1 + m_2)^2}$$

$$ds_{\text{eff}}^2 = -A(r; \nu) dt^2 + B(r; \nu) dr^2 + r^2 (d\theta^2 + \sin^2 \theta d\varphi^2)$$



## Goal:

- **Analytic computations** to obtain fast and accurate waveform models to be compared with LVK data and preparing for future experiments
- **NR simulations** provide accurate solutions to Einstein Eqs but they have limits (high computational cost, restricted parameter space or waveform length)
- **Many Tools:** Combine various approximations & perturbative approaches :
  - \* PN expansion: small velocities  $v/c \ll 1$ , weak fields  $GM/rc^2 \ll 1$
  - ➔ \* PM expansion: weak fields  $GM/rc^2 \ll 1$  but ANY  $v/c \implies$  high energy scattering
  - \* EFT methods, QFT (generalised unitarity, double copy relations...), tutti-frutti

## Strategy:

- Consider invariant quantities: for instance take the **scattering angle** (up to 4PM)
- Use this knowledge, **recast it into EOB language**====>potential
- Use this info to **INFORM the classical 2-body problem in GR**
- **Improve gravitational waveform models** (eccentric, hyperbolic signals,...)
- **Compare with Numerical Relativity** exact results (hopefully, better output than PN)

...some defining personality traits



At 12:18 p.m. Eugène would always gather all available colleagues to go to lunch, and this led Guido Altarelli to observe

“Were Eugène to disappear the whole lab would starve to death!”

*(Courtesy of Bernard Julia)*

## ...some defining personality traits

- Watching movies every evenings
- Walking very fast while absorbed in thoughts
- Being sharply on time in arriving and leaving the department (except with PvN)
- Remembering the content of every reference
- His dress code and his charm

*(Courtesy of Bernard Julia)*

Because one does not need to shout to be heard,  
sometimes a whisper is more effective.

And it was through those whispers, the careful choice of  
topics, the thought behind the words,  
that Eugène came to be revered in his lifetime,  
a reverence that will only grow now that he has passed away.

**Thank you Eugène for being a lighthouse  
for many of us!**