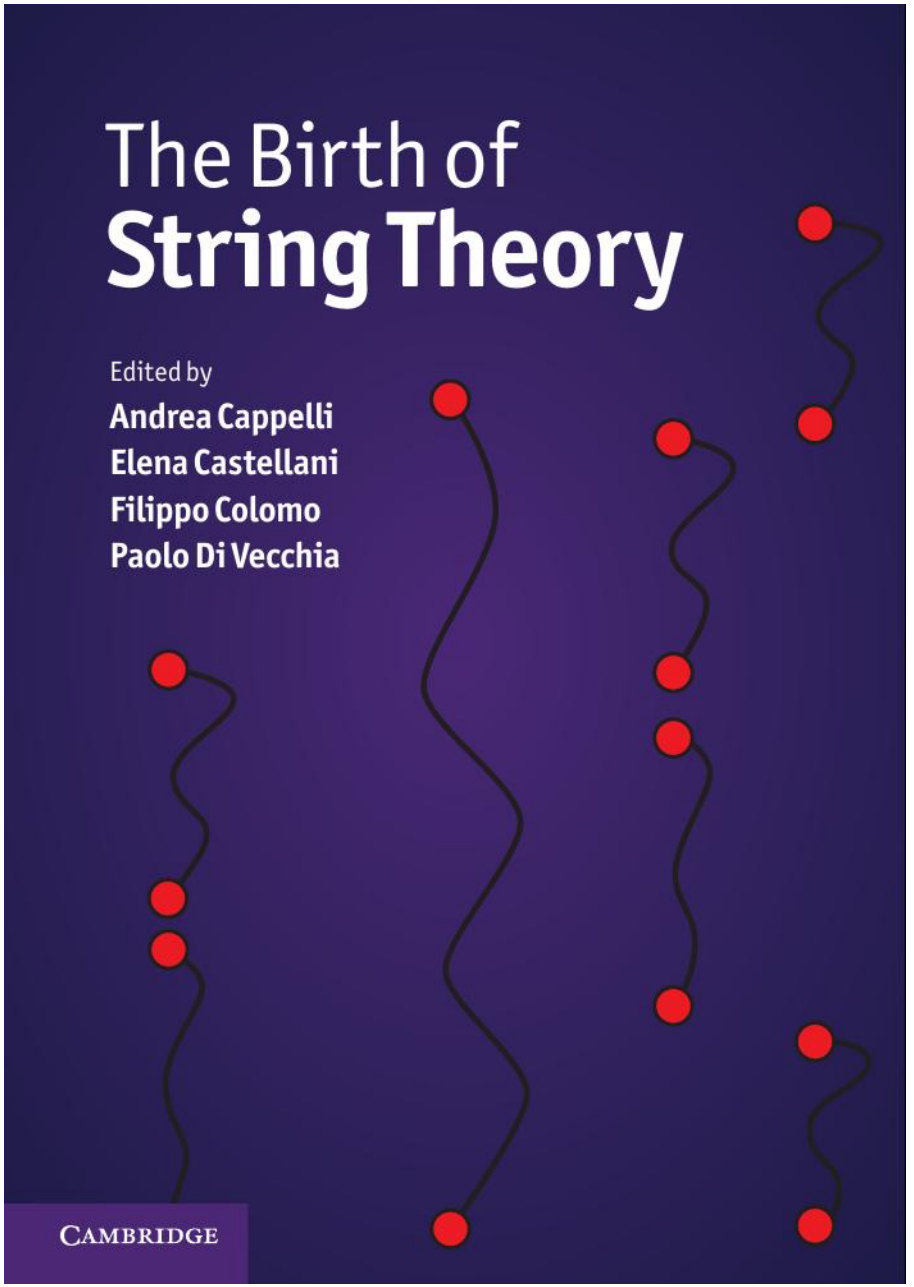
Outline

- book content
- motivations
- storyline



Content

- history from 1968 (Veneziano amplitude) to 1984 (first string revolution)
- 7 parts with introductions, 35 contributors and 5 appendices:

I. Overview	*(Veneziano, Schwarz, E. Castellani)*
II. The prehistory: the analytic S-matrix	*(Ademollo, Rubinstein, Freund, Gell-Mann)*
III. The Dual Resonance Model	*(Di Vecchia, Shapiro, Amati, Clavelli, Lovelace, Musto, Nicodemi, Sciuto)*
IV. The string	*(Goddard, Susskind, Nielsen, Nambu, Fairlie, Mandelstam, Brower)*
V. Beyond the bosonic string	*(Olive, Ramond, Neveu, Corrigan, Bardakci & Halpern, Gervais, Montonen)*
VI. The superstring	*(Gliozzi, Yoneya, Brink, Di Vecchia, Cremmer, Schwarz)*
VII. Preparing the string renaissance	*(Green, Polyakov, Cappelli & Colomo)*

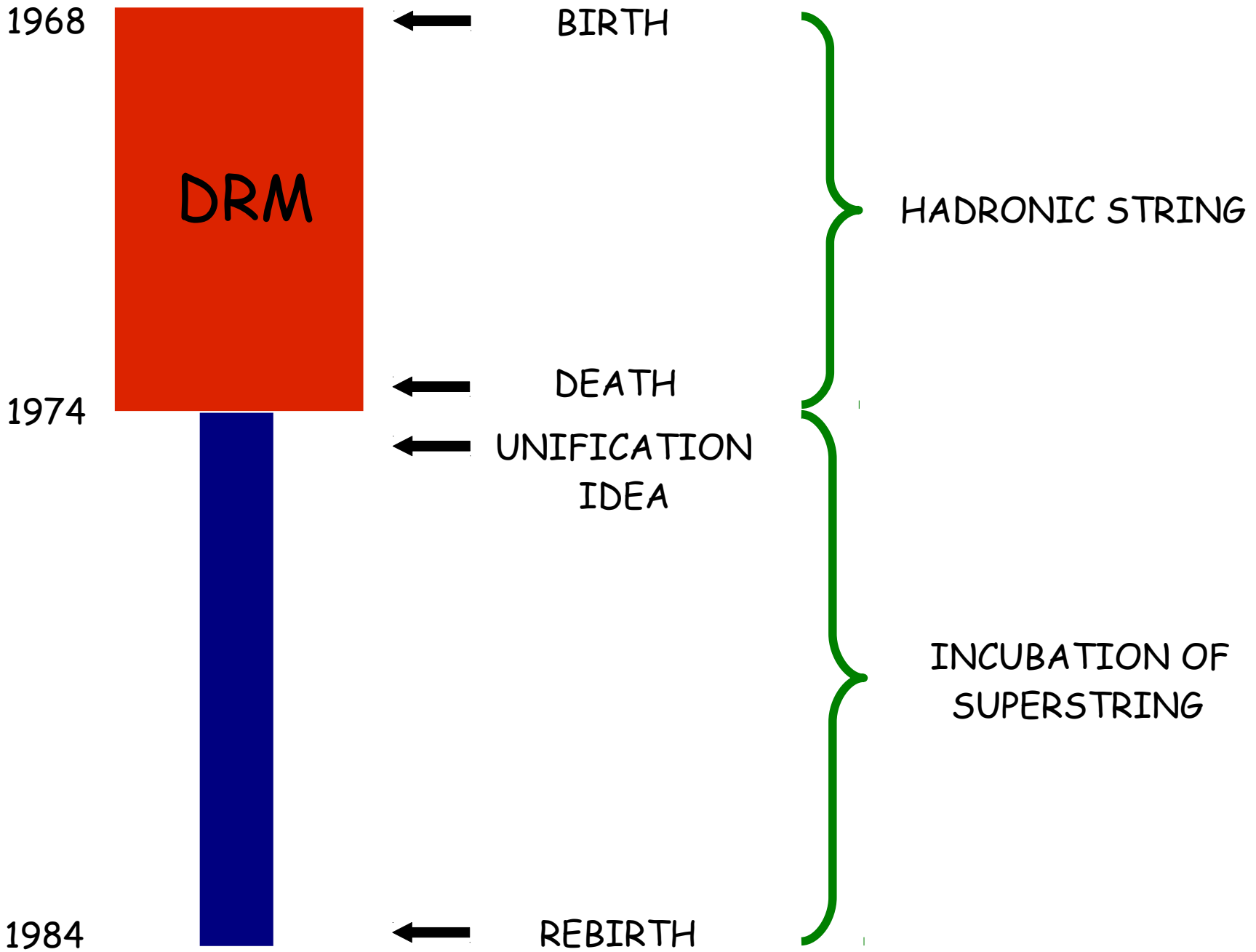
Motivations

- seminar on history & philosophy of physics in Florence

- workshop on string history at the Galileo Galilei Institute in May 2007

  within the first string program

- the early string:
  - a "scientific saga", not so well known and not yet recorded
  - great ideas that were fully developed later and also found application in many other domains


1968
DRM
BIRTH
HADRONIC STRING
DEATH
1974
UNIFICATION
IDEA
INCUBATION OF
SUPERSTRING
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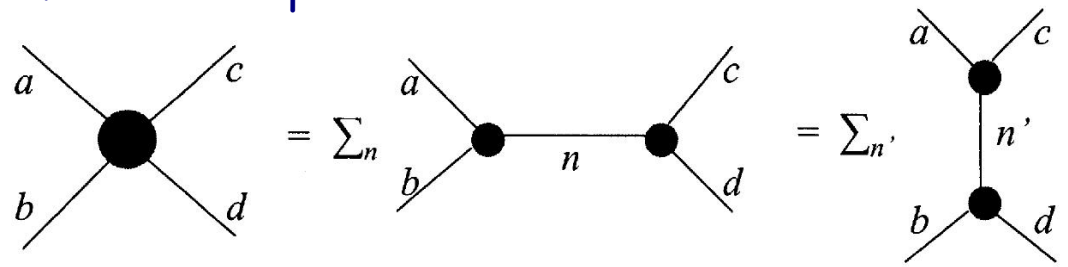
REBIRTH

Dual Resonance Model

- strong interactions in the sixties: about 50 baryons and 20 mesons in linear Regge trajectories

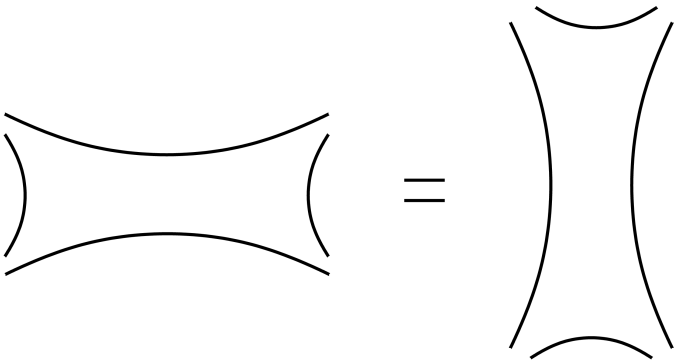
$$J = \alpha(s) = \alpha_0 + \alpha' s, \quad s = M^2 \qquad \alpha' \text{ universal}$$

- quarks were only "technical"; perturbative quantum field theory was abandoned
- S-matrix approach: the bootstrap

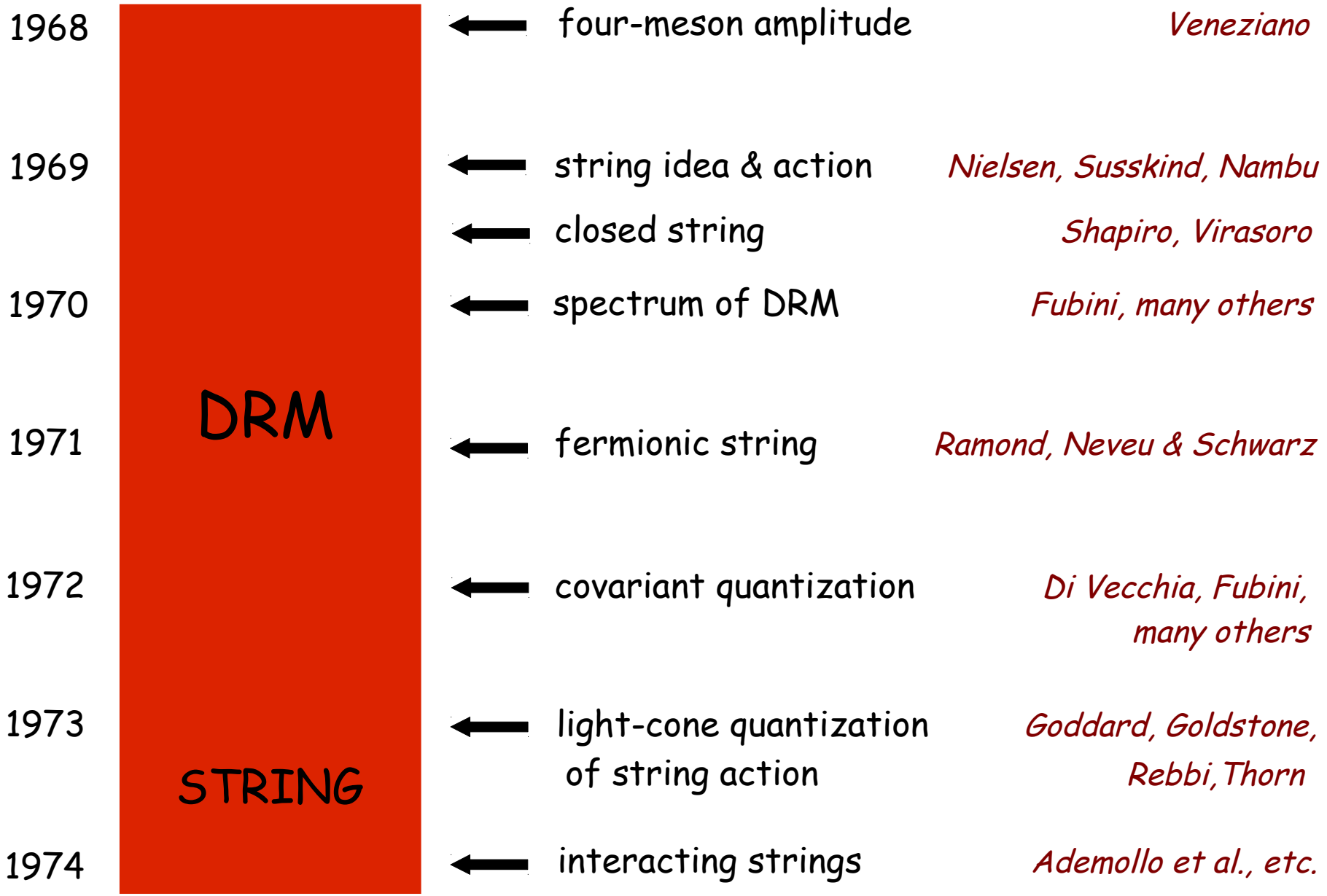


- poles on Regge trajectories & Regge behaviour $A(s,t) \sim \beta(t) s^{\alpha(t)}, \quad s \gg -t > 0$
- Veneziano closed-form solution $\pi\pi \to \pi\omega$

$$A(s,t) = \frac{\Gamma(1-\alpha(s))\,\Gamma(1-\alpha(t))}{\Gamma(2-\alpha(s)-\alpha(t))}$$



Planar duality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four-meson amplitude
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spectrum of DRM
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STRING
1974
interacting strings
Ademollo et al., etc.

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	extra dimensions	*Lovelace*
	world-sheet supersymmetry	*Gervais & Sakita*
1972	covariant quantization	*Di Vecchia, Fubini, many others*
	field-theory limit	*Scherk, Neveu, Yoneya*
1973	light-cone quantization of string action	*Goddard, Goldstone, Rebbi, Thorn*
1974	interacting strings	*Ademollo et al., etc.*

Hadronic string

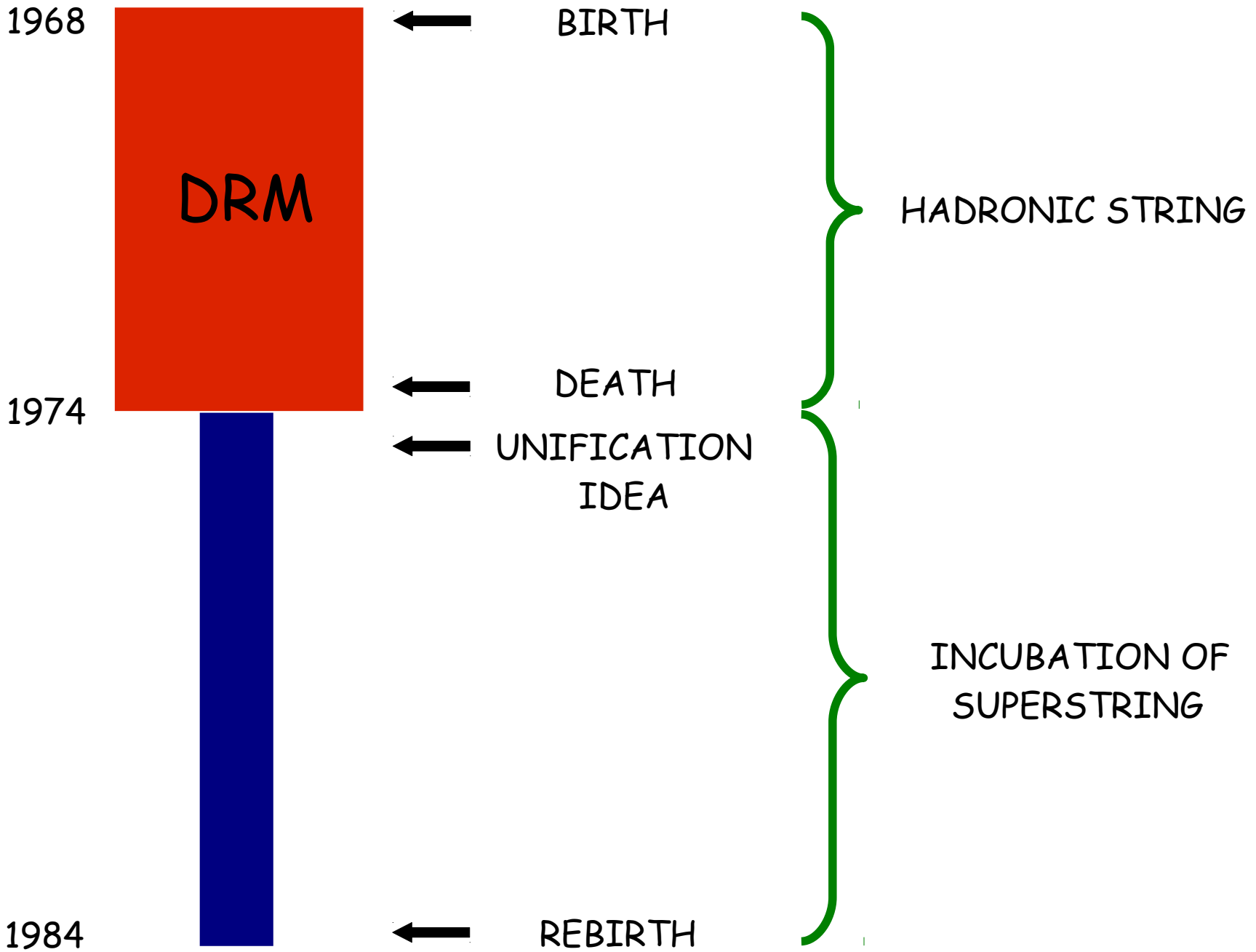
- Reasons to be born (1968)

  - Veneziano amplitude: simple closed-form solution to S-matrix bootstrap

  - initial phenomenological appeal was replaced by fascination for the beautiful structure of the theory (stemming from two-dimensional conformal symmetry)

- Reasons to die (in 1974)

  - D=26
  - $\alpha_0 = 1, 2$ i.e. massless particles with spin 1 and 2
  - soft scattering  Deep Inelastic Scattering & QCD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Superstring unification (1974)

- the $\alpha' \to 0$ limit shows that string theory is an extension of field theory rather then an alternative to it

- the remaining particles are massless with spin one and two

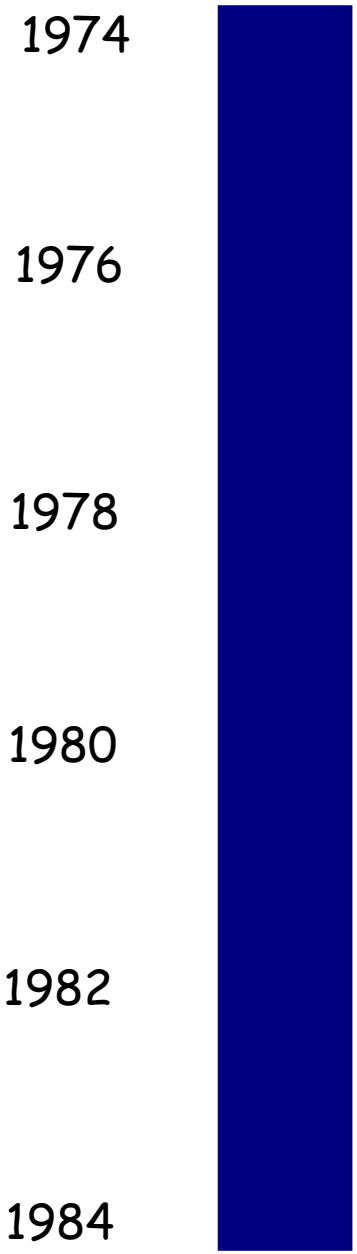
- the superstring is consistent quantum mechanically

- dynamics of massless particles is uniquely determined:

  - non-Abelian gauge theories for spin one

  - gravity for spin two

→ string theory unifies (predicts) gauge theories and gravity



gauge & gravity unification — *Scherk & Schwarz, Yoneya*

Kaluza-Klein compactification — *Cremmer, Scherk*

open superstring (type I) — *Gliozzi, Scherk, Olive*

RNS string action — *Brink, Di Vecchia, Howe; Deser & Zumino*

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supergravity — *Freedman, Van Nieuwenhuizen, Ferrara*

d=11 supergravity — *Cremmer, Julia, Scherk*

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IIA & IIB closed superstrings — *Green & Schwarz*

gravitational anomalies — *Alvarez-Gaumé & Witten*

anomaly cancellation in type I — *Green & Schwarz*

heterotic strings — *Gross, Harvey, Martinec, Rohm*

Calabi-Yau compactifications — *Candelas, Horowitz, Strominger, Witten*

Superstring

- Reasons to be reborn (in 1984)

  Unification of gauge theories and gravity beyond the SM, with:

  - chiral fermions without chiral anomalies
  - supergravity without infinities
  - five (six) consistent theories

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- Reasons to die again

  - .....next book

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- Reasons to die again (not quite)

  - .....next book
  - gauge/gravity correspondence: the hadronic string is back

String theory at large

- supersymmetry and extra dimensions
- theoretical physics  many areas of mathematics
- conformal field theory
  gauge/gravity correspondence  statistical mechanics
  & condensed matter

 NEW TOOLS in theoretical physics 

String theory at large

- supersymmetry and extra dimensions
- theoretical physics ⟷ many areas of mathematics
- conformal field theory gauge/gravity correspondence → statistical mechanics & condensed matter

→ NEW TOOLS in theoretical physics ←

"Rock & Roll saved my life " (Wim Wenders)

String theory physicist's

About history

"The garbage of the past often becomes the treasure of the present (and *vice versa*)"

A. M. Polyakov

"When a good idea is around, many people have it at the same time: the credit goes to the one that explains it better"

S. Fubini

"...although to study the history of physics and to distribute credits is an interesting enterprise, I am not yet prepared for it"

A. M. Polyakov

Bibliography

- Book web page: http://theory.fi.infn.it/colomo/string-book/

- Three choral books on history of fundamental interactions (Cambridge UK):

  - The Rise of the Standard Model — *(1997) Hoddeson, L., Brown, L. M., Riordan, M., Dresden, M. eds.*

  - Pions to Quarks — *(2009) Brown, L. M., Dresden, M. , Hoddeson, L. eds.*

  - The Birth of Particle Physics — *(1986) Brown, L. M., Hoddeson., L. eds.*

- Another volume on history-philosophy-sociology of string theory:

  -Forty Years of String Theory: Reflecting on the Foundations — *(2013) De Haro, S., Dieks, D., ' t Hooft, G., Verlinde, E. eds., Foundations of Physics 43*