Luciano Girardello Memorial, Milano, 16 January, 2023

My encounters with Luciano

Elias Kiritsis

Prelude

- I have met Luciano in the Institut d'Ete de l'ENS in the early 1990's.

- I was seduced by his mild character and his gentleness.

- Quickly I found out that he was a mature, first rate physicist.

- Although I never collaborated with him, I have on many occasions long physics discussions:

♠ at the Institut d'Été at ENS, but also later

♠ when I was at CERN, 1992-1998 and he would be visiting occasionally.

- I intersected his research path twice:

Helicity supertraces

PHYSICAL REVIEW D VOLUME 20, NUMBER 2 15 JULY 197

General mass formula in broken supersymmetry

S. Ferrara
Laboratori Nazionali di Frascati, Istituto Nazionale di Física Nucleare, Frascati, Italy

L. Girardello*
Gordon McKay Laboratory, Harvard University, Cambridge, Massachusetts 02138

F. Palumbo
Laboratori Nazionali di Frascati, Istituto Nazionale di Física Nucleare, Frascati, Italy

(Received 13 April 1979)

The mass formula $\sum_J (-1)^{2J}(2J+1)m_J{}^2 = 0$ is derived for a very general class of interactions with spontaneously broken supersymmetry. It shows the vanishing of the graded trace of the square of the mass operator, with m_J the mass associated with a (real) field of spin J. This mass relation is shown to be true even in the presence of explicit breaking, provided it fulfills suitable requirements.

• In 1995 I published a paper with C. Kounnas

Infrared regularization of superstring theory and the one loop calculation of coupling constants

Elias Kiritsis (CERN), Costas Kounnas (CERN) (Dec, 1994)

Published in: *Nucl.Phys.B* 442 (1995) 472-493 • e-Print: hep-th/9501020 [hep-th]

where:

♠ We presented a general, modular-invariant way of regularising the IR divergences of loop amplitudes in string theory

♠ We gave a general formula for one loop thresholds for gauge and gravitational corrections

♠ We gave a calculation of the one-loop integrals.

• Nine months later, Harvey+Moore published a paper also on one-loop thresholds

Algebras, BPS states, and strings

Jeffrey A. Harvey (Chicago U., EFI), Gregory W. Moore (Yale U.) (Oct, 1995)

Published in: *Nucl.Phys.B* 463 (1996) 315-368 • e-Print: hep-th/9510182 [hep-th]

where:

♠ They pointed out that for gauge thresholds in supersymmetric superstring theories, only BPS states contribute at one loop.

♠ They gave a much more elegant and holomorphic result for the threshold.

♠ They speculated that BPS states form a unusual kind of algebra.

Playing with the expressions of thresholds, we realized that the relevant formulae involved Helicity Supertraces

$$B_{2n}(R) = \mathrm{Tr}_R[(-1)^{2\lambda}\lambda^{2n}]\,. \qquad (1)$$

Such traces are filters for different types of BPS states.

• I gave many such formulae in my string theory lectures that were published by Leuven University Press in 1997.

• At the same time, Ferrara informed me of his original paper with Luciano, which contains the use of the first and simplest helicity supertrace.

• More than 20 years later I was surprised to find out that such traces are used very often by A. Sen and others when they calculate black-hole entropies from string theory.

Holographic gauge theory flows

• The second time we crossed paths, was through the influential set of works on holographic RG flows in sYM (GPPZ flows)

• In the first, non-supersymmetric CFTs were found, after a flows from N=4 sYM.

• In the second, an N=1 flow leading to sYM was found.

• The holographic C-function was also introduced.

• For me, this was a principal motivation to understand holographic RG flows and especially the role, nature and interpretation of singularities that appear in such solutions.

• Although since then, enormous progress has been achieved, the main question about singularities remains, in part, obscure.

JHEP HYPER VERSION

RECEIVED: *December 18, 1998*, ACCEPTED: *December 22, 1998*

Novel local CFT and exact results on perturbations of N=4 super Yang Mills from AdS dynamics

Luciano Girardello

Dipartimento di Fisica, Università di Milano
via Celoria 16 I 20133 Milano, Italy
E-mail: girardello@milano.infn.it

Michela Petrini

Theoretical Physics Group, Blackett Laboratory, Imperial College
London SW7 2BZ, U.K.
E-mail: m.petrini@ic.ac.uk

Massimo Porrati

Department of Physics, NYU, 4 Washington Pl.
New York, NY 10003, USA
E-mail: massimo.porrati@nyu.edu

Alberto Zaffaroni

Theory Division CERN
Ch 1211 Geneva 23, Switzerland
E-mail: alberto.zaffaroni@cern.ch

The supergravity dual of $N = 1$ super Yang–Mills theory

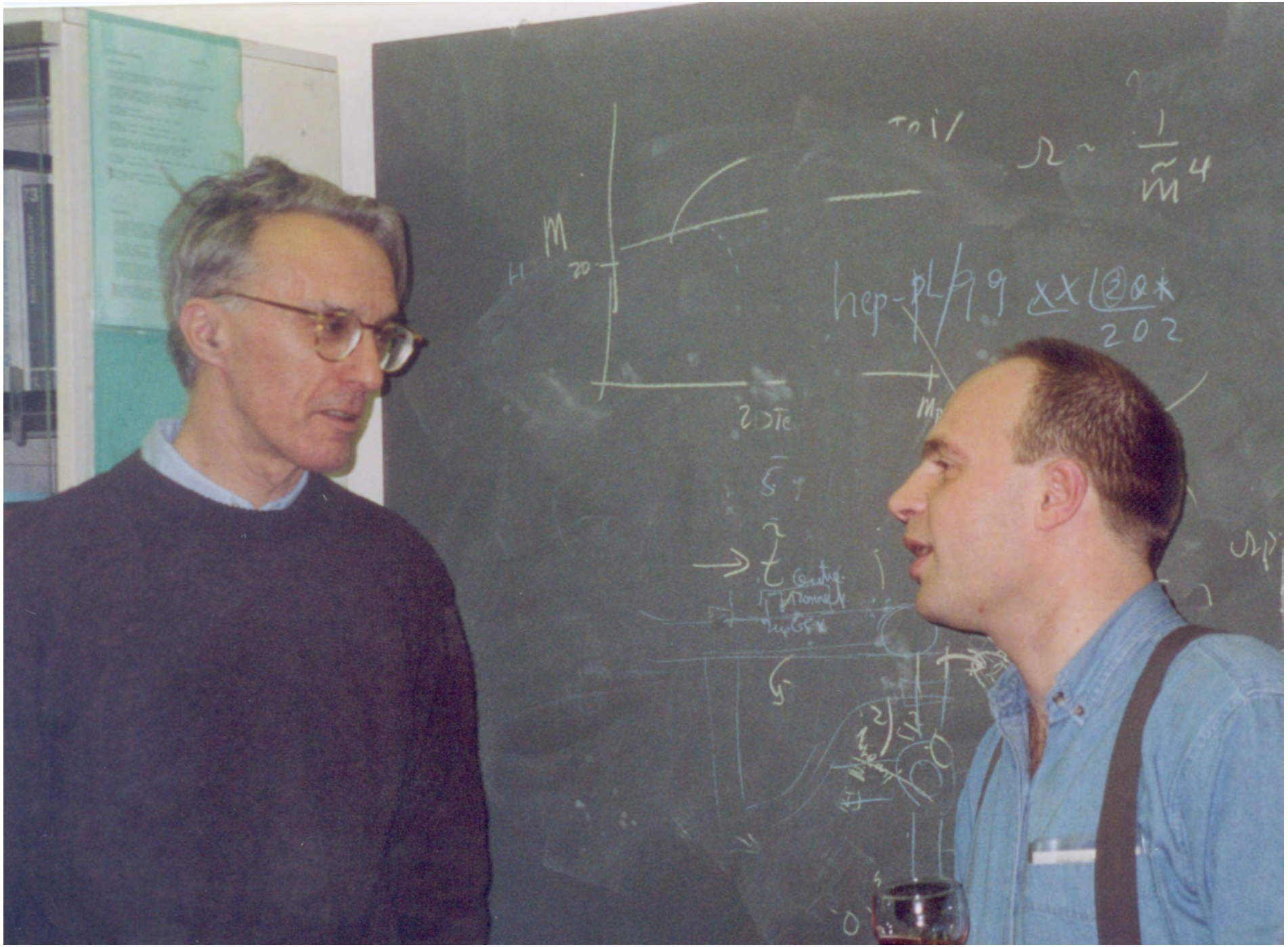
L. Girardello [a], M. Petrini [b], M. Porrati [c], A. Zaffaroni [a]

[a] *Dipartimento di Fisica, Università di Milano-Bicocca and INFN, Sezione di Milano, Italy*
[b] *Theoretical Physics Group, Blackett Laboratory, Imperial College, London SW7 2BZ, UK*
[c] *Department of Physics, NYU, 4 Washington Pl., New York, NY 10003, USA*

Received 12 October 1999; accepted 6 December 1999

Abstract

We find an exact, $N = 1$ supersymmetric kink solution of 5d gauged supergravity. We associate this solution with the RG flow from $N = 4$ super Yang–Mills theory, deformed by a relevant operator, to pure $N = 1$ super Yang–Mills in the IR. We test this identification by computing various QFT quantities using the supergravity dual: the tension of electric and magnetic strings and the gaugino condensate. As demanded by our identification, our kink solution is a true deformation of $N = 4$, that exhibits confinement of quarks, magnetic screening, and spontaneous chiral symmetry breaking.


hep-ph/9
202

Epilogue

- Luciano was a superb physicist and a gentleman.

- He is missed and he is remembered, but his legacy will outlast us!