Giuseppe Marchesini Memorial Conference, 19 May 2017

From pre-confinement to pre-collapse:
"imprese" (challenging ventures?) with Pino

Gabriele Veneziano

...ogni villa, ogni borgo, ogni paese
è testimon di sue *pazzesche* imprese...

Outline

- Berkeley 1969
- S-matrix days
- Switching to QCD
- From pre-confinement to HERWIG
- Gravitational scattering and pre-collapse
- More "imprese"

Berkeley, summer 1969

A very interesting summer from every point of view:

- Discover the West coast (visiting from MIT)
- The students' movement in Berkeley
- Pino was a post-doc in Jim Ball's group in Salt Lake City, also visiting Berkeley
- We (& Sonia & Edy) met and immediately sympathized, the start of a long friendship (later extended to our respective children)

S-Matrix days

- We had a common interest in high-energy (soft) hadron physics: Regge poles, cuts, Reggeon Field Theory (RFT)
- Soon after (> 1970?) I started using ideas borrowed from the Dual Resonance Model (later String Theory) about replacing the perturbative expansion by a topological one, …but missed the 1/N idea…
- After 't Hooft's 1974 paper I proposed a $1/N_f$ topological expansion in the DRM. But the TE idea looked like having a broader validity and a wider range of applications.
- In 1975 I invited Pino (then a fellow at CERN) to visit the Weizmann Institute (where I had been back since 1972 while spending extended summers at CERN).

A side remark…

- We applied this framework to multiparticle reactions and RFT and had a first joint paper:

G. Marchesini and G. Veneziano, Non-vanishing of the bare triple-Pomeron coupling from s-channel unitarity Phys. Lett. 36B (1975) 271.

- Bare Pomeron: "cylinder" topology
- Bare triple-Pomeron coupling (input to RFT): "trousers" topology
- The tool: unitarity sum rules for inclusive cross sections (treated a la Mueller) for the simplest topologies

Non-vanishing of the bare Triple-Pomeron coupling from s-channel unitarity[†]

WIS-75/8-Ph

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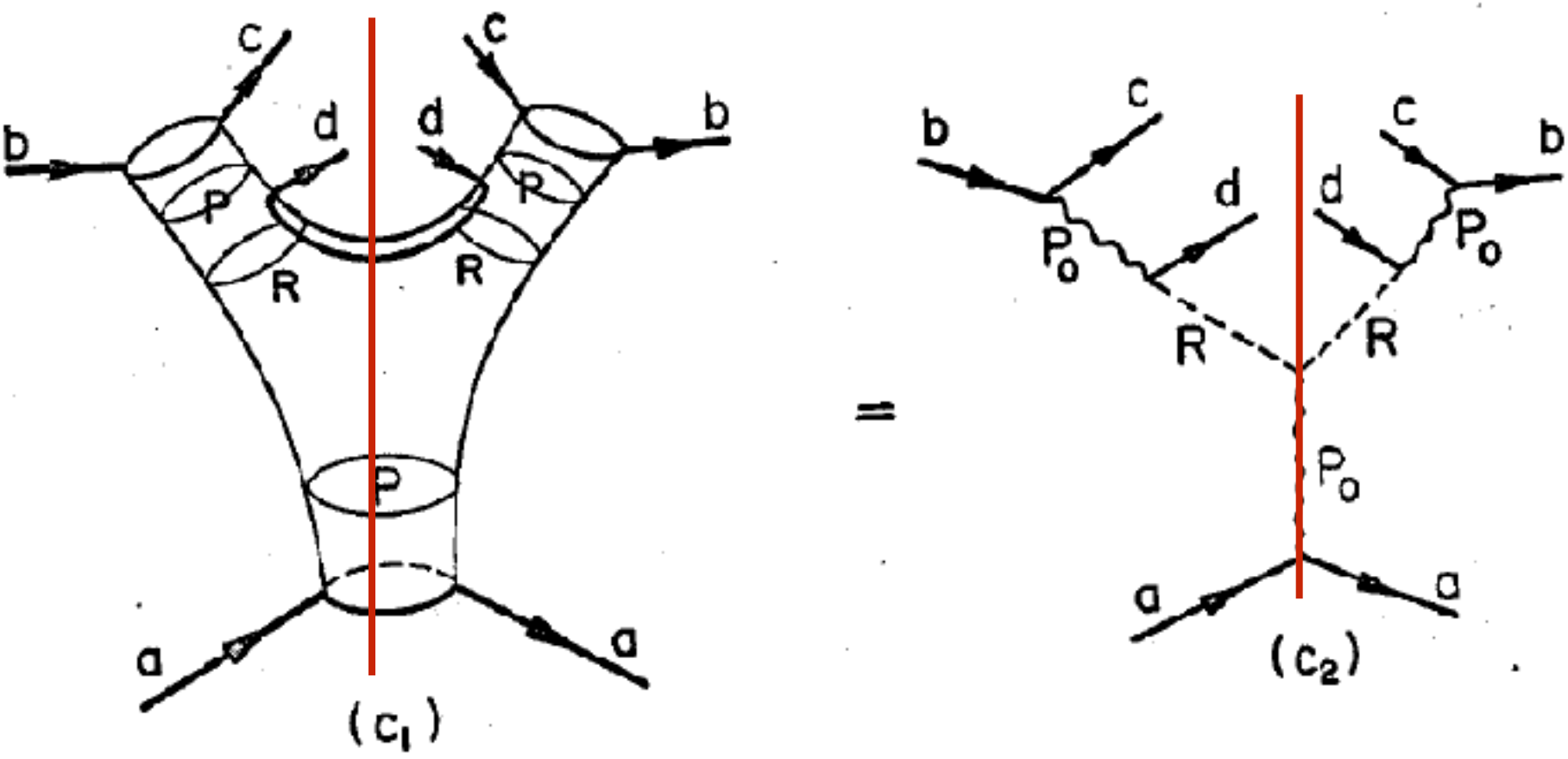

- Integrating over particle d gives a lower bound on the TPC: $g_{PPP(0,0,0)} > 0$ (though $O(1/N)$).
- NB: Recent LHC results appear to confirm the predictions of RFT for $\alpha_P(0) > 1$ & $g_{PPP(0,0,0)} > 0$!

With Marcello Ciafaloni, we also wrote two long papers using topological expansion ideas for a reinterpretation of RFT and its cutting rules with manifest s and t-channel unitarity

M. Ciafaloni, **G. Marchesini** and G. Veneziano
A topological expansion for high-energy hadronic collisions: I. General properties and connection with the Reggeon calculus, Nucl. Phys. B98 (1975) 472.

M. Ciafaloni, **G. Marchesini** and G. Veneziano
A topological expansion for high-energy hadronic collisions: II. s-channel discontinuities and multiparticle content, Nucl. Phys. B98 (1975) 493.

WIS 75/22 Ph

A topological expansion for high energy hadronic collisions: I. General properties and connection with the Reggeon calculus(†)

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Nuclear Physics B98 (1975) 472–492

A TOPOLOGICAL EXPANSION FOR HIGH-ENERGY HADRONIC COLLISIONS

(I). General properties and connection with the reggeon calculus *

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Received 24 June 1975

In this and in a companion paper a "topological expansion" for high-energy hadronic processes is proposed and discussed. In this first paper the general properties of the expansion and its connection with Gribov's reggeon calculus are presented. The topological expansion is first defined mathematically for a large class of theories and is shown to be equivalent to a "large N expansion" in some theories which include planar dual models and non-Abelian gauge theories. Next, the definition of the bare parameters is given in terms of graphs on a sphere. The bare pomeron pole and its couplings are thus introduced. The (inclusive) form of s-channel unitarity and its consequences for the above couplings are recalled. It is then shown how the expansion in the number of "handles" of the graph can be related to Gribov's reggeon calculus and how, with the aid of discontinuity equations in the J-plane, scaling solutions can be obtained and critical indices can be computed to yield known results. Our main new results, including the study of s-channel discontinuities and of positivity constraints as well as the definition of a new fireball expansion, and the discussion of the relevance of this theory at finite (present) energies are presented in the second paper.

1. Introduction and summary

At present, one of the most powerful tools in the study of high-energy hadronic reactions appears to be the reggeon calculus (RC) of Gribov and coworkers [1]. In spite of recent progress, this approach is still affected by a number of conceptual and practical difficulties such as:

* Supported in part by the Israel Commission for Basic Research.
** On leave of absence from the University of Parma, Italy.

Switching over to QCD

- From 1976 my own interests switched to QCD (e.g. TE from large-N @ fixed N_f/N_c).
- PQCD: factorization theorem, jet calculus, pre-confinement
- NPQCD: U(1)-problem, effective lagrangians.
- I like to think that I gently rescued Pino (and Marcello) from S-Matrix/RFT into QCD.

- A rather technical paper on hard processes

D. Amati, A. Bassetto, M. Ciafaloni, **G. Marchesini** and G. Veneziano, A treatment of hard processes sensitive to the infra-red structure of QCD, Nucl. Phys. B173 (1980) 429.

and a less technical one on jets

G. Marchesini, L. Trentadue and G. Veneziano, Space-time description of colour screening via jet calculus techniques, Nucl. Phys. B181 (1981) 335.

- Other speakers will mention the very important contributions of Pino to PQCD, so I will not go over them.
- I will only add a few words about (my own recollection of) the birth of HERWIG (1983). Bryan can correct me…

Pre-confinement

- In 1979 Daniele A. and myself wrote a short letter concerning the flow of color in the evolution of QCD partonic showers
- We observed that the most likely outcome of perturbative jet evolution, as the energy is increased, is the formation of limited-mass color singlets
- The formation of large-mass color singlets would carry, in PT, an exponential suppression factor
- This did not mean confinement, of course, but the typical perturbative final state was ripe for being easily turned into light hadrons.
- We dubbed this property "pre-confinement"

PRECONFINEMENT AS A PROPERTY OF PERTURBATIVE QCD

Ref.TH.2620-CERN
2 February 1979

D. Amati and G. Veneziano
CERN -- Geneva

ABSTRACT

We argue that the evolution of jets produced in hard processes can be computed perturbatively in QCD up to the appearance of a "preconfinement" stage consisting of finite mass colourless clusters of quarks and gluons. All basic properties of QCD go into the proof of this result : as a comparison, ϕ^3_6 is found to have unlimited mass clusters.

From pre-confinement to HERWIG

- One day (~ 1980-'82) Daniele and I were having coffee in the CERN cafeteria discussing whether one could possibly turn the pre-confinement idea into a quantitative computational tool for jet fragmentation into hadrons.
- Bryan was sitting not far from us. We thought: here is someone who could be good at this!
- We approached him and briefly discussed.
- Bryan sounded interested (he had also made the switch to QCD) but was not yet very familiar with the details of our PQCD work.

- Not much later Pino came in and formed with Bryan a most formidable team. Soon after HERWIG was born.
- It also incorporated the interference effects (the I in HERWIG) discovered by Al, together with other subtleties overlooked by A&V.

Another challenge: pre-collapse

Since 1987 Amati, Ciafaloni and myself have been studying transplanckian energy string collisions as a theoretical tool for addressing some outstanding conceptual problems in quantum gravity (in the good old spirit of QM's gedanken experiments).
We got many results in the regimes of gravitational deflection, tidal excitations and other string-size effects, but the gravitational collapse regime (where the puzzles of QG appear) remains a big challenge to this date.

Twenty years later (2007) ACV proposed a simplified approach to the problem hopefully allowing to determine (at least semi-quantitatively) the parameter-space-surface beyond which collapse should occur, as well as the nature of the final state while approaching such critical surface:

Pre-Collapse

Approx. consisted in reducing the 4D problem to a 2D one. But even the simplified problem could not be solved even numerically.
This is where Pino (and Enrico) came in...

High energy gravitational scattering: a numerical study

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Once more: a perfect partnership for tackling a new challenge!

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High energy gravitational scattering: a numerical study

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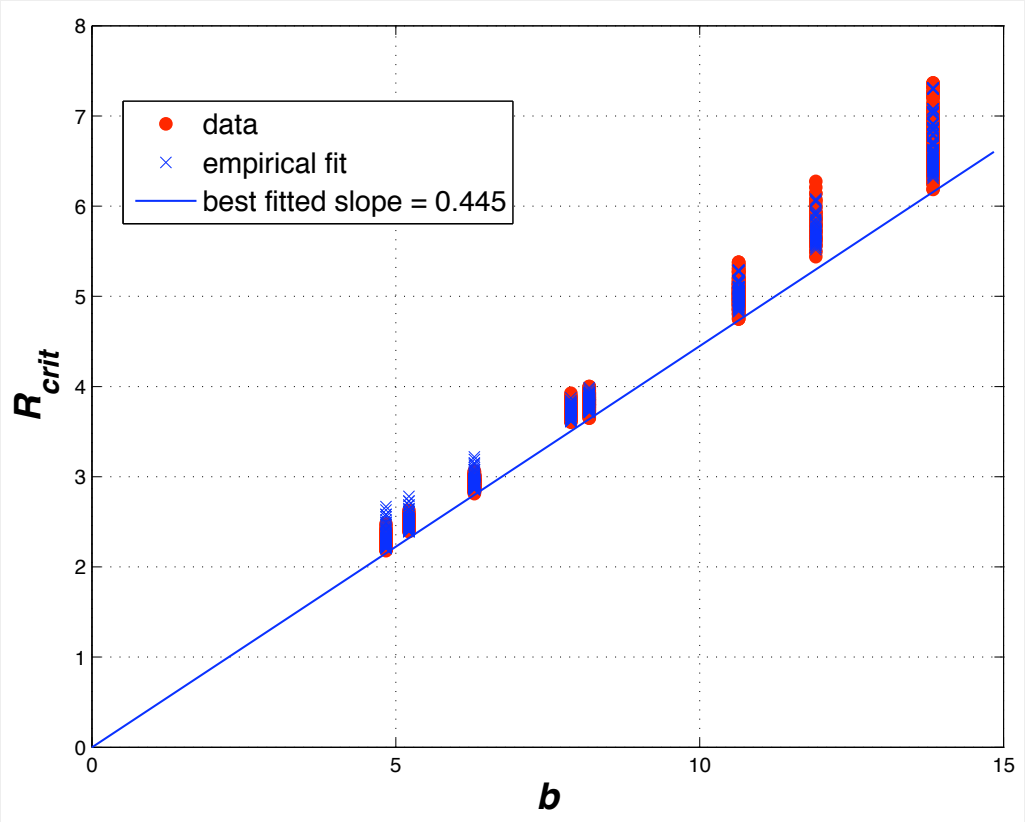
Abstract: The $S-$matrix in gravitational high energy scattering is computed from the region of large impact parameters b down to the regime where classical gravitational collapse is expected to occur. By solving the equation of an effective action introduced by Amati, Ciafaloni and Veneziano we find that the perturbative expansion around the leading eikonal result diverges at a critical value signalling the onset of a new regime. We then discuss the main features of our explicitly unitary S matrix down to the Schwarzschild's radius $R \quad 2G\sqrt{s}$, where it diverges at a critical value $b \simeq 2.25\,R$ of the impact parameter. The nature of the singularity is studied with particular attention to the scaling behaviour of various observables at the transition. The numerical approach is validated by reproducing the known exact solution in the axially symmetric case to high accuracy.



G. Marchesini & E. Onofri, 0803.0250

Another successful "impresa" !

An even harder impresa: the GGI

- Most of us were skeptical about the GGI idea:
  - financial problems
  - housing problems
  - lack of personnel
  - distance from phys. dept. (Sesto F.o)

Pino was stubborn in pushing it: and was right!

To conclude

Pino liked challenges. He was never discouraged by something looking like an impossible problem:

- In theoretical research;
- In scientific policy (the move to Milano & the creation of the theory group at Bicocca, the GGI)
- In everyday's life.

Another kind of "imprese"

- In the early eighties (from my recollection of our daughter's age) we had a nice vacation together (pensione "Al tramonto", Viticcio, Elba Island)
- Here Pino gave in completely to his adventurous spirit…every day he was ready for a new impresa…

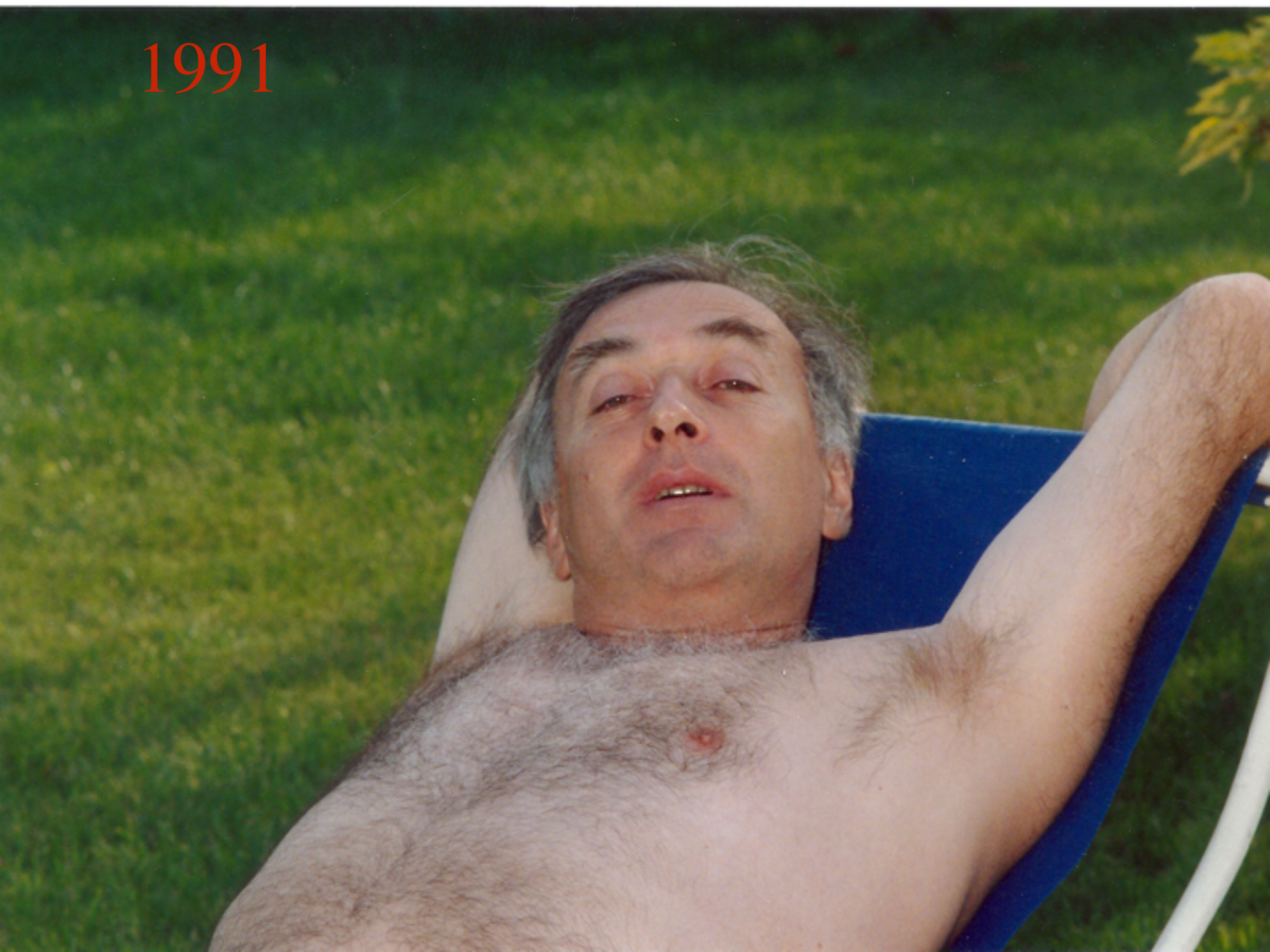
He faced new ventures as new battles he was determined to win.

Too bad he did not manage to win a last one a little over a year ago…

To conclude

A short photo gallery


1991


1991


2011

2012


2012


2015


2015

Thank You Pino

Thank You All