Guido and high energy QCD

Giorgio Parisi

The Antefact: the Thesis

The advisor was Nicola Cabibbo. The students were Roberto Benzi and Guido Martinelli.

I was acting as advisor.

There were two papers written by all us:

• Anomalous dimensions from a high temperature expansion without a lattice (1976).

• High temperature expansion without lattice (1977).

In the same spirit, I think, there was a paper by Guido alone:

• A simple model to study the Yang and Mills gauge theory for quark confinement using the high temperature expansion techniques (1976).

Machine group at Frascati

- Direct X-ray observation of lattice parameter changes due to magnetostriction in nickel single crystal.

- ALFA, feasibility study of an electron pulse stretcher to increase the duty factor of the Frascati linac.

- Ala-A 1.2 GeV High Luminosity Electron-Positron Storage Ring. Design Study.

He gets a permanent position in the group.

Effective partons distribution

I was in Paris in 1976-1978 and Guido Altarelli in 1976-1977. In the spring 1977 we write the paper ASYMPTOTIC FREEDOM IN PARTON LANGUAGE, the so called at that time Altarelli-Parisi equations.

This paper stemmed from a proposal from Guido, i.e. to make previously-obtained results on scale violations clearer and more exploitable. The motivations of the paper were clearly stated in the introduction. When speaking of the standard operator product approach to scaling violations in QCD, we wrote: *In spite of the relative simplicity of the final results, their derivation, although theoretically rigorous, is somewhat abstract and formal, being formulated in the language of renormalization group equations for the coefficient functions of the local operators which appear in the light cone expansion for the product of two currents.*

The two Guidos

There is a work fo Altarelli, Parisi, Petronzio *Transverse momentum in Drell-Yan processes* of October 1977 (quite likely most of the work was done in Paris.

In the fall 1977 Guido Altarelli come back to Rome and I remain in Paris.

As soon as Guido Altarelli arrives in Rome, he starts to work with Guido Martinelli *The average p^2 is found to be asymptotically proportional to W^2 (the hadronic invariant mass squared) with a coefficient function that depends little on x.*

Guido was still woring at the machine group

Keith Ellis joins the group

Photo taken in Erice by Guido Martinelli.

Keith was a few years in Rome (1974-1977?) and worked mainly with Altarelli Parisi and Petronzio on QCD related problems

New results

Next to the leading corrections (Altarelli, Ellis, Martinelli)

- *Leptoproduction and Drell-Yan processes beyond the leading approximation in chromodynamics* (July 1978)

- Large perturbative corrections to the Drell-Yan process in QCD (April 1979) (37 pages).

The modifications of the Drell-Yan formula (expressed in terms of scale-dependent parton densities derived from measurements in deep inelastic leptoproduction) are so large that the retention of only the first-order correction terms in $\alpha(Q^2)$ is unjustified.

- *Processes involving fragmentation functions beyond the leading order in QCD* (also with So-Young Pi) (June 1979)

Guido goes to CERN

- *Weak non-leptonic decays beyond leading logarithms in QCD* (September 1980) (Altarelli, Curci, Martinelli, Petrarca). We compute the two-loop anomalous dimensions of the four-fermion operators relevant to weak non-leptonic decays and discuss the physical implications for strange and charm particle decays. In particular, we derive the complete order α_S corrections to the inclusive decay width of a heavy quark.

- *QCD non-leading corrections to weak decays as an application of regularization by dimensional reduction* (December 1980 (Altarelli, Curci, Martinelli, Petrarca) (52 pages),

- *Leptonic decay of heavy flavors: A theoretical update* (Altarelli, Cabibbo, Corbo, Maiani, Martinelli) (1982),

New accelerators, new predictions

- *Vector boson production at colliders: a theoretical reappraisal* (Altarelli, Ellis, Greco, Martinelli 1984).

- *Vector boson production at present and future colliders* (Altarelli, Ellis, Martinelli, 1985).

- *Lepton pair production at ISR energies and QCD* (Altarelli, Ellis, Martinelli, 1985).

Lattice theories enter in the game

The two dimensional $O(3)$ non linear sigma model

• *Monte Carlo simulations for the two-dimensional $O(3)$ non-linear sigma model* (Martinelli ,Parisi, Petronzio 1981).

• *Topological charge on the lattice: The $O(3)$ case* (Martinelli, Petronzio, Virasoro 1982).

• *Improving the lattice action near the continuum limit* (Martinelli. Parisi, Petronzio 1982).

• *A Monte Carlo simulation with an "improved" action for the $O(3)$ non-linear sigma model* (Falcioni, Martinelli, Paciello, Taglienti, Parisi 1983).

Lattice QCD: simulations

• *Hadron spectroscopy in lattice QCD* (Fucito, Martinelli, Omero, Parisi, Petronzio, Rapuano 1982),

• *The proton and neutron magnetic moments in lattice QCD* (Martinelli, Parisi, Petronzio, Rapuano 1982).

• *Strange hadrons in lattice QCD* Martinelli, C Omero, G Parisi, R Petronzio 1982). • *Boundary effects and hadron masses in lattice QCD* (Martinelli, Parisi, Petronzio, Rapuano 1983).

• *Hadron spectrum in quenched QCD on a 103× 20 lattice* (Lipps, Martinelli, Petronzio, Rapuano 1983).

Analitic computations for Lattice QCD

- *Computation of the relation between the quark masses in lattice gauge theories and on the continuum (Arroyo, Yndurain, Martinelli 1982).*

- *Two-loop corrections to the parameters of one-plaquette actions (Ellis, Martinelli 1984).*

- *The connection between local operators on the lattice and in the continuum and its relation to meson decay constants (Martinelli, Yi-Cheng 1983).*

- *One loop corrections to extended operators on the lattice (Martinelli, Yi-Cheng 1983).*

- *The four-fermion operators of the weak hamiltonian on the lattice and in the continuum (Martinelli 1984).*

Numerical simulations for weak interactions

- *Weak interactions on the lattice* (Cabbibo, Martinelli, Petronzio 1984).

Here I leave the floor to Luciano.

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Happy Birthday Guido!!!!