

## Remembering Raymond

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Don't expect that I shall speak on BRS (I omitted T deliberately after some conversations with Raymond). I am not an expert on non-abelian gauge theories. I am grateful to Camillo Imbimbo for his beautiful presentation which helped me begin to understand BRS.

I believe that I am the person who has known Raymond for the longest time. During the summer of 1952, at Les Houches, Loup Verlet and I accepted to be members of the new theoretical physics group at Ecole Normale started by Maurice Lévy (now 92), at the invitation of Yves Rocard. At the same time, we met Louis Michel who was then at Ecole Polytechnique in the laboratory of Louis Leprince Ringuet. During the autumn of 1952, Loup Verlet and I went every week to the seminar held in the Leprince Ringuet laboratory. One day we met Louis Michel in a corridor accompanied by a young man in Kaki uniform (not with the "bicorne"). Louis presented us his collaborator: Raymond Stora.

They were calculating the decay spectrum of a lepton sufficiently heavy to decay into a muon. Then the standard calculation of the muon decay by Louis Michel, depending only on the "Michel parameter" had to be modified, and this is what they were doing. The motivation was that there seemed to exist such a heavy lepton, but soon this candidate for a heavy lepton disappeared. However, many years later, Martin Pearl discovered the tau lepton (about 1800 MeV) and so, the ratio of the mass of the muon to the mass of the tau was not negligible and the calculation of Michel and Stora applied. I attracted the attention of Sau Lan Wu who was measuring the decay of the Tau at LEP on this calculation.

Now I open a parenthesis about the seminars given by Louis Michel on weak interactions even though it does not concern Raymond.

Louis Michel spoke about left-right symmetry. He said that, of course, there is no left-right symmetry in biology. The asymmetry propagates through genetics and the only problem is (symbolically: I am not a creationist) why Adam and Eve had their heart to the left. In particle physics everybody believed there was a complete left-right symmetry, technically called parity

conservation. Louis Michel pointed out that there was absolutely no indication that parity was conserved in weak interactions.

This was 1952, 3 years before Lee and Yang, and others, raised the question and proposed tests of parity violation! My testimony is confirmed by what Thérèse Michel remembers. I should have asked Raymond but it did not come to my mind.

My next meeting with Raymond was at MIT, in 1956, where I visited my new friends, Martin Blume and Shelley Glashow, whom I met during the first Latin American summer school in Mexico City. I met him during a seminar given by Francis Low on dispersion relations. Raymond was doing his Ph D under S. Olbert on the evolution of the hadronic component of cosmic rays in the atmosphere.

Back at Saclay, Raymond wrote a very important paper with Marcel Froissart (also recently deceased) on the depolarisation of particle beams in accelerators. This paper is used by machine engineers worldwide. He also participated in a new proof of dispersion relations with Bros, Froissart, Messiah, and Omnès which was never published.

My contacts with Raymond became intense through his short and long visits to CERN where he collaborated with Bros, Epstein and Glaser in the domain of Axiomatic field theory.

Later, when he moved from Saclay to Marseille we met quite often since I was member, and later chairman, of the scientific committee of the center for theoretical physics.

Part of the time he was director of this center, where his diplomatic qualities were essential to remove the tensions between the members.

Of course, when Raymond moved to Annecy, after spending a year at CERN our contacts became even more intense. This continued when Raymond retired and spent most of his time at CERN, till the end, because Raymond even sick continued to work.

Raymond's culture was immense, not only scientific but literary, historical, musical (this I learnt only today, because I never spoke of music with him, but only with Jacques Prentki and Luis Alvarez-Gaumé) and he loved old books. I happen to receive wonderful catalogues of old books about once every 6 months. I gave these catalogues to Raymond, and now, I don't know what to do with them. I can give them to anyone interested.

In Math, he knew old maths and new maths. I can give an

example. Almost every evening I listen to a program on the French TV called "Questions pour un champion". Once a question was "who is the mathematician who found a way to construct a regular polygon with 17 sides". The answer was "Gauss". The next day, I go to the office of Raymond and he, immediately gave me the proof, indicating that this can be generalized to other polygons with more sides.

Raymond's merit was that he made others benefit from his immense knowledge. He always welcomed anyone who needed help, and, most of the time he effectively helped. I know at least two cases, one indirect and one direct.

The indirect one comes because, in 1967-1968 Gilbert Mahoux and I decided to extend the proof of the Froissart bound to particles of arbitrary spin. We used helicity amplitudes. Kinematical singularities of these amplitudes must be eliminated. This is done in a work by Gilles Cohen-Tannoudji, André Morel (deceased) and Henri Navelet. They make it very clear that they had considerable help from Raymond.

The other example is that, K.Chadan, N.N.Khuri, T.T. Wu and I studied scattering in 2 space dimensions (in fact Jacques Bros and Daniel Iagolnitzer had already worked on that). Again we needed the right kinematical factor and it took 5 minutes for Raymond to get it.

The merits of Raymond were recognized by several prestigious prizes: the Joannidès prize from the French Academy of Sciences, the Ricard prize from the French Physical Society, The Medal Max Planck from the German Physical Society and finally the Dannie Heinemann Prize in 2009, from the American Physical Society as I learnt only 3 months before he died.

Raymond was so modest that he told nobody that he got the prize and did not even go to the United States to receive it. I learnt about it because Alain Rouet wrote an article about the problem of climatic change and, to give more weight to his intervention signed "Alain Rouet, recipient of the Heinemann Prize". Normally I would have thought that this a bit ridiculous because inventing BRS does not guarantee that you are an expert on the climate, but, thanks to that, I had the pleasure to congratulate Raymond.

Raymond also received the Légion d'Honneur and was elected corresponding member of the French Academy of Sciences. Why "corresponding" and not full member? that's an absurdity. I am not

saying that because I am myself a "corresponding member"(laughter in the room!). It is a fact the Raymond was better than some of the full members.

I remember that I called Marie Françoise because I wanted to visit Raymond and bring him again one of these catalogues of ancient books that I mentioned before, but she said that he was in the hospital and was going to get out the next day. I promised to visit him, but, as we know, something very tragic happened.

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