Remembering Alfredo Molinari

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Alfredo Molinari left us more than two years ago: for many of us, he has been a teacher, a friend, an unforgettable presence in all scientific discussions.

He conveyed to the whole community a continuous struggling toward the understanding of physics, especially of those highly non-trivial objects, which we call many-body systems: nuclei, nuclear matter, Superfluid and superconducting systems, etc.

When ordinary theoretical methods were insufficient, he afforded statistical descriptions, touching most aspects of the modern many-body physics.

Alfredo graduated in 1959 with a thesis of the properties of atomic nuclei under the influence of the electromagnetic field: this item, following the evolution of the modern experiments and the questions raised by the continuous progress of our understanding of nuclear dynamics, has accompanied his scientific research through the years.

His academic career led him to obtain “Libera docenza” in Theoretical Physics in 1966, and then the Chair in Theoretical Physics, first in Ferrara, in 1976, and shortly after back to Torino, where he has been Full Professor since 1978.

Starting from 1965 Alfredo visited important International Institutions, where he initiated fruitful and durable collaborations with distinguished Scientists:

1965 – 1968 Niels Bohr Institute of Copenhagen University

1968 – 1969 Research Associate at Cornell University, Ithaca NY

1973 – 1974 research Associate at Massachusetts Institute of Technology (MIT), Cambridge (USA)

1978—1979 Research associate at the Theory Division of CERN (Ginevra)

From 1990 to 1994 Scientific Attaché for the Italian Embassy of Washington, located by the Italian Consulate in Boston.

These are important facts, something to enumerate in writing his own CV, but our memory of Alfredo goes well beyond.

In the end of 1973, I was close to the end of my studies in Physics and I was looking for a thesis argument in theoretical physics. I had never met Alfredo as a professor of the Faculty, since in that period he was frequently, almost continuously, abroad. However, prof. Verde, of whom I had attended my favorite lectures in Theoretical and in Nuclear Physics, told me to look for a young Assistant (that was the official role of Researchers) just come back from the States with a lot of interesting ideas to further develop. The office of Alfredo at that time (a period in which the "new" building of the Institute of Physics was under construction) was a narrow, dark attic, hot in summer and with a very little window. However, inside this little room you could find a big charge of enthusiasm and struggle to understand the ultimate secrets of atomic nuclei: that was Alfredo, all his life.

In going through the most significant contributions of Alfredo to Science, his main collaborations both with Italian colleagues (not only in Torino) and with well-recognized scientists all over the word will be mentioned.

Alfredo with his first three "students": Wanda Alberico, Cris Milanesio and Nanni Pollarolo

Structure of nuclei: collective vibrational states and rotational properties of deformed nuclei (1968-1974)

These ideas started during the Copenhagen period, in collaboration with Blonqvist, and continued with some renowned papers with Tullio Regge and, later, with Broglia and Pollarolo.

Riccardo Broglia at that time was sharing with Alfredo the vivid atmosphere of Copenhagen, while Nanni Pollarolo, the first "young" researcher in Torino who got in touch with Alfredo, could benefit from this collaboration and move later on to Copenhagen for an independent scientific career. In a way Nanni was the first brick of the School of theoretical nuclear physics, which Alfredo was able to raise in Torino.

Dynamical properties in electron-nucleus collisions (1966-1977)

The intriguing results of the first experimental activities in this field, first at Stanford and later at Orsay, stimulated several researches of Alfredo: first in collaboration with the local colleagues (and former university mates), Bottino and Ciocchetti. Later with the Nobel Prize Hans Bethe, with whom Alfredo became acquainted during his period in Cornell, yet keeping a reciprocal friendship in the subsequent years.

Nevertheless, Alfredo considered Hans Bethe as a myth (me too, of course) and I still remember the occasion when Bethe was invited as a lecturer to a Varenna School directed by Alfredo: I had the honor of meeting him at the airport and bring him to Varenna with my small, old car (a red 127 at the time). Many recommendations on how to manage with him... Then in Malpensa I saw Bethe, coming together with Mikkel Johnson (also well known to me) with a lot of luggage for both: I was really embarrassed and felt unable to let both of them to step in my small car. But Bethe removed any embarrass, invited me to closely pack both of them and start for Varenna. It was an amusing and pleasant trip and Alfredo was astonished at our arrival in Varenna, totally different from what he was expecting: you are crazy, how could you treat Nobel Prize Bethe like that!

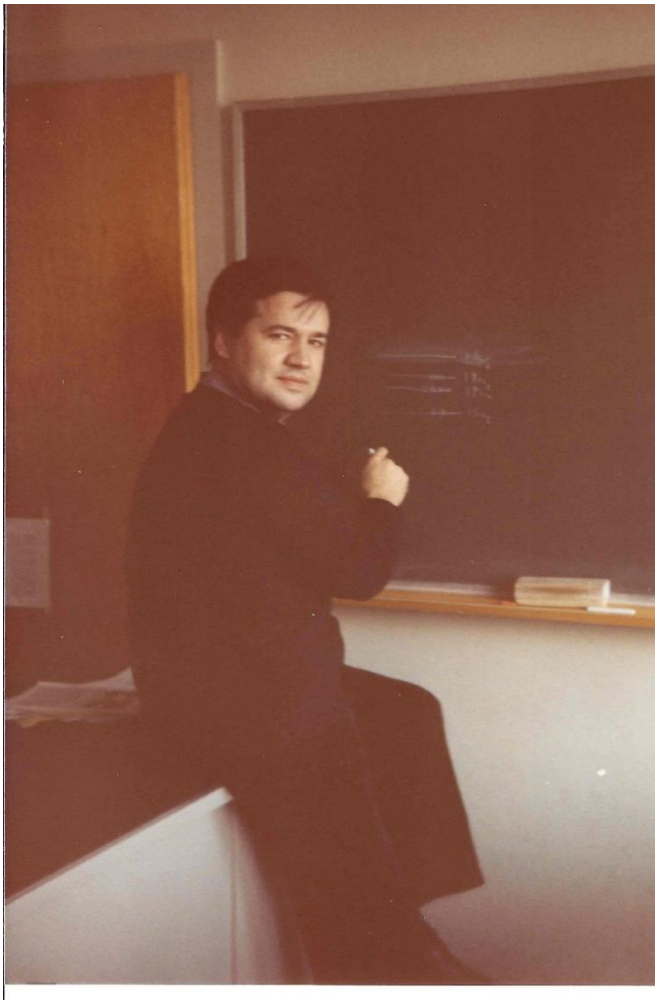
But let's go back to the activity of Alfredo in the study of electron-nucleus scattering: beyond elastic scattering, in the first 80's several experiments (mainly at Saclay and at Bates) gave interesting results on the quasi-elastic scattering of electrons on several nuclei, being able to separate the (inclusive) longitudinal and transverse cross sections. It was a new item, apparently little interesting since the total cross sections could be rather well reproduced with the simple Fermi gas model.

Nevertheless, since 1976 Alfredo had started to elaborate (in collaboration with Alberico and Cenni) the theory of the nuclear response function both in nuclear matter and in finite nuclei, also including the effects of NN interactions within the RPA approximation. This background was the basis for two different, long-lasting collaborations: with Magda Ericson, at CERN and Lyon, and with Bill Donnelly, at MIT.

The role of the pion in nuclear correlations (I): (1978-1990)

The first steps in the collaboration with Magda Ericson go back with the first research period of Alfredo at CERN: Magda and Torleif Ericson had been investigating peculiar effects of the pions in their interactions with nucleons.

From that point started the idea of taking special care of the pion inside nuclear dynamics: well known as a component of the NN interaction, the pion was usually considered as having little influence on nuclear properties, but the collective effects based on the exchange of this meson could be striking, as the proposed softening of the quasi-elastic peak.



Alfredo at Theory Division of CERN in 1982

Then the idea was extended in an analysis of the longitudinal and transverse electron-nucleus inelastic cross sections, again looking for the collective effects of NN correlations (not only pions, but also rho-mesons, short-range interactions, together with the excitation of the Delta resonance). Moreover, Alfredo, Magda and myself started to investigate the role of meson exchange currents and two-body correlations (again the pion at work) at relatively high-energy transfers, where theory and experiment were brought into agreement by these processes.

Again, the pion was protagonist in the explanation of non-mesonic weak decay of Lambda hypernuclei (the so-called nucleon induced decay), a paper at the origin of many subsequent works by other research teams.

People in Lyon (Delorme, Chanfray and Magda) had developed a semiclassical approach to describe nuclear response functions. Alfredo and I joined this approach, being able to use the convenient formalism of nuclear matter to reproduce results for finite nuclei and successfully compare with the experiment.

Alfredo and Ida Molinari, Nora De Marco and Alessandro Drago, at PANIC Conference, Uppsala, 1999

Alfredo and Ida Molinari, Lynn and Mikkel Johnson, Torino 2002

The role of the pion in nuclear correlations (II): (1990-2002)

The works on two-body mesonic currents had started within relativistic expressions for the E.M. currents themselves. This raised the attention of T.W. Donnelly who started collaboration with Alfredo, Barbaro, De Pace and I, concentrating on the so-called Parity-Violating (PV) Electron nucleus scattering, a small but significant part of the electroweak interaction, carried out by the exchange of a Z and measured by the asymmetry of the differently polarized electrons. This item was long investigated by experiments at BATES, at Jefferson Lab and in Mainz. After setting the proper relativistic description in the frame of the Fermi gas, the influence of the pion revealed subtle effects in the vector and axial nuclear responses, together with the proper treatment of relativistic effects and gauge invariance.

From there on, a series of seminal papers of the Torino-MIT collaboration, which paved the way to more and more accurate analysis of the measured PV electromagnetic responses and finally went into the investigation of neutrino-nucleus scattering.

Before touching this point, I like to point out that, in the first part of this period, Alfredo was Scientific Attaché by the Boston Consulate, never stopping his own scientific activity, beyond the diplomatical one. Yet he enforced the collaboration

between INFN and MIT, leading to a well-established agreement, quite interesting for the whole theoretical physics community.

Superscaling and neutrino scattering: (2004-2008)

By extending the Torino-MIT collaboration to research groups in Spain (Sevilla, Granada) the inclusive electron scattering was analyzed from the point of view of Scaling (in terms of kinematical variables) and Superscaling (in terms of Fermi momentum, for several nuclei). Alfredo and collaborators found amazing regularities. A seminal paper of 2005 has received great attention and interest.

Later, the scaling approach was then inverted and predictions were made for charge-changing neutrino reactions at energies of a few GeV. This approach, supported with some phenomenology (the so-called SuSA model), is now considered one of the best models to be employed in experimental analysis of neutrino-nucleon scattering data.

Deconfined matter, the Quark-Gluon Plasma (QGP): (2005-2014)

This subject became, during the last 2-3 decades, one of the main interests of the nuclear and particle physics community, both from experimental and theoretical points of view. Alfredo was ready to grasp the potential relevance of the many facets of this elusive state of matter.

Ordinary matter contains strictly confined quarks and gluons, but QCD (specifically lattice-QCD) predicts the transition to a deconfined phase, the QGP, providing that the temperature and/or the density of the system are sufficiently high: to produce QGP in laboratory is a challenge, which is presently realized in ultra-relativistic heavy ion collisions. To provide an unambiguous theoretical interpretation of the data, showing that the QGP was there and describing specific properties of it, is an even more difficult task.

Alfredo joined the venture, starting from the PhD thesis of Beraudo: the "QGP Torino group" also included De Pace, Nardi and myself, leading, in recent years, to a joint collaboration with experimental researchers of ALICE. The usual enthusiasm of Alfredo toward novel challenges produced a number of papers with timely results, highly appreciated by the community.

Miscellaneous

During the Years Alfredo touched, in his research work, a variety of arguments related with the investigation of many-body systems. Among these the pairing

interactions among nucleons, leading to a bosonization of the fermionic system, with peculiar results for the energy spectrum, as well as the nuclear description in terms of BCS-type correlations, again in connection with Superscaling (collaborations with Barbaro, Palumbo, Cenni, Donnelly).

Another issue, developed in collaboration with the colleague Bottino and myself, pointed to the relevance of atomic nuclei in connection with rare (or yet unobserved) events like neutron-antineutron oscillations, double proton decay, double Beta decay. In these processes, of great interest for the hypothesis of baryon and/or lepton number violations, an accurate knowledge of nuclear structure and interactions is crucial for a correct interpretation of the experimental data and for exploiting the expectations for lower/upper bounds in lifetimes. Starting from the ’80-s on, these researches have acquired a growing importance, leading to the birth of new research fields, like the investigation of dark matter, one of the crucial issues, nowadays, for astro-particle physics.

Finally, one of the last objects of the unexhausted curiosity of Alfredo (actually the work he was reviewing during his last days) were some aspects of nuclear structure connected with a chaotic behaviour of the constituents. On this issue, Alfredo, together with De Pace, developed an intense collaboration with Hans Weidenmueller, strengthening their personal friendship and reciprocal esteem.

Varenna School 2002: some of Alfredo’s students (from left: Maieron, Nardi; from the right: Quaglia, Ratti, Martini)

Thus far, though in a very limited overview, what concerns the scientific merits of Alfredo. However, it is time to focus on his qualities as a **Teacher**, in the actual and broad sense of the word.

Alfredo started to teach Many-Body physics at the University of Torino in the end of the ’70-is and continued on this subject (with several variations of title and precise content of the course) until retirement. He also had a course on Structure of Matter, but obviously he could not avoid expressing his best enthusiasm in a subject, which was daily bread for his research. In spite of being a “free-choice” course, Many-Body physics has always attracted students, who later, quite often, asked Alfredo to be the advisor for their Thesis. In several occasion we were sharing our students, at the level of Master and PhD thesis, encouraging and supporting them in their path toward scientific research.

Alfredo had the great merit of creating around him, in spite of the difficult financial situation of the Italian University, a research group which will continue his heritage in the future: after myself, Arturo De Pace and Maria Barbaro became researchers in Torino, while Alessandro Drago (also PhD student of Alfredo) started his career in Ferrara, the University where Alfredo had been working in the beginning of his full-professorship.

Years later, also Marzia Nardi and (more recently) Andrea Beraudo joined the group as INFN researchers. But during the decades many other students were attracted by the uncommon professor of Many-Body physics, enjoying his lectures and being personally and directly involved during lecture time, by direct questions on the long formulas written on the blackboard: every student had a nick-name given by Alfredo himself and kept it sometimes even after graduation. A special technique to maintain alive the attention of students was the use of the bamboo-pointer, always present in his lecture room and pointed not only toward the blackboard but also, sometime, toward the public, in order to press one or the other student to answer the posed question: never a trivial question, rather a suggestion to use the brain toward an independent reasoning.

Many students, who graduated with him or with me and later found their way toward PhD or Post-doc positions in Italy or abroad, keep permanent memory of those lecture and genuine affection for the Professor who, with unorthodox style and methods, raised in them and shared with them his genuine, unlimited passion for nuclear and many-body physics, his continuous effort to understand more and more deeply every small detail.

The presence of Alfredo in the Department was particularly felt on the occasion of Seminars: independently on the presented subject, Alfredo was there, in the first row, posing questions to the speaker during and after the talk, always timely and appropriate ones, often allowing also other people, who didn't dare to ask, to better understanding. This was, somehow still is, a bad habit in Italy to be silent during lectures and seminars: an attitude, which Alfredo continuously reproached to his silent students: he also gave a special definition to this behaviour, which I cannot report because nowadays it would be considered "politically incorrect".

The same happened during Conferences, Workshops, Schools: especially when the schedule was not too rigid, Alfredo enjoyed the competences of the speakers/lecturers in order to deepen his own knowledge: Physics for him was unique. In spite of the multiple, unavoidable specializations, nature is one and only one and Alfredo had a firm curiosity toward all aspects of Science, toward all facets of theoretical physics.

For this purpose Alfredo also dedicated many efforts toward the organization of Physics Schools, in particular he has directed several Courses of the International School of Physics "Enrico Fermi" of the Italian Physical Society in Varenna, in the Years 1980-2002.

Lecturers at the Varenna School 2002: from left Alfredo, A. Di Giacomo with wife, Alberico, Bill Donnelly with wife, Ida Molinari.

Alfredo's Birthday at the Varenna School 2002

He organized, as well, with the collaboration of Maria Barbaro and Bill Donnelly, several, regular Collaboration Meetings at the European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) from 2003 to 2011, and contributed to the organization of several events (Workshops, seminal Meetings, PhD Schools) in Torino.

Last (but not Least)

Before closing this personal memory of Alfredo Molinari, let me add a few, non-negligible details of his personal life.

Alfredo was an excellent pianist: his performances regularly delighted after dinners with friends and colleagues:

Alfredo liked mountains very much; he walked with pleasure together with his family, as we can see in this picture, taken in Val Varaita.

Finally a few words about family life: Alfredo dedicated most of his time to Science: he didn't care about "stupid" detail of ordinary life, like preparing meals (not even coffee), organizing travels, buying the necessary stuff to survive. He only took care (in the office and at home) of almost maniacal order. Nevertheless, he could realize what he liked in life thanks to the continuous care of Ida, who provided with love and attention for all his necessities. We recognize the great scientific merits of Alfredo, but we cannot forget that behind every great man there is (very often, and this is the case) a great woman.

The last picture combines together many students of Alfredo and some of his affectionate collaborators, with the background of the Torino Institute of Physics, which hosted a large fraction of Alfredo's life.

From left to right: Wanda Alberico, Arturo De Pace, Marco Martini, Claudia Ratti, Maria Barbaro, Alfredo, Magda Ericson, Andrea Beraudo, Rinaldo Cenni, Marzia Nardi, Hans Weidenmueller, Bill Donnelly (by the courtesy of Ida Molinari)