



## Livio Scarsi in memoriam (1927-2006)

M.C. MACCARONE AND B. SACCO

*Ist. Astrofisica Spaziale e Fisica Cosmica, IASF-Pa/INAF, Via La Malfa 153, 90146, Palermo, Italy*  
*Cettina.Maccarone@iasf-palermo.inaf.it*

**Abstract:** It's really difficult to condensate in few pages all what Professor Livio Scarsi did and promoted during his scientific activity. The article want to be a simple but sincere tribute to his memory.

Born 25 May 1927 in Rocca Grimalda, Northern Italy, Prof. Livio Scarsi has been a major protagonist of the physics, astrophysics and space research of the twentieth century. His brilliant scientific career is acknowledged by a large number of responsibility assignments, collaborations, academic and honorary positions and awards.

Livio Scarsi, leader of international research programs and space missions, has carried out functions of direction and scientific advising in many institutions, as the Italian Consiglio Nazionale delle Ricerche, the Servizio Attività Spaziali, now Agenzia Spaziale Italiana, the European Space Agency, the Russian Academy of Science.

Member of the Accademia dei Lincei, the Accademia Europea, the International Astronautics Academy, he awarded the "Bruno Rossi Prize" of the American Astronomical Society and received the Laurea Honoris Causa in Physics of the Université de Paris 7 Denis Diderot.

The scientific career of Livio Scarsi starts at Genoa University, as physics student in the Institute of Augusto Occhialini, father of Beppo Occhialini. On 1950 Livio took the degree in physics discussing a thesis on 'Cosmic Radiation Soft Electromagnetic Component at Pic du Midi: Investigation with nuclear emulsions'; his tutor was Giuseppe (Beppo) Occhialini. During the university studies in Genoa, Livio knew Bruno Rossi.

From Livio's memories:

*... Still a student, I was working on my 'Tesi di Laurea' when I was approached by a distinct Gentleman who introduced himself:*

*"My name is Bruno Rossi. I have dropped in for a courtesy visit to Prof. Augusto Occhialini ...; he will be able to meet me in about an hour. In the meantime can you kindly give me an hand to track down some references I need to complete the bibliography of a book I am writing on Cosmic Rays?"*

*It is what I did, taking the advantage of getting first hand news on the progress of research in the field...*

Beppo Occhialini and Bruno Rossi become the reference points in the scientific life of Livio.

Just after the Degree, Livio is Assistant Professor of Physics at the University of Genoa and Research Associate at the National Institute of Nuclear Physics, INFN, in Milan. His scientific interests are in the search of new particles in Cosmic Radiation with the technique of nuclear emulsions: the epochal G-Stack experiment flown in the upper atmosphere with stratospheric balloons allowed the first systematic classification of decay modes for K-mesons and hyperons before the intervention of the super accelerators. After a period of two years at the Centre d'Etudes Nucleaires in Saclay, France, in 1957 Livio comes back in Milan where Beppo Occhialini suggests him a new and larger horizon:

From Livio's memories:

*... Beppo said:*

*"My young friend: better for you to get out from here and go to hunt for the freedom of creativity before being trapped in the monocultural world of the particle physics ..."*

*In 1957 I left Milan and the world of 'elementary particles' to reach MIT with a Fullbright Fel-*

*lowship; I was joining Bruno Rossi and John Linsley in the experiment planned to investigate the extreme end of the 'cosmic ray' energy spectrum ( $E > 10^{18}eV$ ) with the giant Extensive Air Shower Array at Volcano Ranch, near Albuquerque in New Mexico...*

In Volcano Ranch, John Linsley and Livio Scarsi install the so-called "Desert Queen", 19 plastic scintillators ( $3.3m^2$  area each) in hexagon array of 1800m diameter. The scintillators were coupled with photomultipliers and oscilloscopes controlled by photo-cameras. Among many observed showers, one contains more than 30 billions particles corresponding to a primary particle energy of  $6 \times 10^{19}eV$ : it is the first evidence of existence of Primary Cosmic Rays with energy  $> 10^{19}eV$ , allowing the extension of the Cosmic Ray Energy spectrum up to  $10^{19}eV$ .

Livio arrives in Cambridge, Massachusetts "... just in time to watch at the TV on the 4th of October 1957 the USSR opening the Space Era with the launch of Sputnik..."; was this a premonition? who knows, but it is a fact that starting from 1961, when he came back in Milan, Livio Scarsi strongly contributes to the birth of Space Physics in Italy and in Europe, assuming function of scientific advising in many institutions as the late European Space Research Organization, ESRO, then European Space Agency, ESA.

In 1967 Livio Scarsi is Full Professor of Advanced Physics at the University of Palermo where he activates a new field of research: the Astrophysics of the High Energies.

A part a brief period at the University of Rome La Sapienza, (1981-1983, chair of Space Physics, Faculty of Science) and occasional semesters at the University of Mogadiscio, Somalia (coordinator of Teaching Activity and Courses), Livio Scarsi dedicates his scientific activity to the Physics from Space and to his group. In few years, the Palermo group grows so much to carry to the birth, in 1980, of the "Istituto di Fisica Cosmica con Applicazioni all'Informatica" of the National Council of Research, IFCAI/CNR, specially dedicated to the realization of great projects of Space research; Livio Scarsi is appointed Director of the new Institute. The denomination of the new Institute is not casual: Livio believes in the importance of the interdisciplinary world, in its history and evolution; un-

der the auspices of the Ettore Majorana Centre in Erice, Italy, in 1984 Livio Scarsi promotes and is co-Director of the "Data Analysis in Astronomy" Workshop Series that marked the beginning of all the similar symposia in the world. With its first five editions, the series has provided an updated overview of advanced methods and related applications to astronomy and astrophysics, allowing astrophysicists and computer scientists to discuss, debate and compare results and methods, theory and experiments. The sixth edition, organized in April 2007 and entitled to Livio Scarsi, has followed the spirit and the indications Livio provided us until his last days.

Starting from the year 2000, although formally retired from the University, Livio Scarsi continues his scientific activity as essential protagonist at the Institute he established years before (now Istituto di Astrofisica Spaziale e Fisica Cosmica, IASF-Palermo/INAF).

At the end of the 1960s, and with the creation of the new Institute in Palermo, the activity of Livio Scarsi mainly concerns proposals, implementation and scientific driving of Space missions and facilities in the framework of the international Space community, participating as main actor.

He continues the research on rare components of the Cosmic Radiation with detectors on board of rockets (as the first experiment in Italy in the ESRO Program) and on board of stratospheric balloons, contributing to the improvement of such techniques and to the establishment of a permanent balloon launch facility in Sicily. One of the most relevant scientific results was the detection of pulsed emission of Gamma Radiation from the Crab Nebula Pulsar PSR0531+21. This activity continues with COS-B, the first European survey satellite to explore the gamma-ray sky. The payload included the pulsar synchronizer detector constructed and operated by the Palermo Group, led by Livio Scarsi. COS-B (launched on 15 August 1975 and active for ten years) provided the first complete map of the gamma-ray emission in the Galaxy above 50 MeV, the identification of galactic and extragalactic sources and the first catalogue of gamma-ray sources, promoting the gamma-ray astronomy to an adult and recognized branch of Astronomy.

The more remarkable success of Livio Scarsi has surely been the realization of the satellite for X-astronomy SAX, developed in collaboration between the Italian Space Agency ASI and the Dutch Space Organization SRON. In its first design, SAX was presented to the Italian Space Plan in 1981 and approved for a launch planned in 1988 by Shuttle, but the program was canceled in 1987 due to the Challenger disaster (January 1986); it was thanks to the strong and resolute leadership of Livio Scarsi, Chairman of the SAX Science Steering Committee, that the mission was re-oriented towards an Expendable Launch Vehicle. SAX, launched on 30 April 1996 with an Atlas-Centaur, was at once named BeppoSAX in honour of Beppo Occhialini; Livio Scarsi led the mission until its switch-off, 6 years up to April 30, 2002.

BeppoSAX has been a space venture of extraordinary success and a landmark in X-ray astronomy. It has promoted a fundamental progress in the various branches of galactic and extragalactic high-energy astrophysics, documented by more than 2000 scientific papers. The highlight is represented by the discovery of the source counterpart of the Gamma Ray Burst. For this, *"The 1998 Rossi Prize of the High Energy Astrophysics Division of the American Astronomical Society is awarded to the BeppoSAX Team, represented by Prof. Livio Scarsi and Dr. Jan van Paradijs for the discovery of the X-ray and optical afterglow of gamma-ray bursts, making possible the solution to the 30 year old problem of fixing the distances to the gamma-ray burst sources."*

Many scientific groups from Italy and Europe contributed to the realization of BeppoSAX, as well as, and in a determining way, the Italian Space Industry, as Alenia, Laben and Telespazio in order to cite those of greater relief: Livio always has considered fundamental and has cured in detail the relationship between scientific and industry world, thinking that a great enterprise could be realized only through their tight collaboration.

The success of BeppoSAX does not permit Livio to forget his first love, "cosmic rays". So, at the beginning of 1990s, starts PLASTEX, the Palermo-Leeds Air Shower Tracking Experiment. Using detectors and electronics of a CERN experiment no more in operation, and following a first idea by John Linsley, now in Palermo, the group led by

Livio Scarsi implements in Haverah Park the experiment PLASTEX running in conjunction with the GREX array settled by the Leeds group led by Alan Watson. PLASTEX is devoted to the study of space-time structure of Extensive Air Showers.

Always animated from juvenile enthusiasm and attracted from the challenges, in 1995 Livio Scarsi activates a new project, the observation of the Extremely High Energy Cosmic Rays from Space. As John Linsley wrote:

*... On 15 May, 1995, my wife Paola telephoned me in Palermo that Yoshiyuki Takahashi was trying to get in touch with me from Marshall Space Flight Center. His message was, "I have written a paper about a Maximum-energy Air Shower Observing Satellite, MASS. The technology and neutrino detection capability relate to John's original idea of 1979. I would like to send my text to John, and talk with him." As soon as we had talked, I told Livio Scarsi what had happened. "It sounds as if it might be fun", he said. "But it will be hard for me to explain 'MASS' to the Italian Space Agency. We should call it something more general." After a few tries we came up with "Airwatch", short for "Space Airwatch"...*

This was the beginning of many activities related to the Airwatch program: in few years, an International Consortium of more than 50 Institutions was activated under the leadership of Livio Scarsi and, at the end of 1999, the project of a new observatory devoted to the investigation of Cosmic Rays of extreme energy from Space, EUSO, was proposed to ESA as a "free-flyer" mission in response to the "Call for Proposals for Two Flexi-Missions (F2/F3)". Although no room was available as free-flyer in the F2/F3 program, the project was recognized to be of very high scientific interest in the astronomy and astroparticle areas and in March 2000 ESA selects EUSO for the "accommodation study" on the International Space Station, ISS.

Livio Scarsi then enters in the new millennium with the ambitious project EUSO, acronym of Extreme Universe Space Observatory, the first Space mission devoted to the investigation of Cosmic Rays of extreme energy (UHECR,  $E > 5 \times 10^{19} eV$ ), the detection being performed by looking at the streak of fluorescence light produced when such a particle interacts with the Earth's atmosphere. Accommodated as external payload on



board of the International Space Station, EUSO will observe the fluorescence signal looking downward the dark Earth's atmosphere under a 60 full field-of-view. Fluorescence light will be imaged by a large Fresnel lens optics onto a finely segmented focal surface detector. The highly focal surface segmentation and the fast detector time resolution will allow reconstructing the shower arrival direction and energy with high precision. EUSO was expected to detect of the order of  $10^3$  per year UHECRs with  $E > 10^{20} eV$  and to open a window into the High Energy Neutrino Universe.

More than one hundred fifty researchers from several scientific institutions in six European countries, in USA and in Japan participates to the challenge. Once again, Livio Scarsi is the leader of a big international collaboration.

EUSO Phase A (Conceptual Design and Feasibility Study) was successfully completed in July 2004 and the ESA Board considered the EUSO mission mature to move in Phase B (Detailed design and Implementation)... but...

In November 2005 EUSO is frozen by European Space Agency due to difficulties (ESA financial, ISS, Shuttle, ...)

Livio didn't have time to find a solution, as eighteen years before when the Challenger disaster stopped the SAX program.

On March 16, 2006, he left us !

... but the memory of Livio Scarsi, with his extraordinary personality and his enthusiasm, will continue to act as example for the Scientific Community.

All people knew Livio have had the way to appreciate his high scientific skill, his charisma, his iron will to argue for what he believed, his passion for the challenges with an eye to the future and naturally with a conscience of the present, his optimism in all the situations, his deep humanity, his ability to instil in the young people the passion for the research, ... and his always present suggestion:

...*"Hello guys, enjoy your life!"*