

## "Frontier Research in Astrophysics" Concluding Address

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**Franco Giovannelli**<sup>\*†</sup>

*INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

*E-mail: franco.giovannelli@iaps.inaf.it*

Before I officially conclude this workshop – and far be it from me to attempt more conclusive remarks than those effected by Diego Turrini, Janusz Ziółkowski and René Hudeč –, I would like to comment on a few highlights coming from our very fruitful week of discussions about *Frontier Research in Astrophysics*. I make no pretension of completeness in these brief remarks.

*Frontier Research in Astrophysics,*

*26-31 May 2014*

*Mondello (Palermo), Italy*

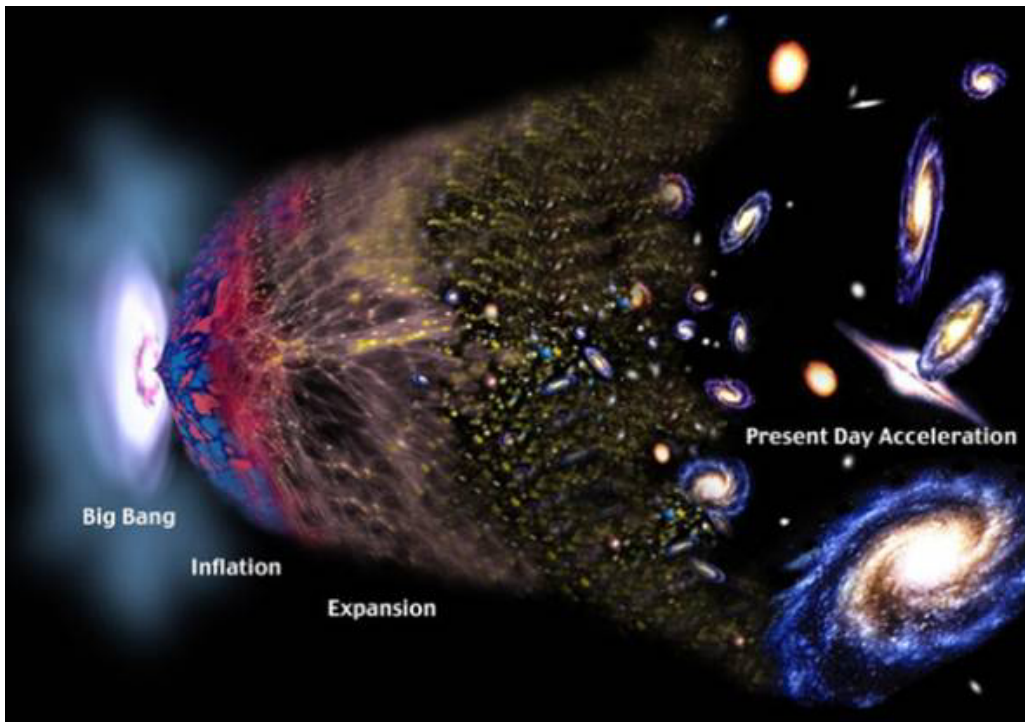
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<sup>\*</sup>Speaker.

<sup>†</sup>A footnote may follow.

Undoubtedly, the advent of spacecraft and satellite observatories has given a strong impulse to astronomy. Starting in the mid-seventies, almost all the electromagnetic spectrum has been continuously surveyed by many space experiments. In addition, Astroparticle Physics, the new field of physics, was born roughly twenty-five years ago from the joining of efforts of the communities of High Energy Astrophysicists and Particle Physicists. During this relatively short time, Astroparticle Physics developed dynamically through the study of cosmic sources that are emitters of photons, charged particles, and neutrinos. Some of these sources can produce gravitational waves which are likely to be detectable in the near future with the new generation of ground- and space-based gravitational wave experiments, such as LIGO and LISA, respectively. Meanwhile, the Large Hadron Collider (LHC) has produced excellent results related to research on the Higgs boson, and in general about the study of pp collisions at TeV energies that have never before been obtained in ground-based laboratories.

These results, together with those coming from the Hubble Space Telescope (HST) with its deep survey of faraway objects of the Universe, and with the VHE emission detected from a number of cosmic sources, both galactic and extragalactic, bear witness to the validity of the Big Bang theory, described by the standard model. Recently the collaboration of the BICEP2 experiment claims the detection of E-mode and B-mode polarization of the Cosmic Microwave Background (CMB). If B-mode polarization can be confirmed, the inflationary model of the Universe would be definitively confirmed. However, big discoveries need big confirmations.



**Figure 1:** Sketch of the evolution of our Universe from the Big Bang till now (Paul Salahuddin Armstrong, 2014).

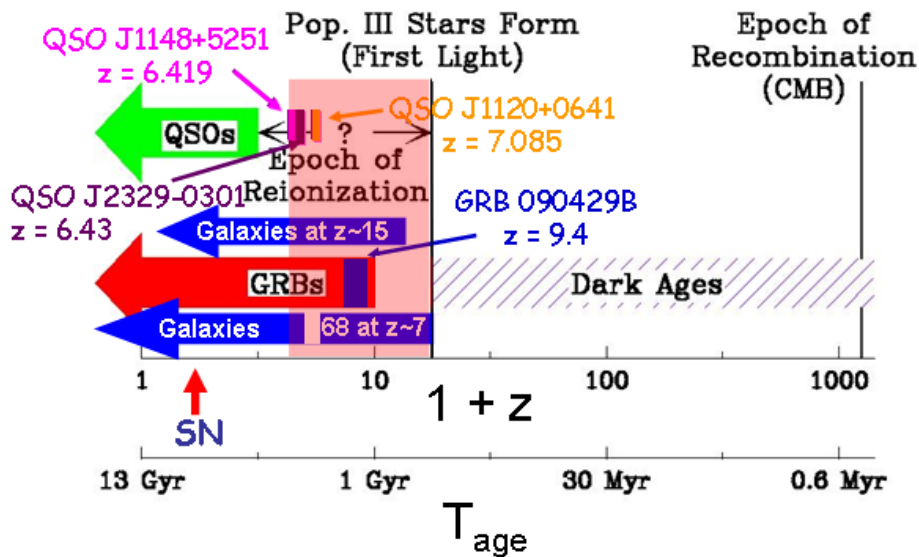
In this fruitful workshop, we have discussed many topics that can be placed at different times in the evolutionary track of our Universe, as sketched in Fig. 1 (Salahuddin Armstrong, 2014). In

other words, we have gone along the bridge of ideas that links the Big Bang and Biology.

Among the many experimental and theoretical results of frontier astrophysics discussed during this workshop, I would like to remark on a few of them that, in my opinion, will condition future investigations.

Theoretical and observational works show that jets from AGN can trigger star formation, as found for instance in the surroundings of the microquasar GRS 1915+105. Therefore, the jet-induced star formation by a microquasar will be crucial in the next epoch of observations: high-energy and low-energy phenomena are clearly interconnected. In fact, jets from stellar black holes may have been important sources that trigger star formation during the re-ionization epoch of the universe.

Now there is rather good agreement about the epoch of re-ionization, as shown in Figure 2 (Giovannelli & Sabau-Graziati, this workshop). But how re-ionization really occurs is still subject of debate. Indeed, Dopita et al. (2011), in considering that recent observations show that the measured rates of star formation in the early universe are insufficient to produce re-ionization, suggest the presence of another source of ionizing photons. This source could be the fast accretion shocks formed around the cores of the most massive haloes.



**Figure 2:** A sketch of reionization epoch (Giovannelli & Sabau-Graziati, 2015 – after Xiangping Wu’s Talk at the Summer School on "Cosmic Reionization" at the KIAA-PKU , Beijing, China, July 1-11, 2008 ).

The idea that GRBs could be associated with the emission of gravitational waves (GWs) is now popular. Indeed, short GRBs are believed to be produced by the mergers of either double NSs or NS-BH binaries, and the recent observation of a kilonova associated with GRB130603B (see, e.g. Tanvir et al., 2013) lends support to this hypothesis. Such compact binary coalescences generate strong GWs in the sensitive frequency band of Earth-based gravitational wave detectors. However, till now the sensitivity of GW detectors is not sufficient for such detections. This will be one of the most intriguing investigation of the next decades.

In my opinion, the most exciting future investigations will be those devoted to the discovery of exoplanets in the vicinity of solar system, and especially those within the habitable zone of

their mother stars. Next generation instruments (ground- and space-based) will provide valuable information about this intriguing problem. In the next decades we could participate in the discovery of life on exoplanets thanks to the many experiments studying their compositions and the atmospheres.

The possibility of life on exoplanets has become the main question for both scientists and humanity in general.

How to cross the bridge between the Big Bang and Biology and, especially, how to orient ourselves once we have arrived on the bank of "biology" is a matter of interest many men and women of great knowledge, especially those involved in improving human knowledge.

During this fruitful workshop, we hope to have demonstrated once more the "*Vulcano Theorem*" enunciated in 1984 in my concluding address: **It is possible to develop science seriously even if smiling.**

But, as you probably suspected, this workshop has been organized under peaceful and friendly surroundings. Therefore, I would like to mention and to support Tolstoy's philosophy.

"**Think again**", was written by Lev Nikolàevic Tolstòj (Leo Nikolayevich Tolstoy) in 1904, at the beginning of the Russian-Japanese War. The human condition described by Tolstoy in the state of war is "Like spiders in a glass".

A pamphlet that is not only against carnage, but:

"Again the suffering that benefits nobody, again the lies, and again the universal process of stupidity, the turning of men into beasts...",

...but that is also against the racism and the hypocrisy of the educated:

"Scholars ... deal extensively with the laws of the migration of peoples, the relationship between the white and the yellow race, between Buddhism and Christianity, and according to their deductions and considerations justify the killing of men ...".

... It shows unequivocally the Tolstoyan base of Gandhi's non-violence doctrine:

"I cannot act in any other way than God requires of me, and therefore, as a man, I cannot take part in any war, neither directly nor through a third party, nor by giving orders, nor by cooperating in any form, nor by encouraging doing it: **I cannot, I will not and I will not do it.**"

And finally, I would like to conclude with few wonderful words of Dr Daisaku Ikeda (2001) – president of the Soka Gakkai International (SGI) – reported in the booklet *For Today and Tomorrow* - the thought of 30th May:

*"The one who has many friends has greater opportunities for growth. In this way, one both makes society a better place, and lives happier and more satisfied. In all cases, human relations, the inter-personal interaction and communication are of vital importance. We must establish and nurture friendship and contacts with many people, both in our environment, and in society in general. In this manner our life will open up and will flourish".*

We could go back to early childhood when we were as the "little prince".

One sees clearly only with the heart. What is essential is invisible to the eye (from "The Little Prince" by Antoine de Saint Exupéry).

And the search for the essential is of extreme interest to a large number of men of great learning who are in agreement with Paul Salahuddin Armstrong, who said in his 2014 talk "*Human Family*;

*Past, Present and Future*", at the "New Humanity Movement-Event" (Paul Salahuddin Armstrong, 2014):

*Today we travel the world, making connections, doing business, and building relationships in person or online with fellow members of our Human Family from all parts of the Earth. We are becoming more conscious that what happens in one place, affects people everywhere. We are not alone... We are not isolated... Only through building bridges of Love and Understanding can we ensure the well-being of everyone in our Human Family.*

The search for the essential is so important that even famous noble-minded scientists try to attempt the difficult way of the possible convergence of science and life in its more sublime meaning. For instance Pier Luigi Luisi founded in 1985 the *International Week of Cortona "Science and the Wholeness of Life"*, dedicated to the integration of Scientific Disciplines and Humanities. Later he published the book *"The emergence of Life. From Chemical Origins to Synthetic Biology"* (Luisi, 2006) in which he resumed the consecutive stages from prebiotic chemistry to synthetic biology, uniquely combining both approaches. Indeed, the origin of life from inanimate matter has been the focus of much research for decades, both experimentally and philosophically. Friedrich Rolle, a German philosopher and biologist, wrote *"The general reasons for this assumption are so categorical that I have no doubt that sooner or later it will be possible to demonstrate such an assumption in an unambiguous and scientific way, or even repeat the process experimentally"* (Rolle, 1863).

In the book *"The Systems View of Life: A Unifying Vision"* (Capra & Luisi, 2014) the authors integrate in a single framework of coherent thought ideas, models and theories that are the foundation of the systemic vision of life, highlighting the economic, ecological, political and spiritual implications.

Personally, I would like to resume and remark some fundamental concepts read in the book, that I completely share.

Life is a network of complex and inseparable relationships that renders the understanding of an individual phenomenon indivisible from the understanding the entire ecosystem in which it occurs. Therefore the answers can not be found by relying exclusively to the scientific method, but is now required an "holistic" approach, able to reflect on connectivity, relationships and contexts as well as properties and functions of the individual parts.

The discipline that best reflects the systemic vision of life is ecology, which reconnects the life sciences with the earth sciences and studies the interaction of organisms with each other and with the surrounding environment. The new ecological science - that has emerged from organismic biology only in the late twentieth century, when the concept of ecosystem developed - is not anthropocentric but eco-centric, that is characterized by the awareness that all living things are tied together in networks of interdependence.

Ecology is the ideal bridge between science and spirituality. In fact, within the systemic view of life, it is essential the concept of balance between science - responsible for the material and technological progress - and spirituality, responsible for the internal growth of individuals and ethical limitations imposed by the excessive consumption of resources of the planet. The balance between science and spirituality determines the welfare of society.

The bridge between the Big Bang and Biology ferries us from the original point to the biologically active side where sentient life and then science start. But to close correctly the "run" of it, it

is necessary to cross one bridge more: The bridge between science and spirituality. If this bridge is properly covered, our society will flourish.

Personally, I feel obligated to point out some observations that seem fundamental about the philosophical and social implications of contemporary science. These observations lead to interesting conclusions about the origin of life and self-organization of natural and synthetic systems. These findings are in keeping with the Buddhist view of the universe. It is understood as a living organism being composed of myriads of components all related and interacting with one another. Life can be seen as a system of interconnected autopoietic systems. The organism interacts with the environment in a "cognitive" way. At the same time, the organism "creates" its own environment and the environment allows the creation of the organism. But this is the concept of dependent origin. According to this concept, every phenomenon is the product of the interaction of every other phenomenon in the universe.

The consequence of this view are of extraordinary importance above all in ethics: it asserts that all living beings and their environment are inextricably linked, and that their essence is not absolute but "of relationship." It leads us to respect every individual being and its inherent rights. In other words, this view leads us to live and act without distinguishing our own happiness from that of others. Ultimately this view leads to the TOTAL RESPECT OF LIFE in the most general meaning.

It is my pleasure to thank:

- the Scientific Organizing Committee (James H. Beall, Dmitry Bisikalo, - Thomas Boller, Riccardo Claudi, Sergio Colafrancesco, Franco Giovannelli - (Chairperson), Reniĳ Hudeĳ, Paolo Persi, Valentin M. Pillet, Lola - Sabau-Graziati, and Andrea Santangelo);
- The super-efficient Local Organizing Committe (Franco Giovannelli - (Chairperson), Daniela Giovannini, Paolo Persi, and Francesco Reale - (Co-Chairperson).

Particular thanks to:

- the Informatic Operator (Francesco Reale alias FIGARO, the factotum) for helping in informatics and solving all related problems during the preparation and development of the workshop and in Mondello, at the registration desk, in the conference room, on the terrace, and ... more;
- the Executive Secretary Daniela Giovannini, who smoothed all the inconveniences that occurred at the registration desk with professionalism and moreover with her nice smile;
- the directors of the INAF-IAPS, DCU&CE-INTA, MPE, E-O. HULBURT Ctr-NRL, St. Johniĳs College, IAA/University SAND 1, ASCR/AI Ondĳejov & Czech Technical University, INAF-OAPD, School of Physics - Wits University, National Solar Observatory, RAS - Institute of Astronomy;
- the actresses Lisa Colosimo and Flavia Giovannelli;
- the violinist Alessandro Perpich and pianist Valentina Usai;
- the staff of the Splendid Hotel La Torre.

On behalf of the SOC and LOC, I am pleased to thank all participants and especially the speakers for their active contributions in rendering this workshop updated with their talks, alive with their discussions, and friendly with their attitudes. A special thank to the three colleagues and

friends (Diego Turrini, Janusz Ziółkowski, and René Hudeč who kindly accepted the not easy task of making the concluding remarks of the workshop.

Finally, on behalf of all participants, I would like to express my warm tanks to the Chèf, Mr Daniele Inzerillo, who prepared for us a large number of delicacies.

I hope to meet all of you once again during our next Mondello Workshop.

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