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Concluding Address

Franco Giovannelli ⋆

INAF – Istituto di Astrofisica Spaziale e Fisica Cosmica, Roma
Area di Ricerca CNR di Roma-2, Via del Fosso del Cavaliere, 100, I 00133 Roma, Italy

Abstract Before to conclude officially this workshop - far from me the idea to attempt some concluding remarks already well done by Janusz Ziołkowski, Sergio Colafrancesco and René Hudec - I would like to comment few highlights coming out from our fruitful week of discussions about *multifrequency astrophysics*, without any pretension of completeness.

Key words: Multifrequency Astrophysics

1 COMMENTS ABOUT SOME HIGHLIGHTS

I would like to comment, without any pretension of completeness, few highlights coming out from our fruitful week of discussions about *multifrequency astrophysics*, and the possible results we can reasonably expect in the near future.

1.1 Cosmic Microwave Background

The Diffuse Extragalactic Background Radiation (DEBRA) is the up-to-date multifrequency witness of the original Big Bang and it permeates the whole Universe. Then its knowledge allows the study of many astrophysical, cosmological, and particle physics phenomena. The analysis of the different components of DEBRA leads to the Grand Unified Photon Spectrum (GUPS), covering 29 orders of magnitude of the electromagnetic spectrum, from 10^{-9} to 10^{20} eV. This spectrum is continuously updated thanks to the numerous space– and ground–based multifrequency experiments. In the near future we will witness results coming from TeV astronomy, which could fill the gap around these energies where only upper limits are at present available (Giovannelli & Sabau-Graziati, this book, figure 15).

1.2 The High Energy Sky

The high energy sky before the sixties was simply empty. Only optical, a few UV and radio measurements were available. Now the X-ray sky is populated by about a million sources. The GeV γ-ray sky is increasing its population following the same slope of the number of detected X-ray sources versus time, but two orders of magnitude lower, simply because γ-ray photons are less than X-ray ones (Giovannelli & Sabau-Graziati, this book, figure 21). Good news are coming from TeV astronomy. The VHE sky, which was empty about 20 years ago, is now populated by many galactic and extragalactic sources for a total of more than 40 sources. This is probably the most exciting news discussed during this workshop. Also in this case, multifrequency approach is fundamental in order to search for the associations of the unidentified GeV and TeV γ-ray sources with known sources which appear in other energy ranges.

1.3 Gamma-ray Astronomy as Probe for Cosmic-rays

A particular attention is necessary at the highest energies where the cosmic ray spectrum extends to 10^{20} eV (Giovannelli & Sabau-Graziati, this book, figure 20). Yet the origins of such spectacularly high energy particles remain obscure.

⋆ E-mail: franco.giovannelli@iasf-roma.inaf.it

It is becoming increasingly clear that the energy régime covered by VHE γ-ray astronomy will be able to address a number of significant scientific questions, which include: i) What parameters determine the cut-off energy for pulsed γ-rays from pulsars? ii) What is the role of shell-type supernovae in the production of cosmic rays? iii) At what energies do AGN blazar spectra cut-off? iv) Are gamma blazar spectral cut-offs intrinsic to the source or due to intergalactic absorption? v) Is the dominant particle species in AGN jets leptonic or hadronic? vi) Can intergalactic absorption of the VHE emission of AGN's be a tool to calibrate the epoch of galaxy formation, the Hubble parameter, and the distance to γ-ray bursts? vii) Are there sources of γ-rays which are 'loud' at VHEs, but 'quiet' at other wavelengths?

1.4 Jets and GRBs

By means of simultaneous and coordinated multifrequency observations it has been possible to draw a strong analogy between quasars and microquasars. The emitted spectra of jets are strongly dependent on the angle formed by the beam axis and the line of sight, and obviously by the Lorentz factor of the particles. So, observations of jet sources at different frequencies can provide new inputs for the comprehension of such extremely efficient carriers of energy, like for the cosmological GRBs.

More than 100 claimed association of GRBs with the host galaxies at high redshift, at the moment, favors the extragalactic origin of GRBs. However, such an origin has not yet definitively demonstrated, at least for most of them. Many observational features remain still unclear in the model of cosmological GRBs. Observations of γ-ray flashes and the correspondent afterglows in different energy ranges put serious bounds to the models for GRBs, and fomented heated arguments among theoreticians, not yet completely solved. Critical experimental evidences are needed: spectra of prompt optical afterglows; study of hard γ-ray afterglows; search for orphans optical afterglows in all sky monitoring. Cosmological GRBs may come from collapse of massive rotating star followed by the formation of a Kerr black hole surrounded by a massive magnetized disc, and rapid accretion leading to a GRB; or from sources described by exotic models.

2 CONCLUSIONS

During this workshop we have once more remarked that:

- **a) multifrequency astrophysics is mandatory** for a faster and better development of science;
- **b) astrophysics is clearly moving toward higher and higher energies.** HE, VHE and UHE astrophysics are the most powerful tools for sounding the deepest secrets of the Universe.

I completely agree with the *nomination for the conference hit* given by Janusz Ziołkowski to TeV astronomy.

Finally, on behalf of the members of the Scientific Organizing Committee, I would like to express many thanks to the participants, and to the members of the Local Organizing Committee.

I could say more words, but I sincerely think that the moment to close this workshop has actually arrived. Thanks a lot to everybody.

The workshop is closed, see you next time!