CONCLUDING REMARKS

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I was really afraid when Alberto asked me to give concluding remarks at this conference. Particle theorist by education, with most of the career spent on calculating Feynmann diagrams for hard processes in QCD, what could I really contribute? But then I realized that if I, in a sense outsider and allien, can be convinced and impressed by the results presented at the conference, it speaks for itself.

And indeed, you have convinced and impressed me. I started my adventure with GRB in 2003, convinced by Bohdan Paczyński to drop QCD and start building small robotic telescopes. I understood that GRBs carry a promise of fundamental discoveries – today I would say that GRBs have made it into the history of science as a unique context, unique tool to study fundamental physics and the Universe at the same time.

We have heard an impressive account how the field was born and how clever (and persistent) people designed the first detectors and flew them on board on early satellite missions. We could follow the technological progress which finally led to the most advanced instruments on board of *Swift*, *Integral*, *Fermi* and other satellites.

The importance of adequate technology is very much visible in the context of observations of GRB emissions, both prompt and afterglow. An enormous amount of high-quality data has been collected so far. Discovery of precursors to short GRBs raised the question of to which extent the classification of GRB into short and long ones makes sense at all. High quality, time- and energy-resolved data pose a real challenge to the theory. We have seen quite a number of models and numerical simulations. I have seen similar situation in particle physics many times – as a rule, extending range of observations, in this case improving time and energy resolution poses serious difficulties to models, even if undergoing

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physics of radiation and dynamics of relativistic plasma is very well understood piece-wise. Here, the key factor is probably the complicated environment in which all these processes coexist and interact with each other. In my personal opinion model fitting could profit from consideration and a better understanding of a more general physical picture.

It might be also useful to develop meaningful tools to analyze common, averaged over the certain subsample of events features of GRB radiation rather than apply modeling to each event separately. Clearly, better data, with time resolved multiband spectrometry, photometry, polarization, and radio will further constrain our thinking about mechanisms of emission. I think that we are still in the phase when theorists need to be inspired by the data in the first place, so theorists, please go back to the data and try to understand them.

I would very much like to see that our understanding of GRBs dynamics is extended towards progenitor/central engine mechanism. Here, GRB physics overlap with another very “hot” topic, namely ongoing effort for detection of gravitational waves. If gravitational waves originate in a sudden change of space-time geometry caused by a progenitor explosion, a source of gravitational waves might be also a source of strong electromagnetic emission. Hence, understanding of the central engine mechanism is not only interesting because of fascination about relativistic physics in strong gravitational fields which governs these events, but also because of the first gravitational waves detection – which would be a potentially Nobel prize discovery.

Another very interesting topic has been the host galaxies study. Most of these galaxies would never attract observer’s attention, and yet as it follows from the data, the population of GRB hosts galaxies is different from *e.g.* population of “supernova” galaxies. Large – *z* GRBs have also emerged as a unique tool to probe the very early Universe. It has been proven in a few cases that because of these observations we can indeed successfully reach back in time to the onset of observable Universe and gather information about its evolution. It is a mind-blowing development, isn’t it?

From the side of detectors and satellites, the situation looks very good. *Swift*, *Fermi*, *Integral* and other telescopes forming the IPN and the ground-based telescopes gathered in GCN form together an example of a very successful, perhaps the most successful ever observational campaign. We have also witnessed a whole series of talks and poster contributions about new ideas and new developments aiming at improving time resolution and extending robotic networks in order to facilitate 24h/day coverage and fast, automatic response to alerts.

In particular, new satellite detectors, like *UFFO-Pathfinder* or *LobsterEye*, or new ground-based installations, like *MegaTORTORA* were presented at the very last day of the conference. These projects use innovative technology in order to achieve a much faster response to alerts combined with a higher spacial or time resolution. Their success will soon bring us even more very interesting and significant data.

It has been a very fruitful conference. I am honoured to be able to thank wholeheartedly Alberto and other members of LCO and SOC for such an inspiring event. But I would like to extend these thanks to you all. We are all living on the stage, somewhat at a corner place, of the enormous theatre, the Universe. The script is full of unexpected and violent event. As, I believe, Richard Feynman put it, humans are the only known species which show interest in understanding of this script, as far as it goes. Truth to tell, during last couple of years I have observed that this interest is waning, at least officially. The Polish Minister of Science told me a few months ago that if the government debt is going to raise too fast “we will take money from science”. And yet I am convinced that this quest is absolutely crucial for survival of homo sapiens. Hence, GRB are special and you, people who study them, you are very special. Thank you and come safely home.