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Concluding Remarks

Janusz Ziółkowski ⋆

Copernicus Astronomical Center, ul. Bartycka 18, 00-716 Warsaw, Poland

Abstract After a canonical disclaimer and some general remarks, I will make brief comments on three arbitrarily selected topics: dark matter, gamma-ray bursts and neutron stars (both isolated and in the X-ray binaries). Next, I will announce my personal nomination for the hit of the conference. I will end with traditional acknowledgements and a call to show up at Vulcano next year.

1 INTRODUCTION

As stated above (see abstract), I have to start with a classical statement that the selection of topics for these concluding remarks is based on personal impressions and as such it has to be arbitrary and unfair to many exciting topics that will not be mentioned. Then, I should state that, although no major breakthroughs were presented, we still had an excellent conference. We heard a lot of excellent talks on a very wide range of exciting topics of modern astrophysics. To add a grain of salt, I should mention that some traditional topics like the status of HST and JWST or new highlights from SWIFT were missing, although they could be easily included (prospective speakers were present at the conference).

Continuing the general remarks, I would like to notice some retreat from such topics as dark matter (DM) or gamma-ray bursts (GRBs) towards more classical topics such as X-ray binaries (XRBs), neutron stars (NSs), black holes (BHs) or clusters of galaxies. In my opinion, this retreat is due to the fact that topics that yesterday were still exotic (like DM or GRBs), today became a routine everyday work of astronomers. This is a measure of a rapid progress made by present day astrophysics. Another testimony to the triumph of modern astrophysics is the fact, that particle physicists asking for their expensive (multibilion EUR) toys like LHC, more and more justify them quoting astrophysical problems. At the same time, astrophysicists just do their job and achieve excellent results (using much cheaper toys).

After this self-laudation, I will now briefly discuss the three topics listed in the abstract.

2 DARK MATTER

We have heard many excellent talks, clearly demonstrating that DM became a subject of routine everyday investigation by astronomers. We can determine, quite precisely, its distribution in the Universe. We have seen some breathtaking pictures, especially one - that of merging cluster 1E0657–558. This object is composed of two clusters which after a collision are now receding from each other. We have at our disposal technics that permit us to map separately the distribution of stellar components of both clusters, the distribution of hot, X-ray emitting, intracluster gas and the distribution of DM. We can see, with our very eyes, that dissipationless stellar components from both clusters, after passing each other, are now well separated. The same is true about DM components of both clusters. At the same time, the intracluster gas from both clusters glued together and now forms one cloud staying between the two clusters. This gas is clearly separated from stellar and DM components of both clusters. This picture is a powerful testimony to the real existence of DM in the Universe.

The near future will be even brighter for DM researchers. After the launch of GLAST next year, we should be able (as demonstrated by Aldo Morselli) to detect and identify many point DM gamma-ray sources. The spectra of these sources (originating from DM particles annihilation) have properties that

⋆ E-mail: `jz@camk.edu.pl`

permit to distinguish them easily from "normal" astrophysical point gamma-ray sources. With GLAST observations, we should be able to estimate the mass of DM particles with an accuracy of $\sim$15% at 150 GeV and $\sim 10\%$ at 1 TeV. It seems that we really witness a beginning of a "golden era" in DM astrophysics!

3 GAMMA-RAY BURSTS

I will briefly mention two developments that I consider important in this field: the lack of achromatic breaks in GRBs light curves and the first possible candidates for short GRBs originating from distant magnetars.

3.1 No Achromatic Breaks in GRBs Light Curves

Practically, everybody agrees now that GRBs are strongly collimated phenomena. The common wisdom estimate leads to the beaming factor of the order 10^{-3} to 10^{-2}. This estimate of beaming is based on the achromatic breaks in the GRBs light curves. However, the substantial amount of data accumulated by now from SWIFT indicate that, in most cases, the breaks are either chromatic or absent (only one case of truly achromatic break was found in SWIFT data). Therefore, the observational evidence seems to be shifting in favor of CB (cannon ball) model, advocated for some years by Arnon Dar and Alvaro de Rujula. We have to stay patient and remain optimistic: the correct model will prevail.

3.2 Short GRBs from Distant Magnetars

Three giant flares of magnetars were observed so far in our Galaxy (flare of SGR 0566–60 on March 5, 1979, flare of 1914–00 on August 28, 1998 and flare of SGR 1806–20 on Dec. 27, 2004). Each event consisted of the initial, very hard ($\sim$ 1 MeV) and very energetic spike lasting less than a second, and subsequent much softer ($\sim$ 20 keV) tail lasting several minutes. Such giant flares of magnetars (occurring at a rate of 0.1 yr $^{-1}$ in our Galaxy) must be frequent in nearby galaxies. If they occur within $\sim$ 100 Mpc, only the initial spikes are seen and, therefore, such events *have* to be classified as typical short GRBs (if they occur beyond $\sim$ 100 Mpc, they are too dim to be observed). It seems, therefore, that some short GRBs are just giant flares of distant magnetars.

Kevin Hurley presented us the first two possible examples of such events: GRB051103 and GRB070201. The first GRB originated possibly in the halo of M81, the second in the halo of M31. Their energies would then be 7×10^{46} and 6×10^{46} erg. Both values are consistent with giant flares of magnetars, but are much smaller than typical energies of GRBs.

4 NEUTRON STARS

We witnessed during this workshop a revival of NSs as one of the leading topics of the conference. This is, most likely, due to the recent discovery of new numerous classes of objects that are NSs or contain NSs. Discovery of a new type of beasts called RRATs (Rotating RAdio Transients) more than doubled the number of detectable NSs in our Galaxy (in fact, we expect about 20 000 RRATs to be detectable with SKA). Discovery by INTEGRAL of two new classes of high mass XRBs (HMXBs): obscured INTEGRAL sources and supergiant fast X-ray transients (SFXTs) more than doubled the number of known supergiant HMXBs. We have heard excellent talks by Nanda Rea and Sylvain Chaty about all these new fascinating objects. We were told by Didier Barret about the possible discovery of fastest spinning neutron star (XTE J1739–285, $P_{\rm spin}$ = 0.89 ms). We were offered a convincing evidence in favor of really superstrong magnetic fields in magnetars (Kevin Hurley). And we received a wealth of information about many other topics related to neutron stars (gamma-ray pulsars, X-ray pulsars, bursters, atols, Z-sources, dippers, QPOs, NSs masses, equation of state etc.). Truly, NSs were a major topic of our conference.

5 NOMINATIONS FOR THE CONFERENCE HIT

This year, my personal nomination for the conference hit goes to the TeV astronomy. This field just started its golden age and is in an early phase of it. The situation reminds the dawn of an X-ray astronomy few decades ago. Probably, in a few years we shall witness a similar start of a golden era for the neutrino astronomy (remember a talk by Jim Beall two years ago). Returning to the TeV astronomy, it is really impressive how much this field developed during recent few years. The beautiful talks by Andrea Santangelo, Marc Ribo and Hendrik Bartko demonstrated this very convincingly. MILAGRO, VERITAS and, especially, HESS and MAGIC are doing excellent job. We detected by now over 40 sources (few years ago we knew just two sources). In addition to extragalactic sources (17), SN remnants (11), pulsar wind nebulae (11) and X-ray binaries (5), we discovered some unexpected sources like a pair of two W-R type stars. We entered an era of precision (just compare huge error boxex of EGRET with the precise, high resolution, photographs of HESS and MAGIC). The nearest future looks even brighter. The present HESS observatory is now being upgraded to HESS II configuration, which will have substantially larger capabilities. The somewhat further future looks still brighter. In a few years time a new powerful instrument named Cherenkov Telescope Array (CTA) should (hopefully) start its work. I refer you to the talk by Marc Ribo for more details. The CTA will be a next generation instrument with really breathtaking capabilities. We may expect many impressive and unexpected discoveries. The future of TeV astronomy looks really bright!

Acknowledgements And now, traditionally, let me join Rene and thank Lola, Franco and all organizers and all participants. It was their collective effort that made this meeting such a pleasant and succesful event.