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THE GRAVITATIONAL VOICE

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News from EGO and VIRGO

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The content of this newsletter does not necessarily represent the opinion of the management.

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"The kilonova generated by GW170817 event observed by Hubble Space Telescope. As shown in the picture set the brightness of this newborn star decreased over time."

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EDITORIAL

In place of the usual editorial, we would like to start this 34th issue of h with the following words from Rainer Weiss about the Nobel Prize award.

"The Nobel prize is intimidating. To think that you belong in the same category as Fermi, Bohr or Einstein is clearly nonsense. To think that you represent a large number of people who have worked on the detection of gravitational waves who together have opened a new field of science is a more convivial idea. I can almost live with that."

C.Bradaschia
Chief Editor

In Memory of Adalberto Giazotto

On the 17th of August this year, a little before three in the afternoon in Pisa, the Virgo interferometer and the American LIGO interferometers recorded the passage of a gravitational wave. The signal was quite different from those measured in the events since 2015. Not two black holes, pure energy capable of curving a ray of light up to capture, but two neutron stars, matter compressed to the maximum density possible by the force of gravity. The combination of Virgo and LIGO, indicating the direction of the source, made it possible for ground- and space-based telescopes to observe a new astronomical object.
The scientists of the LIGO and Virgo collaborations, and thousands of astronomers and astrophysicists with a hundred or so telescopes, worked frenetically to observe all of the phases of a 'kilonova', from its ignition to its cooling. The data showed for the first time that, during this process, starting from neutron matter heavy chemical elements, such as Gold and Uranium, form, and the production is sufficient to explain their abundance in the Universe.

Adalberto Giazotto's vision had been realised. While building Virgo, he convinced his LIGO colleagues to speak of the interferometers as a 'single machine', distributed across the surface of the Earth, with complete sharing of data, and not the sum of three instruments. His vision then extended to the astronomical observatories. As such, even before the events were registered, different communities were ready for the observations; scientifically, but also with agreements and protocols, which recognised the contribution of each participant.

Born in 1940 in Genoa, Adalberto Giazotto graduated in Rome with a thesis in Theoretical Physics and then joined the experimental physics group led first by Edoardo Amaldi and then Gherardo Stoppini, head of Spectroscopy in Pisa. Along with a few Pisan colleagues, in the early 1970s he transferred to Daresbury, in the United Kingdom, to undertake particle physics experiments at one of the most powerful electron synchrotrons of the time. Subsequently, he participated, at CERN in Geneva, in the FRAMM experiment for the photoproduction of particles with charm, alongside a sizeable group of young Pisan physicists.

Unable to complete the long journey to Geneva, starting from the early 1980s, he dedicated himself to the study of General Relativity, recognising that the detection of gravitational waves should be guided, as much as possible, by the nature of the sources and that the experimental techniques must be at the service of that aim. With the available instruments, it was possible to detect interesting, but extremely rare, weak sources, which emit waves that oscillate rapidly. Instead, other sources, which are intense because they are composed of much larger masses, generate waves that oscillate more slowly. These became Giazotto's objective, but the instruments were to be overwhelmed by the vibrations of the terrestrial crust. Starting from the first studies, twenty years of experimentation were necessary before Giazotto and his group were able to understand how to build an instrument capable of recording those oscillations; those from the sources detected in 2015.

A Research Director at the National Institute for Nuclear Physics (INFN), he proposed, along with Alain Brillet in France, to build the Virgo interferometer, which was approved with an international agreement between the INFN and the French National Centre for Scientific Research (CNRS) in 1994. The agreement required the institutions to finance its construction.

In 2002, the Virgo infrastructure: two three-kilometre-long straight tunnels in the Cascina countryside, in which the light of a laser would be able to travel between two mirrors, were delivered for the experiment and, by this time, the idea of the ‘single machine’ was born. Another fifteen years were necessary for the idea to become reality.

With interests in many fields, Giazotto was a passionate collector of crystals. He always expressed his wonder at the beauty that can emerge from the work of nature and of time, as well as from the work of humanity. This was particularly so in relation to music; in itself ephemeral, but the source of enduring emotions. Like the events recorded by Virgo.

An exquisite exponent of a science guided by far reaching knowledge goals, he was practically impervious to the daily mechanisms of the workings of scientific research. He was driven only by the search for perfection necessary in order to undertake “a thing of an enormous difficulty”. Adalberto Giazotto is an extraordinary example of how scientific ideas can be carried forward, without compromise, but always accepting the response of nature, in the end of reaching unthinkable objectives.

Adalberto Giazotto departed on the 16th of November, leaving an unbridgeable emptiness. We wish to send to his family our most sincere condolences. May his memory remain also as an example to our students, in both their studies and in life.

F. Fidecaro

Remembering Adalberto

I met Adalberto back in 1975. I was a young graduate in Applied Physics and I had the opportunity to enter the INFN to participate in the FRAMM experiment directed by Lorenzo Foá (Nicola Menzione's uncle). I was in charge of the electronics of the experiment and Adalberto was in charge of the project, construction and development of the so-called Cherenkov counters.

I always remember him as a very elegant person: he looked like a nobleman. Unlike all the other physicists involved in the experiment, he was always dressed in a suit and tie.
While working with wrenches, screwdrivers, glues etc., he was always impeccable: I called him "the Lord".
One of his great passions was Short-Waves Listening: he often contacted me to ask for my opinion on various technical issues concerning radio.
This passion for Radio Waves would later turn into a greater passion for Gravitational Waves. This is how our collaboration was born: he was an expert in mechanics and optics (as well as high energy) and I in electronics: we were complementary. When in 1981-82 he decided to change the field of research and devote himself to the detection of Gravitational Waves, he immediately wanted me at his side in this new adventure. At first it looked like a game involving a group of less than 10 people.
After more than 30 years, that initial game has become one of the greatest scientific achievements: and all this thanks to his immense passion and his willpower, which allowed him to overcome enormous difficulties.

Thanks Adalberto for what you taught me during these fantastic years: you will remain forever in my thoughts.

D. Passuello

A star left us

Dear colleagues,

Violette left us a few weeks ago. It was a very sad day for the LAL team, for IN2P3 and for Virgo.

Violette was one of the very first physicists from IN2P3 and LAL to join Virgo during the early stages, just before the approval of the project.

She took charge, along with others in Orsay and in Pisa, of the design and the construction of the vacuum pipes; the same pipes that host Advanced Virgo today. In particular, she followed the construction of the vacuum pipe at the CNIM company, with numerous missions to the south of France. Violette also worked on scattered-light issues and developed the absorbing baffles, which are still in use.

After her retirement, due to her great expertise in the Virgo vacuum system, she acted as a consultant to the Vacuum group in Cascina. Until recently she was still very interested in the life of the Orsay group and of course in the LIGO-Virgo results, participating in the LAL group meetings. It always has been a pleasure to discuss with her.

We will remember a very rigorous physicist, and a charming person.

P.Hello

Violette Brisson (©Anne-Marie Lutz LAL)

Augustus Mirabilis

August 2017 will probably be remembered as one of the most important months in the history of astronomy; a mensis mirabilis. After an impressive amount of work done in less than a year by its commissioning team, Virgo was able to join the LIGO scientific run (O2) on August 1st. A few days later, on August 14th and August 17th, two gravitational wave (GW) events, produced respectively by a black hole binary and a neutron star binary, were detected.

The excitement and enthusiasm that permeated those days will remain forever in the minds of those that were working on the detectors.

The first event was Virgo's first detection, the dream that Adalberto Giazotto and Alain Brillet had in mind when they conceived the idea of building a GW detector in Europe.
The second event was the birth of gravitational astronomy. The signal observed by Virgo and LIGO was followed by a gamma ray burst and then by x-ray and electromagnetic emissions. Thanks to Virgo, the sky position of the source was identified with enough precision to point the most powerful telescopes in the world toward it. A newborn star, a kilonova, was observed, marking the beginning of the multi-messenger astronomy era.

V.Boschi

GW140817 triple detection

In Italy, the August 15th holiday celebrates the so-called Feriae Augusti, a festivity introduced by the Roman Emperor Augustus more than 2000 years ago, in 18 BC.

Just the day before the 2017 Feriae Augusti, the Universe decided to give us a wonderful gift: at about 12:30 PM in Italy, the gravitational waves produced by two colliding black holes reached all of the three interferometers of the LIGO-VIRGO network for the first time.
The source, 1.8 billion light years from the Earth, was localized in the Eridanus constellation of the southern sky with unprecedented precision. Thanks to the different orientation of the Virgo arms with respect to LIGO, it was also possible to measure the polarization of the signal and to measure its speed.
The significance of previous LIGO detections also increased, since Virgo is a completely independent instrument, with several differences in its design.

It is difficult to describe what this first detection means for Virgo. Almost exactly 15 years after the inauguration of Virgo, the dreams of A. Giazotto and A. Brillet become real: an interferometer in Europe can detect signals and its role is essential because only with a network of at least three detectors can sources be localized accurately.

At the same time, this detection is the result of the impressive work done day and night by the Virgo commissioning team. In less than a year, a group of a few people was able to make this incredibly complex machine work well enough to detect signals.

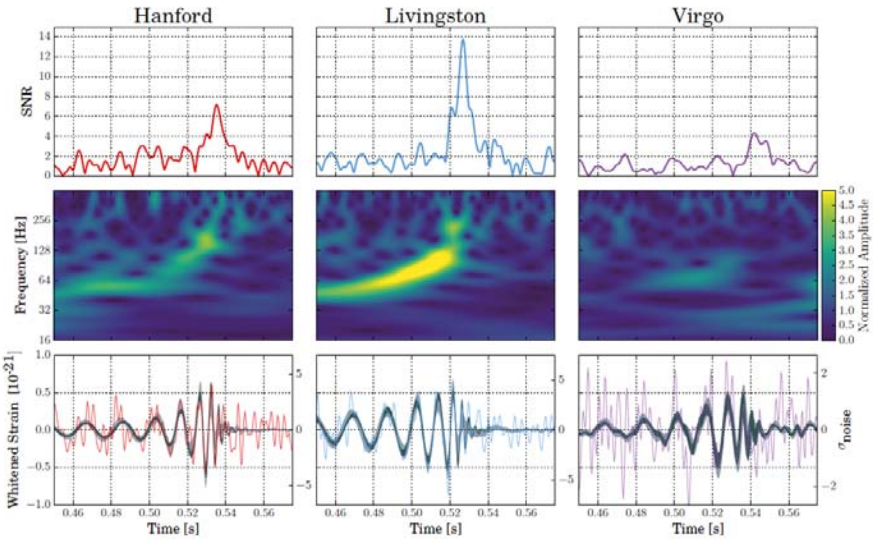
The team worked continuously, essentially without any rest, and faced several difficulties along the road.

The last of these challenges happened just the weekend before the detection: on Friday 11th, very high winds made it impossible to lock the interferometer for the entire day.

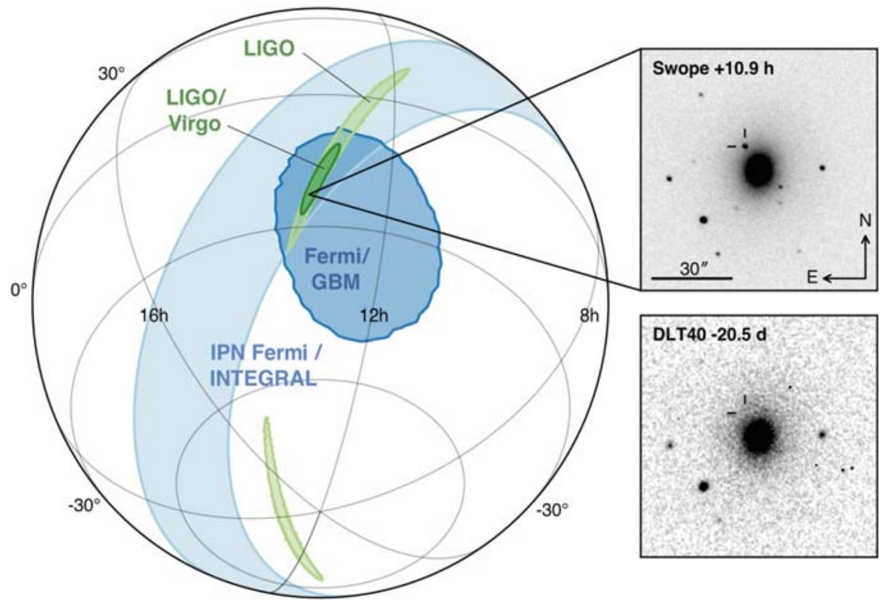
On Saturday morning the wind disappeared, but still the detector, for reasons unknown, was unable to reach its operating state.

Thanks to the work done during that weekend, the interferometer recovered and both the August 14th and August 17th detections were possible.

V.Boschi



GW170817 and the birth of multimessenger astronomy



Last August, about 70 telescopes around the world and in space looked in the very same direction, at a small patch of sky in the Hydra constellation.
This massive armada of telescopes worked together to observe the direction of the GW170817 event detected by LIGO and Virgo. GW170817 was a key event in the development of gravitational wave astronomy, because it was the first signal due to the coalescence of two neutron stars.
Moreover, its interest to the scientific community grew even more when the space and ground-based telescopes detected an electromagnetic emission that was both positionally and temporally consistent with the LIGO-Virgo signal.
GW170817 was the first event to be observed with gravitational waves and light, marking the birth of multimessenger astronomy, a new exciting way to study the cosmos.
It all began on August 17 at 12:41:06, when the Gamma-ray Burst Monitor (GBM) on board the Fermi mission detected a flash of gamma rays, later denominated GRB170817A, and issued a dedicated Gamma Ray Coordinated Network (GCN) circular announcing the discovery. GRBs are short flashes of gamma-ray light produced by catastrophic explosions in the far Universe.
About 6 minutes later, the low-latency gravitational wave pipelines detected a new event in the data of the LIGO-Hanford interferometer. The signal was consistent with the coalescence of a pair of neutron stars merging at about 1.7 seconds before GRB170817A. The signal lasted about 100 seconds, much more than the previous events produced by a black hole – black hole

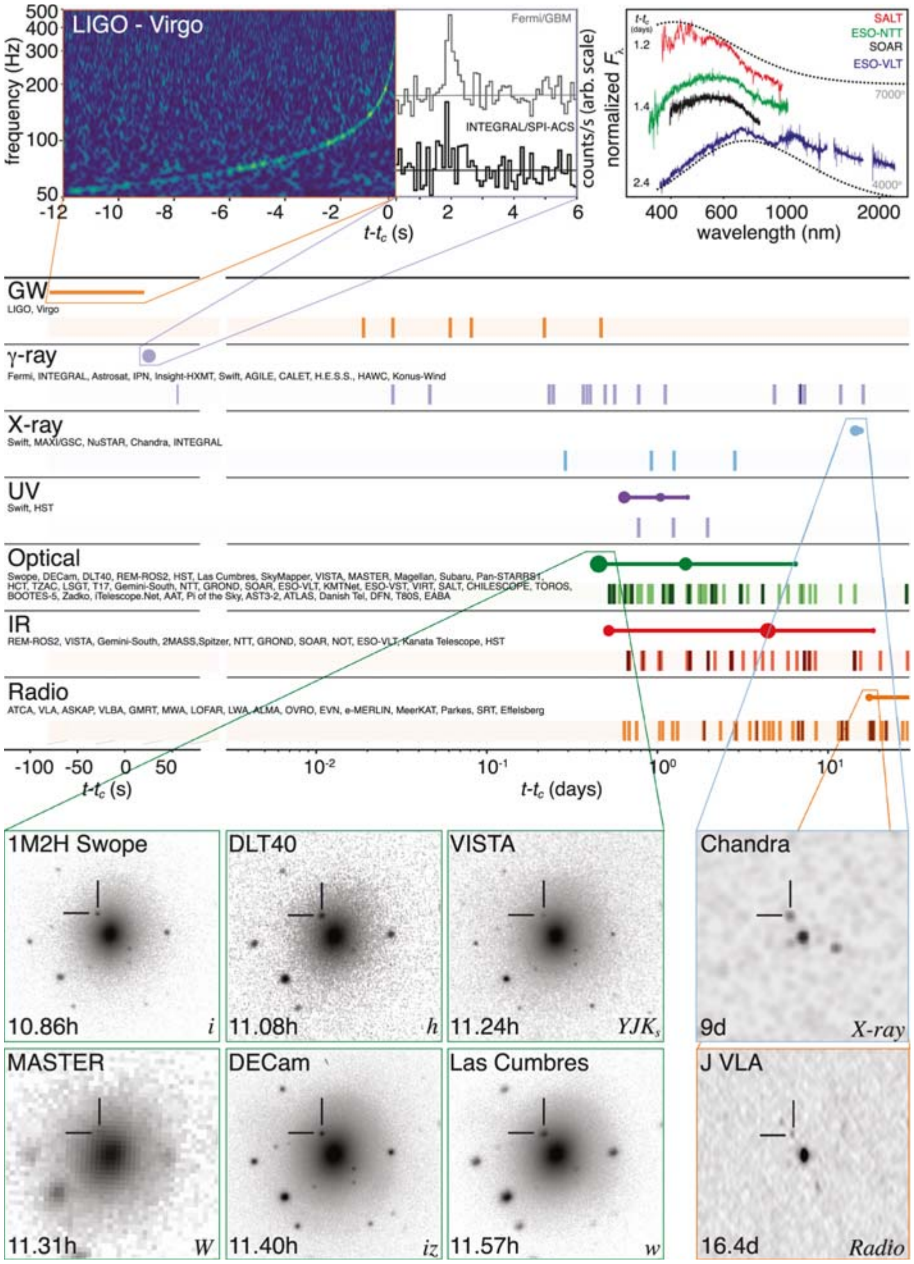
merger, and was detected with a signal-to-noise ratio of about 32, the largest so far.
Combining the LIGO and Virgo data it was also possible to determine the arrival direction within a sky region of about 34 deg², spatially coincident with the direction of the GRB detected by Fermi-GBM and INTEGRAL instruments. Such a small uncertainty region was possible because of the simultaneous three-detector observation of the event.

The information on the event and on its localization was issued in a series of GCN Circulars sent to the astronomers participating in the LIGO-Virgo electromagnetic follow-up program. In these Circulars an estimate of the distance of the event, about 40 Mpc from us, was also issued.
The temporal and spatial coincidence of GW170817 with the GRB detected by Fermi-GBM triggered an extensive observing campaign involving telescopes operating at various wavelengths in space and around the globe. Also, neutrino detectors, such as Icecube and ANTARES were involved in this campaign and looked for astrophysical neutrino related to GW170817.

About 11 hours after the merger, the One-Meter, Two-Hemisphere team announced the discovery of an optical counterpart in the NGC 4993 galaxy, 40 Mpc away. The discovery, made with the 1-m Swope telescope at Las Campanas Observatory in Chile, was also done independently by other five teams. The transient, named initially SSS17a and later renamed AT 2017gfo, was extensively studied by many other teams, who also did accurate spectroscopic analysis.
The main feature was a redward evolution of the kilonova emission, with a rapid decrease of the blue-colored emission within a few days.

The photometric and spectroscopic analysis revealed that the transient emission was due to a kilonova, an exploding source different from the most famous supernova. By analyzing the kilonova spectrum, it was possible to confirm the production of heavy elements, including gold and platinum.
About 9 days after the merger, the Chandra X-ray space telescope detected a transient source at the position of AT 2017gfo, and radio observatories revealed the appearance of a radio counterpart 16 days after the merger.

While the Fermi GBM gamma-ray emission seems to be connected with the relativistic shells emitted right after the merger, it seems that the X-ray and radio emission are related to the late afterglow GRB emission. Joint gravitational and gamma-ray data analysis was key to confirming that the merger and the short GRB emission are related, thus answering one of the main open questions in modern astrophysics, related to the origin of the short GRBs. The analysis of such a rich event was key to tackling various problems in



fundamental physics, including the understanding of the structure of neutron stars, the constraints on the Lorentz violation, and the measurement of the Hubble constant.
GW170817 marked the birth of multimessenger astronomy, i.e. the study of astrophysical sources based on gravitational waves and light as two "cosmic messengers". The key idea is that these messengers can provide complementary information on astrophysical sources, thus providing a clearer picture of these cosmic laboratories. When Virgo and LIGO resume operation later this year, we expect to have a higher rate of events, including neutron star mergers, such as GW170817, which will provide new crucial information on the most extreme objects in the Universe.

M.Razzano

Bayesian statistics @ Virgo

How do we measure gravitational waves properties?

The decade-long efforts that led to the initial observing run of Advanced Virgo have been rewarded with the observation of several black hole binaries and a binary neutron star coalescence.
For these systems we were able to measure masses, position in the sky, distance from Earth and many other physically interesting quantities that officially inaugurated the era of gravitational astrophysics. But how is it possible to extract this information from a signal buried in the interferometer noise?
The actual algorithms that are used to measure the properties of a GW source are extremely complicated and have been developed over a period of more than 10 years by hundreds of scientists in the LIGO-Virgo Collaboration.
However, the basic principle according to which such a difficult measurement can be made is very simple and has its roots in the intuition of Rev. Bayes more than 400 years ago and later put on solid bases by Laplace. Rev. Bayes' intuition is now known as Bayes' theorem. It can be paraphrased as:
The plausibility of a model given some observed phenomenon (or data) is given by the product of how plausible the model is, before having observed the phenomenon in question (the prior), times the likelihood that the phenomenon is among the predictions of the model.

The apparent simplicity of Bayes' theorem is deceiving. To understand it, we first need to understand the basic principles of mathematical logic and of the syllogism. For many, scientific inference is based on the so-called strong syllogism first stated by Aristotle:

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if A is true then B is true - *major premise (the model)*
A is true - *minor premise (the data)*
therefore B is true - *conclusion*

For instance, a classic example is:

All birds have feathers - *major premise*
That animal is a bird - *minor premise*
Therefore that animal has feathers - *conclusion*

The strong syllogism can be thought of as defining a relation of cause-effect (major premise) and the inference is made starting from the assertion that the cause (minor premise) has been observed and therefore the effect (conclusion) is ineluctable. However, the strong syllogism is seldom applicable in science since we very rarely observe the cause for a phenomenon, or simply we do not know what the real cause of that phenomenon is. For instance, for gravitational waves, we could say:

- the movement of the mirrors in an interferometer is caused by the passage of a gravitational wave
- we observed the movement of the mirrors
- therefore a gravitational wave has passed.

Unfortunately, we know that mirrors can move due to a variety of noise sources, thus the major premise must be changed to something like:

- the movement of the mirrors in an interferometer can be caused by the passage of a gravitational wave or by some other instrumental noise
- we observed the movement of the mirrors
- therefore a gravitational wave is probable.

The above is an example of the weak syllogism which is the modus operandi of scientific

interference. As an aside, registering the coincident movement of the mirrors in more than one interferometer vastly increases the probability that this is due to the passage of a gravitational wave.
But how do we measure the properties of a gravitational wave signal? Let's assume that we are extremely confident that a gravitational wave signal is present in Virgo and LIGO data. This means that, when a gravitational wave is present, the detector output s is given by a superposition of instrumental noise n and the gravitational wave signal h:

$$s = n + h$$

If we could somehow subtract the noise from the detector output, we could extract the signal *h*. Unfortunately, we do not know the noise well enough to do so. However, thanks to years of theoretical work, we do know the signal *h* very well. The signal *h*, in fact, is obtained by solving Einstein's equations, either via approximate methods or in super computers, and therefore, for any combination of physical parameters (masses, spins, etc.) we can predict what the signal is going to look like.
The idea then is to choose a set of values for the physical parameters of the signal to predict the gravitational wave signal, subtract it from the detector data and see whether the residuals have the expected properties of pure noise. The last ingredient we need is therefore to understand the properties of the noise *n*.
Since the noise *n* is the superposition of many different processes (thermal fluctuations of the mirror surface, scattered light inside the interferometer, seismic noise, etc.) we can apply the Central Limit Theorem and thus assume that, in the absence of a gravitational wave, each noise realisation will be drawn from a Gaussian distribution. Moreover, the variance of the noise Gaussian distribution is given by the Power Spectral Density.
We now have everything we need to define the likelihood function: General Relativity and the noise statistical properties tell us that the difference between our predicted signal and the data must be distributed according to a Gaussian distribution.
To be able to apply Bayes' theorem, we still need to provide a prior expectation for the signal *h*, and in particular a prior expectation for the physical parameters of the signal.
This is set according to our knowledge of the population of coalescing binaries we expect to observe in Virgo and LIGO.
The most probable values for the parameters of a gravitational wave are the ones that maximise the posterior probability distribution, that is the product of the prior probability function and the likelihood.
To a reasonable degree of approximation, they are the ones for which the residuals look the most like simple Gaussian-distributed noise.

Full posterior distributions, the histograms we report in all our discovery publications, are obtained using LALInference, a set of sophisticated Monte Carlo algorithms that evaluate the posterior probability for millions of possible values of the parameters to be able to calculate not only the most probable values but also their uncertainty. Obtaining reliable values and associated uncertainties can take days or even weeks and the tireless work of tens of scientists.

The reward is the astounding measurement of black hole masses, spins and even unprecedented tests of our understanding of the dynamics of space-time at its most extreme.

W. Del Pozzo

The future of slides

In the recent Virgo Week we considerably improved Virgo slide-preparation techniques. Many of us were able to reduce the font size of the plot scales to such an extent that they were only readable from a maximum distance of about one metre.
This is in perfect agreement with the scope of the slides, which is not to share information, but to show a colourful background for the speakers on stage.

I have been told that the leaders in this tendency have succeeded in using the "Times 2" font; there are also rumours that someone has developed a quantum procedure to use one single pixel to represent a letter.
It is said that using methods derived from quantum computing techniques, we will succeed, in the near future, to pack all of the slides of an international conference into one single page.

Next upgrades will be devoted to minimizing speakers.

C.Bradaschia

7 years as EGO Director

Dear Colleagues, dear friends,

After seven years, on 31 December 2017, I concluded my mandate as Director of the European Gravitational Observatory.

It has been a very complex period, with a large variety of difficult problems; solutions to which were only found thanks to collective effort.

The risk of failure was always in front of us: only very recently, in August 2017, did Virgo achieve its first fundamental objective.

As is natural for human life, sad and happy events arrived, just to quote some: on February 2016 the press conferences to announce the historical first detection of gravitational waves; Ron Drever, Stefano Braccini and Adalberto Giazotto passed away; in September 2017, the G7 Science press conference to announce the first triple coincidence; in October 2017, the press conference to announce the extraordinary start of multi messenger astronomy; the 2017 Nobel Prize for Physics given to our great colleagues Rai Weiss, Barry Barish and Kip Thorne.

Finally, the demonstration that LIGO and Virgo are the solid core of the new science.

I wish to thank warmly all of you for the support, the valuable contribution to my actions, and the friendship that many of you showed.
I am very grateful to all of the people with whom I shared problems, doubts and joy during these unforgettable seven years.

I wish to thank the EGO staff that followed me with confidence and serenity, also in the dark moments.

A very special thank you to the LIGO Direction and LSC management: the continuous interaction with Dave Reitze, Albert Lazzarini, Gaby Gonzales and David Shoemaker reassured, supported, motivated and helped me to proceed in the right direction.

Finally, three friends of the Virgo gang have been near to me day by day and we have been working side by side in the hardest times: Jean-Yves Vinet, Fulvio Ricci and Giovanni Losurdo.

I wish all the best for the future to LIGO/LSC & Virgo/EGO, to you and your families.

Bye,
Federico

Federico Ferrini introducing the joint LIGO Virgo press conference (photo:Tirreno Elba news)

After the discovery the road ahead

I feel privileged and honoured to take up from Federico the direction of EGO in such exciting times. The success of EGO/Virgo was a success not only for the domain of Gravitational Waves per se but for the whole domain of Astroparticle Physics, fulfilling one of the key promises of the Astroparticle Physics European Consortium (APPEC) roadmap.
The opening up of "Multi-Messenger Astronomy", by Virgo/LIGO has been rightly compared to the Galilean gesture producing the first scientific map of the skies.
The period is as delicate as it is exciting, since Virgo and LIGO enter the Observational Era, where stability of operation of the interferometer for long time periods will be as important a goal as the increase in sensitivity. There also comes an exciting period of definition of the possible medium-term upgrades of Advanced Virgo and the beginning of the design of a Third Generation (3G) interferometer, the Einstein Telescope, in a global context.
In order to serve these scientific goals, a series of institutional changes have to be pursued:

extend the EGO Consortium beyond 2020, defining new roles for the existing partners and welcoming new ones; put the 3G interferometer and its adV+ preparation into the ESFRI road-map; accompany the movement with the proper institutional framework, e.g. the ERIC scheme; imbed the whole process in a global collaboration framework of 3G antennas distributed across the world.

In parallel, the convergence with our LIGO collaborators, which started in 2005, and the welcoming of the upcoming new antennas, KAGRA in Japan and later India, has to be rethought, sometimes from scratch, e.g. in the domain of sharing, analysis and access of data or the R&D collaboration, preparing the future generation of antennas.

Furthermore, as happens with all scientific revolutions, the impact of GW discoveries extends over a large spectrum of domains, beyond that of fundamental physics.

For instance, the GW-detection technologies have already produced a series of very encouraging synergies with geoscience. Early-warning earthquake systems and climatic phenomena using GW technology are in development. Gravimeters and seismometers can also be used, in association with other types of sensors, for geophysical searches for buried structures, with applications from energy to archaeology. GW techniques, after the multi-messenger study of the Universe, begin to promise the inauguration of a 'multi-messenger' imaging of the Earth.
Last, but not least, in every scientific revolution there is deeper understanding of the limits of our conceptualisation of the world. Students and the public have understood this and they are more eager than ever to learn all of the things surrounding the GW discovery. We have seen since 2015 the yearly doubling of the visitors to the EGO site. We have to accompany this movement and explain, to schools/universities and the public, the science and methods that accompanied the GW discovery. We should give opportunities for immersion, hands-on experience and citizen science, to real and virtual visitors.

Here again we could say that we should accompany the multi messenger studies of the Universe with a "multi-messenger" environment of education and outreach addressed to Society at large.

For all of the above reasons, plus the extraordinary enthusiasm of EGO and Virgo colleagues, that Ilearn to know day by day, I feel humbled by the task at hand, but also feel highly stimulated by the opportunities in front of us.

S.Katsanevas

Stavros Katsanevas (EGO Director)

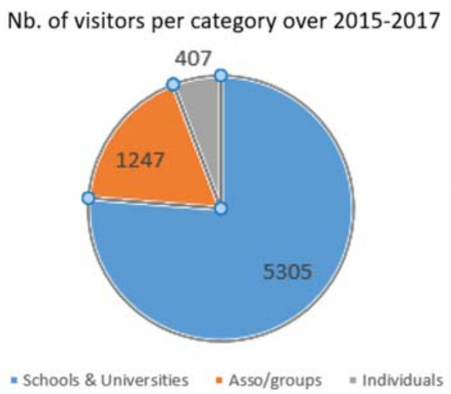
Visits explosion

Most of you know that the past 3 years have seen a large increase in the number of site visits. It is no secret that the announcements related to the gravitational wave detections played a big role in the increase.
1,223 visitors in 2015, 2,050 in 2016, 3,686 in 2017, and 2018 already has a full calendar until the end of June; with more than 100 pending requests afterwards!
It is interesting to look deeper into these figures, to try to depict the typical visitor to Virgo.
Let's start with the place where visitors come from! Without surprise, a large majority of the visitors are Italian (87.7% in 2015).
However, the impact of the GW discoveries in the press worldwide has altered this slightly: in 2017, visitors from abroad represented 21% (there were about 780 of them).

New Zealand was the country furthest afield from which visitors arrived (two tourists who accidentally discovered Virgo). France and Germany regularly send us some of their citizens, whereas countries such as Greece, Luxembourg, Canada and Australia were represented for the first time in 2017.
Some American tourists also stopped by Virgo during their vacation in Europe and we are happy to see that, despite two interferometers in their home country, they feel like visiting Virgo.

Concerning the Italian visitors, there is a fair distribution between Tuscany and the other Regions (50.7% and 49.3% over 2015-2017) with a slight advantage for Tuscany in terms of indivudual visits, while the other regions provided slightly more group-visit visitors.
Now, if we look at the kinds of groups coming to the site, we can be proud to note that schools are very interested in Virgo. Indeed, requests come mainly from schools, exceeding requests from other categories, such as associations/committees/other groups and individuals.

School & University visits represented 74,1% of the total in 2017. In 2015 they had constituted 92% of the total, with the decrease explained by the rise in the number of requests from individuals and other groups.



In the category "Schools & Universities" we also have to distinguish the level of the students, since the content of the seminar held during the visit differs greatly.

In 2017, for instance, 12% of the students were undergraduates, 80% high school students, 7% from middle schools and 1% from elementary schools. The number in terms of units for the undergraduates is relatively constant over the years, whereas the number of high school students has considerably increased from 701 in 2015 to 2,185 in 2017.

In the light of these figures, we can conclude that the typical visitor to Virgo is an Italian-speaking high-school student (which was what we expected). Considering that most of the high school students are from scientific high schools - 'licei scientifici' - and looking at the student lists sent by their teachers, we can see that the most likely visitor to Virgo would probably be an 18-year-old male (note there is no discrimination here, I am just reporting what the class composition tells us).

Finally, let me add that this huge increase in the number of site visits (29 in 2015, 62 in 2016 and 96 in 2017) has reached its limit! We have been fortunate to have been able to deal with such high demand, notwithstanding the commissioning activities and despite a heavy workload for the people who usually act as guides. We now organise two visits per week all year long, so are at maximum capacity in our current configuration.

I have already written this in different messages addressed to our guides, but I would also like to take advantage of the newsletter to THANK once again all those who dedicate time to this activity: Thank you, Merci, Grazie, Gracias, Bedankt!!!

And since I am not the only one who thinks that you are doing a great job as a Virgo guide, let me finish this note with some of the most recent messages sent by happy visitors.

S.Perus

" Ringrazio a nome di tutti, studenti compresi, per la disponibilità e la competenza che avete dimostrato nell'accogliere il nostro gruppo. I miei studenti sono tornati a scuola arricchiti da questa esperienza e anche stamattina parlavano entusiasti di quanto hanno visto e compreso. E' sempre importante vedere la realtà di quello che si apprende da lezioni cattedratiche e dalle pagine dei libri di fisica. La ringrazio per le slides che mi ha inviato. Serviranno per le tesine che alcuni dei miei studenti faranno in vista dei prossimi esami di stato e che coinvolgeranno le onde gravitazionali e VIRGO. Sicuramente ci rivedremo con altri futuri studenti di 5a liceo.
Prof.sa Alessandra Picchioni per il Liceo scientifico B.Varchi di Montevarchi (AR)"
07/03/2018

" Buongiorno!
Sono P.M., l'insegnante del Liceo Scientifico di Albenga (SV), responsabile dell'organizzazione della visita che si è tenuta presso i vostri laboratori nei giorni 03/02/2018 e 10/02/2018.

Le scrivo per ringraziarVi dell' esperienza molto formativa che avete permesso di fare ai nostri alunni. Abbiamo apprezzato moltissimo la chiarezza delle spiegazioni fornite e i dettagli con cui gli esperti hanno illustrato l'esperimento, facendo sì che i nostri studenti, pur possedendo molto modeste conoscenze, potessero seguire proficuamente la lezione e la visita." 17/02/2018

" E' stata una visita molto piacevole; molto bravi i suoi colleghi. Grazie ancora della disponibilità! Leonardo Briganti" 13/11/2017

" Bonsoir,
Notre très attendue visite de Virgo/EGO a donc bien eu lieu comme prévu le 24 octobre dernier. Ce fut une journée extrêmement riche et très bien organisée par vos collègues de Cascina dont la disponibilité était à la hauteur de la gentillesse. Les enfants ont également apprécié cette visite qui les marquera sans nul doute durablement. Mon mari, enseignant de physique de son état, était sur un petit nuage ! Nous tenons à remercier l'ensemble des personnes qui nous ont permis ce voyage et offert cette visite privilégiée, à savoir Séverine, Nicolas, Carlo Fabozzi, Matthieu, Antonio sans oublier Frédéric et Daniel. La famille Aeschelmann" 05/11/2017"

" Bonjour, Merci beaucoup pour l'accueil de toutes les personnes impliquées, nous apprécions toujours autant les conférences du matin et notre visite sur site, et les étudiants étaient enthousiastes! Nous reviendrons l'année prochaine, et nous viserons encore le lendemain d'une nouvelle d'importance, c'était quand même un moment très spécial pour nos jeunes...

" Ringraziando tutti voi di EGO e VIRGO , anche a nome dei miei colleghi e studenti, per l'entusiasmante esperienza che ci avete permeso di vivere in questo momento di peculiare rilevanza scientifica, invio la foto di gruppo. Cordialità, Prof. Mariagabriella Fortina", Istituto di Istruzione Superiore "L. Galvani" Milano, 10/10/2017"

" Grazie per la visita, tutto molto interessante! Buona giornata, Associazione Radioamatori Italiani - IQ5DY- Sezione di Pontedera" 19/06/2017

" Salve, le scrivo ancora una volta per porgere, tramite suo, i ringraziamenti al prof. Carlo Bradaschia e alla dott.ssa Irene Fiori per le loro preziose illustrazioni scientifiche. Molto riconoscenti il Circolo Astrofili Veronesi" 08/05/2017

Foto di gruppo con gli studenti dell'Istituto di Istruzione Superiore "Luigi Galvani" di Milano, durante la loro visita il 10/10/2017.

Italian Minister for Research at EGO

On the 21st of February, we had the honour of welcoming the Italian Minister for Research, Valeria Fedeli, for a visit to the Virgo experiment and to talk about the future. As a matter of fact, the Italian government, through the Ministry of Education, University and Research (MIUR), INFN, Sassari University and Regione Sardegna, support the candidature of the site near to Sos Enatto (Sardinia) for the Einstein Telescope infrastructure (source: http://www.et-gw.eu/).

More details, in Italian, can be found ***here***.

Interesting prospects are in sight !

Frédéric-M. Richard

Foreground (l. to r.): Jo van den Brand, Minister Valeria Fedeli, Federico Ferrini, Stavros Katsanevas, Fulvio Ricci

Michele Punturo giving a copy of the Conceptual Design study document for the future European third generation gravitational wave detector (http://www.et-gw.eu/index.php/etdsdocument)

Safety Corner

Twelve thousand!

That is the number of luminous bodies (lights, LED spotlights, projectors, ceiling lights) present on the EGO site!

Given this number, there is surely no need to convince you of the importance of saving energy.

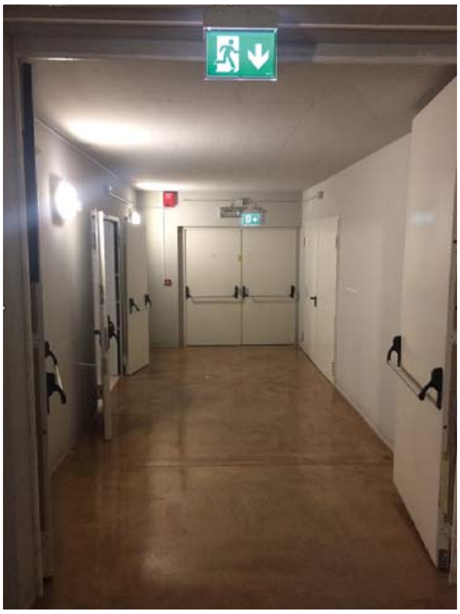
However, this is not the only reason why our electrical-systems responsible, Massimo D'Andrea, has been working so hard over the past few months to complete the replacement work before the beginning of the Virgo commissioning phase.

As a matter of fact, thanks to the replacement of lights, projectors and ceiling lights, we now have improved luminosity and a longevity that has been multiplied by up to ten times with respect to before (think also of the savings in terms of maintenance …).

The improvement has involved a large number of rooms, including: the external path leading to the Main Building, the auditorium, the meeting room, the cafeteria, the seminar room, the North & West End building experimental halls and the Central Building. This is all interesting, of course, but what is the link with Health & Safety?

Safety: Massimo took the opportunity to also replace the emergency lighting system and the exit-route lighting system in the Auditorium and inside the Central Building.

Health: shift workers will soon be delighted to have a new sophisticated lighting system in the Control Room, which respects the human circadian rhythm!



In short: more luminosity, more comfort, no possibility to remain in the dark, cost and time saving with regard to maintenance and in accordance with safety norms.

And, last-minute information: Massimo, on the 11th of April 2018, spoke to a large part of the EGO staff about circadian rhythms and photobiology during a seminar in the Auditorium. It was a real success, partially due, I suppose, to its attractive and engaging title: "Light is life". Thanks to Massimo for all this work!

Frédéric-M. Richard

Departures and arrivals at EGO

Departures

Martin Mohan left EGO at the end of 2017 to return to Ireland.

Bas Swinkels left EGO at the end of January 2018, but has not left the Virgo Collaboration! He is now working at Nikhef and will travel to the site frequently.

Recent Arrivals

In the Interferometer Technology department:

Valerio Boschi has joined EGO to work on Noise & Controls.
Beatrice Montanari has become an EGO staff member within the electronics area.

In the Vacuum and Mechanics department:

Luca Francescon counts now as an EGO staff member in the operations group of the vacuum system.

GOOD NEWS

Maddalena and Monica welcomed another family member:

Febe was born on the 27th of January and has a sweet little face.

Marica Branchesi has been selected in Time's top 100 of last year's most influential people.

Congratulations to Marica!

More information ***here***

We are happy to announce that Giovanni Losurdo, Federico Ferrini and Fulvio Ricci have been nominated **"Commendatori dell'Ordine al Merito della Repubblica Italiana".**
In the picture they are proudly showing the certificates received from the Research Minister Valeria Fedeli in the presence of INFN President Fernando Ferroni.
You can read here about this event