Multi-messenger astronomy with GWs and Neutrinos

lundi 30 mai 2022 - vendredi 3 juin 2022

Observatoire de la Côte d’Azur

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Auteurs correspondants: dornic@cppm.in2p3.fr, pradier@in2p3.fr

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Preparation of the different strategies the next days

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Fast detection and follow-up of high energy transients with COLIBRI

Auteur: Simona Lombardo[1]

[1] *Aix Marseille Univ, CNRS, CNES, LAM, Marseille, France*

Auteur correspondant simona.lombardo@lam.fr

COLIBRI is one of the ground follow-up telescopes under French responsibility especially developed for the SVOM mission, for the gamma-ray burst science and transient exploration. This 1.3 m telescope comes from a collaboration between France and Mexico and it will be commissioned and installed at the Observatorio Astronómico Nacional (Mexico) by the end of 2022/beginning 2023. It will have an optical camera with two branches and a near-infrared camera, to detect the transient in three bands simultaneously. The strength of COLIBRI relies on its unique combination of speed and multi-band sensitivity.
It will be able to point from any position on the sky at any other position in less than 20 s with anabsolute accuracy better than 2.5 arcsec. This, combined with its fast pre-processing pipeline, will allow to detect transient sources and obtain their photometric redshift estimates in less than 5 min from the receival of the alert. I will present the telescope and its status.

GRANDMA project / 29

A multi-messenger data analysis platform for O4

Auteur: Michael Coughlin[1]

[1] *University of Minnesota*

Auteur correspondant cough052@umn.edu

To maximize the science output from kilonovae to be detected during O4, a step forward of our technical toolkits and capabilities is required. To this end, we present recent developments of SkyPortal, an open-source platform for astronomy. Over the past year, we have building this software toolkit into a fully-integrated, multi-messenger platform. In this talk, we will discuss these developments and what we hope to have in place before O4.

Contributed Talks / 31

GRB 211211A - The Attesor Acid GRB

Auteur: David Alexander Kann[1]

[1] *IAA-CSIC*

Auteur correspondant kann@iaa.es

I will give an overview of recent - and confusing! - research on merger-induced GRBs, especially the ultra-bright even GRB 211211A, which seems to combine a photometric kilonova detection with a temporally long GRB.

GRANDMA project / 32

GRB test run Paper update

Auteur: Jean-Grégoire Ducoin[1]

[1] *LAL - Virgo*

Auteur correspondant ducoin@lal.in2p3.fr

I will present the status of the GRB test run paper. General structure of the paper, the proposed paper writing team, the selection of scientific content, done/ongoing/upcoming analysis.

GRANDMA project / 33

GRANDMA web plateform for O4 using Skyportal

Auteur: Thomas Culino[1]

[1] *ELSIV/OCA*

Presentation of the different features of Skyporal for O4. What are the features currently available and how to use them.

Contributed Talks / 34

Effect of Vera C. Rubin Observatory Filter and Return Time Selections on Kilonovae Detectability

Auteurs: Cristina Andrade[1]; Igor Andreoni[2]; Michael Coughlin[1]; Nidhal Guessoum[3]; Raiyah Alserkal[3]

[1] *School of Physics and Astronomy, University of Minnesota*

[2] *Joint Space-Science Institute, Astrophysics Science Division, NASA Goddard Space Flight Center, Department of Astronomy University of Maryland*

[3] *American University of Sharjah, Physics Department*

Auteurs correspondants: cough052@umn.edu, andra104@umn.edu

The discovery of the optical/infra-red counterpart to the neutron binary merger gravitational wave detection (GW170817), which followed a short gamma-ray burst (GRB170817), was a groundbreaking moment in multi-messenger astronomy. It is, to date, the only confirmed joint detection of its kind, though many projects are currently developing wide-field surveys to find more electromagnetic counterparts, known as kilonovae, or similar fast-fading transients. Binary neutron-star mergers are notable astrophysical phenomena; they offer us an opportunity to examine various processes, including astrophysical heavy-element nucleosyntheses, merger-driven mass ejections, wide spectrum electromagnetic emissions, and now gravitational waves. However, developments in these areas require the improvement of kilonova detection methods from varied samples of sources. But this is a rather difficult task because kilonovae are faint and fast fading.
Fortunately, the Vera C. Rubin Observatory (VRO) provides excellent prospects for identifying kilonova candidates either from or independent of gravitational-wave and gamma-ray burst triggers. Its 10-year project called the Legacy Survey of Space and Time (LSST) will conduct surveys of various celestial objects and phenomena and explore an exceptional volume of the sky in 6 photometric filters. Indeed, LSST has the potential to make detecting kilonovae amongst a sea of transients easier and thus open the world of fast transient science at excellent depth. Cadence choices for LSST surveys are especially important for maximizing detections.
In this work, we explore the possibility of optimizing the Vera C. Rubin Observatory ability to detect kilonovae to by studying LSST cadences provided by the project, subsequently studying how detection rates are affected by filter selections, notably red/IR filters (i, z, y) compared to bluer filters (u, g, r), the return timescales for visits of the same area in the sky, and other relevant factors. We assess the benefit of our findings to related scientific interests, including maximizing a range of fast transient discoveries.

GRANDMA project / 35

RAPAS pro-am project

Auteur: Thierry Midavaine[1]

[1] *Institut d'Optique*

Auteur correspondant thierry.midavaine@institutoptique.fr

I will introduce RAPAS, a project granted by Paris Observatory supporting ProAm collaborations. It is going to release first the specification of optical filters enhancing the sensitivity of wide FoV telescope and a first level of classification of the detection to meet the requirements of several program dedicated to astronomical alerts. The target is then to manufacture, then distribute these filters to an amateur group to allow them to demonstrate the photometric accuracy of the compete group and quote the dispersions. In addition I will show a tool allowing the evaluation of the limiting magnitude of any telescope setup. We may discuss if these could be useful for Grandma to conclude.

Contributed Talks / 36

Optimization Simulations for Kilonova Detections in Optical and Near Infrared

Auteurs: Mouza Almualla[None]; Raiyah Alserkal[1]; Michael Coughlin[2]; Nidhal Guessoum[1]

[1] *American University of Sharjah, Physics Department*

[2] *University of Minnesota*

Auteur correspondant cough052@umn.edu

The search for kilonovae, either serendipitously or following a short gamma-ray burst (SGRB) or a gravitational-wave (GW) signal, has become a hot topic in astronomy in general, and multi-messenger astronomy (MMA) in particular. Efforts can be conducted with a variety of instruments (optical or near-infrared, where light curves and timelines are most conducive) and methods (filtering, fixed or dynamic exposures, different cadences and sky coverage, etc.).
We have performed simulations to try to determine the best observational scenarios to maximize kilonova detections, and we here report our work and findings. We have considered observational capabilities and settings of both the Zwicky Transient Facility (ZTF), with its wide field-of-view surveys, and the upcoming Vera C. Rubin Observatory, with its 10-year Legacy Survey of Space and Time (LSST) project.
We find that some observational choices, e.g. the adoption of three epochs per night on a nightly basis, and the prioritization of redder photometric bands, detection efficiencies improve by about a factor of two relative to the nominal cadence. We infer approaches for the optimization of the kilonova searches, e.g. filter selections, notably red/IR filters (i, z, y) compared to bluer filters (u, g, r), the return timescales for visits of the same area in the sky, and other relevant factors, comparing them with existing baseline strategies.

Training / 37

Q and A and tutorials on muphoten and STDpipe data reduction

Auteurs: Pierre Duverne[1]; Sergey Karpov[2]

[1] *IJClab*

[2] *Institute of Physics, Czech Academy of Sciences*

Auteurs correspondants: karpov@fzu.cz, duverne@lal.in2p3.fr

Session for getting a hands-on experience of using two different transient detection and photometry pipeline - Muphoten and STDPipe. Here you will be able to ask questions about how to use it to process your data. Also, we will demonstrate some actual examples based on the data acquired during recent GRANDMA campaigns.

GRANDMA project / 38

WP-G : Towards the scientific exploitation of the Kilonova-Catcher citizen science program

Auteur: Damien TURPIN[1]

[1] *CNES/CEA-Saclay*

Auteur correspondant damien.turpin@cea.fr

In this presentation, I will summarize the goals and the current status of the citizen science project Kilonova-Catcher initiated by GRANDMA to conduct follow-up observations of the O4 GW sources. I will then focus my talk on the next development steps needed to reach our scientific requirements/expectations from this program.

Contributed Talks / 39

SIRIS, a ultra low noise and ultra high dynamic SWIR camera

Auteur: Julien Dubouil[1]

[1] *IMCCE*

Auteur correspondant julien.dubouil@obspm.fr

A presentation of the technological aspects of the camera, and their interest in astronomical observations with the T1M at Pic du Midi.
Use of the combined lin/log and non destructive readout modes for noise reduction and HDR.

Contributed Talks / 40

Which CBs could be transformed in the known sources of GWs

Auteur: Nino Kochiashvili[1]

[1] *Abastumani Observatory, Georgia*

Auteur correspondant nino.kochiashvili@iliauni.edu.ge

After the discovery of gravitational waves we saw that there must be black holes of different masses in the compact binaries, including the ones having fairly high masses. The remnant masses observed to date in the BBH mergers range from 17 to 170 solar masses.
In my presentation I will discuss the possibilities of what type of CBs could be their progenitors.

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GRANDMA observations in Abastumani, the Georgian Team

Auteur: Nino Kochiashvili[1]

[1] *Abastumani Astrophysical Observatory*

Auteur correspondant nino.kochiashvili@iliauni.edu.ge

I will talk about how GRANDMA observations are made at the Abastumani observatory using the 70 cm Meniscus telescope. I will also mention other projects that are being carried out with this telescope. I will discuss the current situation and news expected in the near future.

Contributed Talks / 42

Search for GW in coincidence with burst sources during 03

Auteur: Iara Tosta e Melo[1]

[1] *INFN LNS*

Auteur correspondant iara.tosta.melo@gmail.com

Multi-messenger astronomy is a vast and expanding field as electromagnetic (EM) observations are no longer the only way of exploring the Universe.
Due to the new messengers, astrophysical events with both gravitational waves (GWs) and EM emission are no longer a dream of the astronomical community.
A breakthrough for GW multi-messenger astronomy came when the LIGO-Virgo network detected a GW signal of two low-mass compact objects consistent with a binary neutron star (BNS, GW170817), an event that generated a short gamma-ray burst (GRB), and a kilonova. While GW170817 represents the testimony to BNS mergers being the progenitor of at least some GRBs, a wide range of highly energetic astrophysical phenomena is expected to be accompanied by the emission of GWs and photons. Here we present an unmodelled method to search for GWs having gamma and radio counterparts, using the LIGO/Virgo data and observations of partner telescopes. We also discuss the most recent results of the unmodelled coherent searches targeting astrophysical events during the first part of the LIGO-Virgo third observing run.

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GRANDMA GRB Observational Campaign Spring 2021: WPC Report

Auteur: Iara Tosta e Melo[1]

[1] *INFN LNS*

Auteur correspondant iara.tosta.melo@gmail.com

Report of the WPC group about the organization, coordination and activies during GRB spring campaign

Contributed Talks / 44

WOLF RAYET TYPE WR 134 STAR SHORT-TERM PHOTOMETRIC VARIABILITY

Auteur: SHABNAM AGHAYEVA[1]

[1] *GRANDMA*

Auteur correspondant sebnem-agayeva-94@mail.ru

The results of the study of photometric observation material obtained in June 2021 with a CCD photometer in the 60-cm telescope of the Shamakhi Astrophysics Observatory named N.Tusi of Wolf 134 type WR 134 star are given. Observations of the star WR 134 were made in filter V of the international UBV photometric system and its short-term (approximately one hour) photometric variability was detected. The mean quadratic error assigned to the control star was 0.004. The MaxIm DL software folder was used to process the photometric images of the star under study.

Contributed Talks / 45

ShaO observations T-Tauri and methods for the photometry

Auteur: Zumrud Vidadi[1]

[1] *SHAO*

In this report we have presented some results of analysis of the light variation of the star DG Tau, based on 582 nights UBVR photometric observations. We have shown that both the average annual and seasonal values of the star's brightness varies for all photometric bands. The amplitude of the seasonal change in the V band is at 1 mag, and in 50 years, it is nearly 2 mag. Color-dependent brightness diagrams show that the main process driving its brightness variation is the radiation of the disk around the star.
Fourier analysis of the light variation analysis did not detect stable periodic processes in the brightness variability. For the first time, a spectral energy distribution (SED) curve was constructed in the 0.36-100 μm range. For the star SED curve we have used a blackbody approximation. We find a spectrophotometric temperature of the star 3000K, i.e. 1000K less than the effective temperature of the star, due to the partial absorption and scattering of stellar radiation by the disk. The radiation also indicates a strong excess in the near- and far-infrared, again, due to the presence of a disk of gas and dust formed around the central star. We determined a maximal gas temperature at the SED peak of nearly 1500 K, and for the cool dust on the periphery of the disc ~100-200K.

GRANDMA project / 46

Electromagnetic Followup of High Energy Neutrino Alerts with the Grandma Telescope Network

Auteur: Thierry Pradier[1]

[1] *Université de Strasbourg & IPHC/DRS*

Auteur correspondant pradier@in2p3.fr

Since the first measurement of the diffuse flux of cosmic high energy neutrinos (HEN) by IceCube in 2013, only a handful of possible correlations between HEN and astrophysical sources have been established, involving blazars and tidal distruption events (TDE), not all completely conclusive. The identification of the possible astrophysical engines behind the emission of HEN is feasible through the observation of their electromagnetic counterparts, which also allow to discard the possible atmospheric origin of the detected neutrinos. These HEN can be observed with neutrino telescopes currently operating or under construction, IceCube, Baikal/GVD, or the 2 KM3NeT telescopes, ARCA and ORCA.

A followup program of HEN alerts issued by these telescopes can be set up using the Grandma telescope network, with observation strategies depending on the kind of transients, from short-lived (e.g. gamma-ray bursts) to long-duration (e.g. TDE). This contribution aims at describing the scientific case behind such a followup program, from the sources at work to the implementation of the observations and the possible scientific outcomes.

Contributed Talks / 47

Readiness of Maidanak observatory to the observations of optical transients during the O4 run

Auteur: Yusufjon Tillayev[1]

[1] *Ulugh Beg Astronomical Institute*

Auteur correspondant yusuf@astrin.uz

The presentation discovers observational capabilities and limitations of Maidanak observatory. It provides detailed information about the two 60 cm Zeiss telescopes –NT-60 and ST-60 and cameras installed on their foci. Because of smaller aperture, these telescopes have magnitude limitations and are not suitable for observations of faint objects. Installation of a new fast telescope devoted to ToO observations is planned in the second half of this year. Successful and in-time installation of this telescope would provide good opportunity during the O4 observational run.

Contributed Talks / 48

Probing Mass Loss Properties of Supernova Progenitors

Auteur: Priyadarshini Gokuldass[1]

Co-auteurs: N. Brice Orange [2]; Saida Caballero-Nieves [3]

[1] *Florida Institute of Technology*

[2] *OrangeWave Innovative Science, LLC*

[3] *Florida Institute of Techonology*

Auteurs correspondants: pgokuldass2020@my.fit.edu, scaballero@fit.edu, orangewaveno@gmail.com

The evolution and death of massive stars and their effect on the surrounding objects is still an open question in astronomy. The type of Supernova that a star will undergo at the end of its life cycle depends on the mass-loss history of the star. Stars with similar initial mass might end up having different types of end evolution phases and die by different types of supernovae (SNe) processes. In particular, Red and Yellow Supergiant stars (RSG & YSG) begin their life with having identical masses but sometime during their evolution phase, their path to endpoint diverges. This project will address the two methods through which the mass-loss rate of massive stars is analyzed and the theoretical models that are used for the analysis. The first method is to analyze the properties of the circumstellar environment of the massive stars and study the dust content using the 2D modeling code HDUST. The second method is to investigate observations of host galaxies of ultralong GRBs (ulGRBs) and long GRBs, from two ground-based telescopes, to characterize star formation rates and investigate YSGs as a ulGRB progenitor. Such an in-depth study of mass-loss from massive stars will significantly improve our understanding of their life cycle, and the various types of supernova processes, in addition to how supernovae enrich nearby environments.

Contributed Talks / 49

swyft Parameter Inference of Gravitational Waves using Machine Learning

Auteur: Uddipta Bhardwaj[1]

[1] *GRAPPA, University of Amsterdam*

Auteur correspondant u.bhardwaj@uva.nl

In light of the importance of multi-wavelength characterization of gravitational wave sources, fast parameter inference of gravitational waves is a necessity. However, traditional methods like MCMC take several days to weeks for full parameter inference of GWs. After the promise of GW170817 and the associated multi-wavelength follow-up, the LVC promises several more such detectionsin the upcoming observing run.
We present a faster (*O(s)*) alternative to traditional samplers by using Neural Ratio Estimation to

estimate marginals in the ~15D parameter space of a GW signal. For our purposes, we use the ***swyft*** code and produce results comparable to robust, traditional samplers in a fraction of the time, thus aiding in the quest for low latency EM follow-up.

Welcome / 50

Director Welcome speach

Auteur correspondant nelson.christensen@oca.eu

Nelson Christensen and Stéphane Mazevet will welcome you

Welcome / 51

Welcome and organisation of the week

Auteurs correspondants: deugarte@oca.eu, sarah.antier@oca.eu

The SOC will provide you the details of the week organization.

Training / 52

Feedback from FAs of GRB (discussion)

Contributed Talks / 54

Processing of observational data with AbAO-T70

Auteur: Sophia Beradze[None]

As part of the project Grandma, we will talk about photometric processing of observation data obtained using the 70 cm Meniscus telescope of the Abastumani Astrophysical Observatory. To improve data processing we will talk about what difficulties may arise during processing and ways to solve it. Abastumani Team is ready for the upcoming O4 observational run.

Social events / 55

Mini-interview - please upload your text in english here

Contributed Talks / 56

Modelling the host galaxies of binary compact object mergers with observational scaling relation

Auteur: Filippo Santoliquido[None]

Auteur correspondant filippo.santoliquido@hotmail.it

I will present "Modelling the host galaxies of binary compact object mergers with observational scaling relation".

GRANDMA project / 57

Follow-up strategies for GWs

Auteur correspondant sarah.antier@oca.eu

Contributed Talks / 58

STDpipe

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GRB campaign - form

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Discussion on future observational facilities

Contributed Talks / 61

Pic du Midi 1 meter telescope, a swiss knife for transient events

Auteur correspondant francois.colas@obspm.fr

Contributed Talks / 62

GRANDMA GRB article