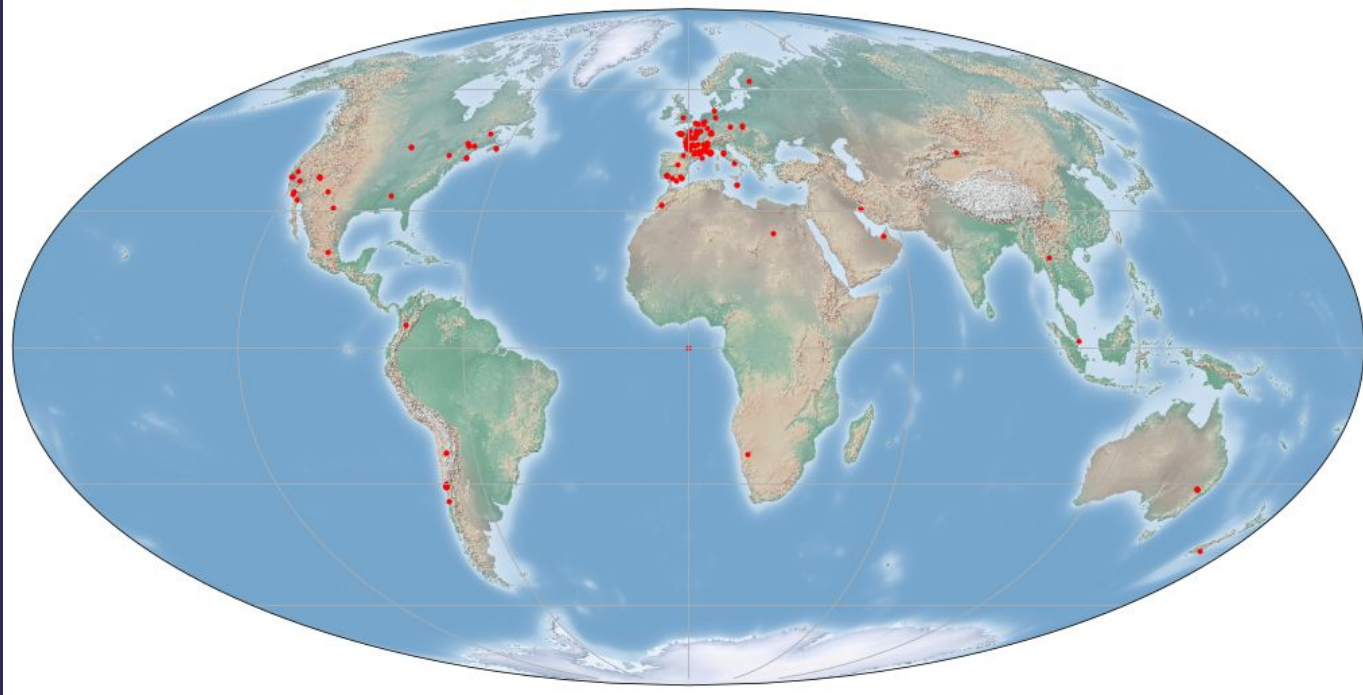# OUTLINES

1. Overview of the 2023 year scientific activities

2. Overview of the 2024 year scientific activities

3. What are we missing to be (much) better
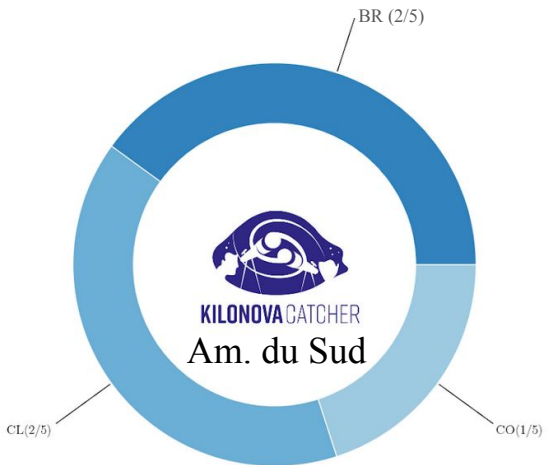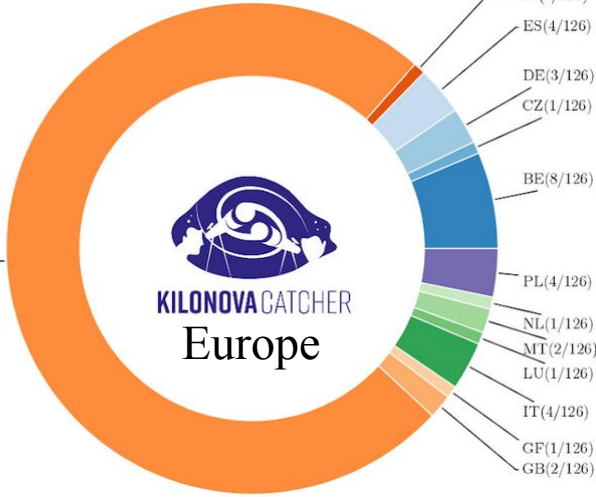
The KNC network

- 177 users
- 139 individual telescopes

Am. du Nord
MX (3/29)
CA (4/29)
US (22/29)

Am. du Sud
BR (2/5)
CL (2/5)
CO (1/5)

Europe
FR (94/126)
FI (1/126)
ES (4/126)
DE (3/126)
CZ (1/126)
BE (8/126)
PL (4/126)
NL (1/126)
MT (2/126)
LU (1/126)
IT (4/126)
GF (1/126)
GB (2/126)

Asie / Océanie
CN (1/9)
AU (2/9)
IN (2/9)
UA (1/9)
NZ (1/9)
SG (1/9)
RU (1/9)

Afrique
AE (1/2)
MA (1/2)
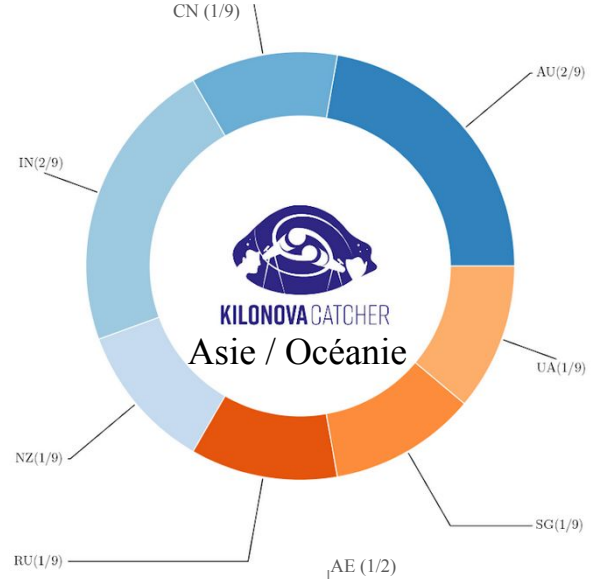
The KNC network connected to GRANDMA

ICARE

MM alerts & Obs. plan

Follow-up images
and
photometric results

KILONOVACATCHER

1

Overview of the 2023 year scientific activities

The follow-up campaign that we engaged in 2023

KILONOVA CATCHER

GRB 230328B	GW O4 start	S230627c	GRB 230812B	ZTF23abnevza	GRB 231115A SN 2023wrk	
March	May	June	August	October	November	2023

| Alert Name	Alert type	#images	filters	Publications
GRB 230328B	Gamma-ray burst	1	Rc	GCN 33550
S230627c	Gravitational waves	60	L, B, Rc, TB, TG, TR	–
GRB 230812B	Gamma-ray burst	46	V, Rc, Ic, r, i	MNRAS paper
ZTF23abnevza	Supernova	54	B, V, Rc, Ic	GCN 34928
GRB 231115A	Gamma-ray burst	9	C, g, B, V, Rc, Ic	GCN 35051
SN 2023wrk	Supernova	461	B,V,Rc,Ic, gri	paper to be submitted

The follow-up campaign that we engaged in 2023

A collection of very diverse stellar cataclysmic events in the Universe
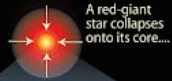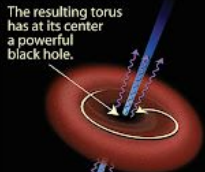
Gamma-ray Bursts
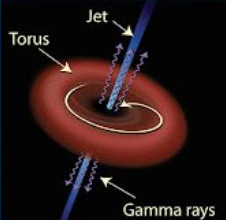
Optical counterparts from the mergers of compact objects (Gravitational waves)
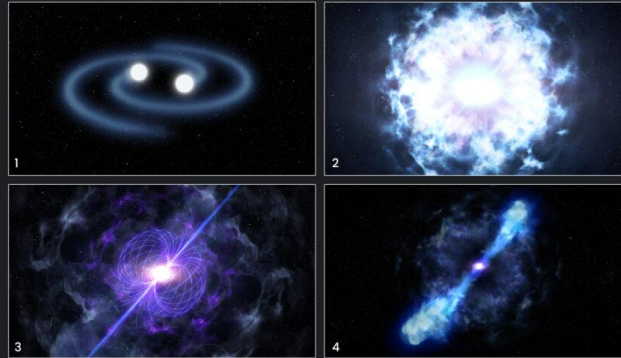
Supernovae
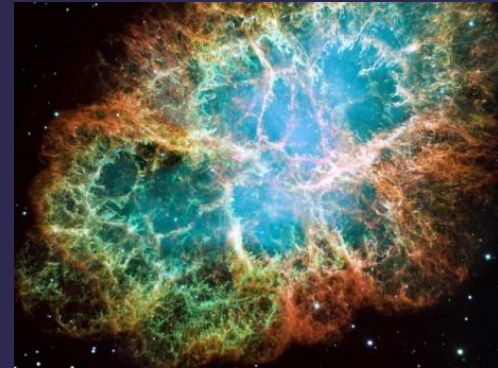
The follow-up campaign that we engaged in 2023

GRB 230328B (a long GRB with an early detection of the optical afterglow):

- **1 image provided (F. Kugel)**
- **We detected the GRB optical afterglow!**

Subject GRB 230328B : GRANDMA/Kilonova-Catcher optical detection
Date 2023-03-31T20:37:22Z (9 months ago)
From Damien Turpin at NAOC (CAS) <dturpin-astro@hotmail.com>

F. Kugel (KNC), D. Turpin (CEA), S. Karpov (FZU), T. Hussenot-Desenonges (IJCLab), S. Antier (OCA/Artemis), P.A. Duverne (APC, U. Paris Cité), P. Hello (IJCLab), A. Klotz (OMP/IRAP) report on behalf of the GRANDMA/Kilonova-Catcher collaboration:

The Kilonova-Catcher telescope network responded to the alert of GRB 230328B (Swift detection: Gropp et al., GCN 33527; Fermi GBM detection: Veres et al., GCN 33526).

The KNC observations were taken by F. Kugel with an ARTEMIS CCD ATIK-460ex camera mounted in the 0.4-m f/2.8 reflector telescope in the Chante-Perdrix Observatory (France).
The afterglow is detected in the 36x60s unfiltered coadded images at about 5.2 hours (midtime of the exposure) after the Swift/BAT trigger time.
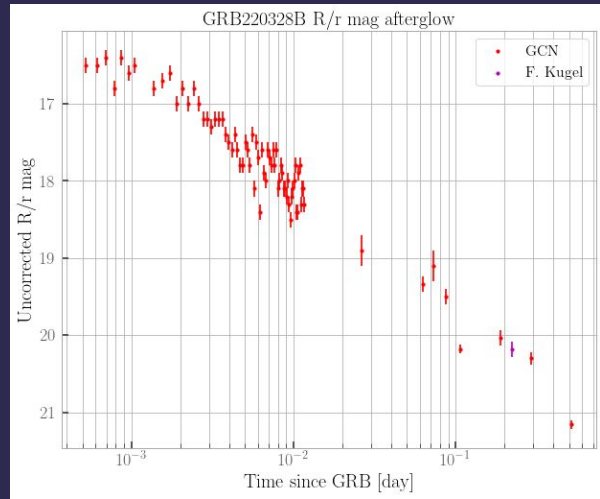
Below, we report our photometric measurement in Rc magnitude.

T-T0 (day) |Exposure| Filter | Mag +/- err |Mag.Lim. (AB)

0.22172 | 36 x 60s | Rc | 20.19 +/- 0.10 | 21.4 (3 sigma)

Our detection is consistent with the detections and limits previously reported in Pankov et al., GCN 33528.; Belkin, GCN 33530; Lu et al., GCN 33534; Catapano et al., GCN 33535; Suresh et al., GCN 33536.; Adami et al., GCN 33537; Gompertz et al., GCN 33538; Komesh et al., GCN 33539; Lu et al., GCN 33540; Ror et al., GCN 33547; Agui Fernandez et al., GCN 33549

The GRANDMA/Kilonova-Cacther images have been calibrated using field stars from the PanSTARRS-DR1 catalog using the STDpipe pipeline (Karpov 2022) and the ps1/r to Rc mag conversion from (Pancino et al. 2022).

GRANDMA is a worldwide telescope network (grandma.ijclab.in2p3.fr) devoted to the observation of transients in the context of multi-messenger astrophysics (Antier et al. 2020 MNRAS 497, 5518). Kilonova-Catcher (KNC) is the citizen science program of GRANDMA (http://kilonovacatcher.in2p3.fr/).

- **A GRANDMA GCN was emitted : https://gcn.nasa.gov/circulars/33550**
- **No more studies about this GRB because of a lack of multi wavelength data from the GRANDMA side**

GRB220328B R/r mag afterglow

The follow-up campaign that we engaged in 2023

S230627c (GW NSBH merger 48% / loc. area = 82 deg^2):

- **Follow-up of two ZTF transient candidate ZTF23aaptudb (O. Aguerre) & ZTF23aaptusa (A. Popowicz, M. Freeberg, D. ST-Gelais)**
- **Sadly, nothing interesting found in association with the GW NSBH event**
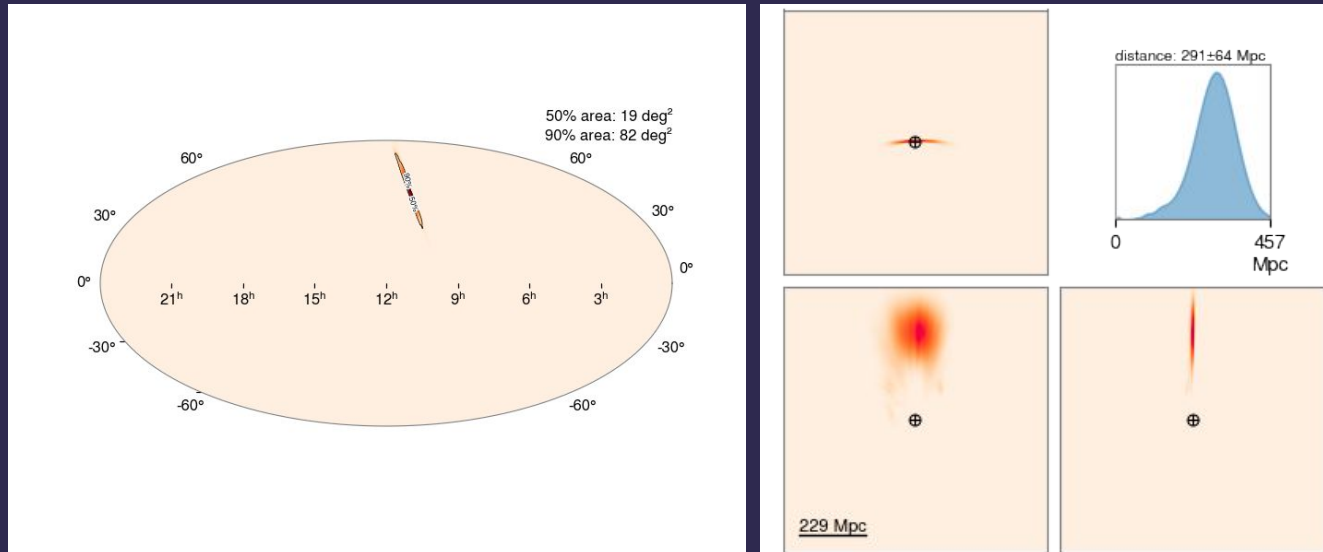
The follow-up campaign that we engaged in 2023

GRB 230812B (Long GRB from the collapse of a massive star, the 3rd brightest GRB ever observed, having multi-wavelength detections:

- **46 images provided (M. Serrau, S. Leonini, M. Freeberg, F. Romanov, M. Odeh, J. Nicolas, L. Rousselot)**
- **We detected the GRB optical afterglow in 10 images (from the stacking of single images)**
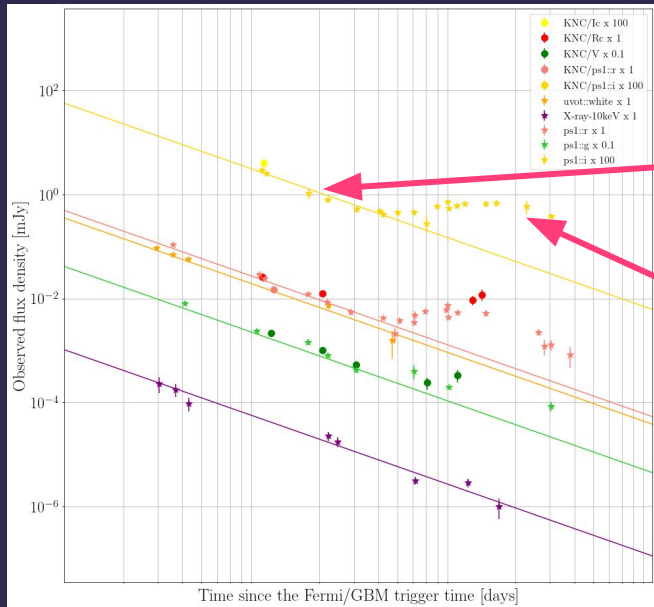
Emission from electrons accelerated in the shock front between the (decelarating) GRB relativistic jet and the interstellar medium

emergence of the Supernova type Ic emission at late times

KILONOVACATCHER

GRB 230812B (Long GRB from the collapse of a massive star, the 3rd brightest GRB ever observed with multi-wavelength detections:

Best fit light curve with a GRB afterglow and SN Ic model

... opening angle of 1.54° seen on-axis. Explanation for the high brightness of the ...

However very low density for the surrounding matter ... rio is still unclear for

... ions. Likely the SN explosion and the ...

- The spectral analysis of the x-ray to optical emission sho... explosion site of the GRB in its host galaxy

Hussenot-Desenonges, T. et al 2024 (MNRAS)

https://ui.adsabs.harvard.edu/abs/2023arXiv231014310H/abstract

co-authors: M. Serrau, S. Leonini, M. Freeberg, L. Rousselot, M. Odeh, J. Nicolas

The follow-up campaign that we engaged in 2023

KILONOVACATCHER

ZTF23abnevza / SN2023vuc (was possibly associated with the Fermi/GBM long GRB GRB 231024A but the association was discarded then):

- **54 images provided (M. Freeberg, M. Odeh, A. Popowicz) under poor conditions (bright moon)**
- **We detected the GRB optical afterglow in the M. Freeberg images**

Subject	GRB 231024A: GRANDMA observations of A 2023vuc/GOTO23baj candidate
Date	2023-11-02T13:35:29Z (2 months ago)
From	Dalya Akl at American Uni. SHJ <dalyaakl.d@gmail.com>
Via	Web form

D. Akl (AUS), D. Turpin (CEA-Saclay/Irfu), P. Gokuldass (ERAU), R. Strausbaugh (EUI), Z. Vidadi (ShAO), S. Antier, A. de Ugarte Postigo (OCA/Artemis), M. Coughlin (UMN), Q. Andre (OCA), J. Peloton, P. Hello (IJCLAB), I. Tosta e Melo (UniCT-DFA), T. Pradier(Unistra/IPHC), S. Karpov, M. Prouza, M. Mašek, M. Blazek (FZU), A. Klotz (IRAP), A. Takey, M. Ismail, M. Abdelkareem, M. Molham (NRIAG), L. Almeida, L. Fraga, W. Corradi, N. Sasaki (LNA), F. Navarete (NOIRLab/SOAR), M. Freeberg (KNC) on behaf of the GRANDMA and Kilonova-Catcher collaborations:

The GRANDMA and Kilonova-Catcher telescope networks observed the source GOTO23baj/SN2023vuc (Gompertz et al., GCN 34878, Iglesias-López et al, GCN 34881), finally classified as a young supernova (Saccardi et al, GCN 34882). We used Skyportal (Coughlin et al., 2023) for the coordination of our observations.

Observations were conducted from 2023-10-25 17:15:51 to 2023-11-01 03:00:12, ~0.91-7.15 days after the GOTO detection time (midtime ref = 2023-10-24T23:23:27.50 from Gompertz et al., GCN 34878).

In the following table, we report a subset of the preliminary photometry of our observations. Magnitudes are reported in the AB and Vega system depending on the filter set.

T-T0 day	MJD	Obser.	Exposure	Filter	Mag +/- err
0.91	60242.886	Les Makes	50X120s	r	18.56+/-0.19 (AB)
1.04	60243.019	FRAM-CTA-N	76x120s	V	18.51 U.L. (Vega)
5.32	60247.290	KNC-T11	17x180s	Rc	18.03+/-0.09 (Vega)
5.92	60247.889	KAO	11x180s	r	18.27+/-0.01 (AB)
5.96	60247.932	KAO	11x180s	i	18.51+/-0.02 (AB)
6.23	60248.206	KNC-T11	17x180s	Rc	18.17+/-0.08 (Vega)
6.81	60248.793	KAO	15x180s	i	18.46+/-0.01 (AB)
6.85	60248.829	KAO	14x180s	r	18.42+/-0.01 (AB)
7.13	60249.105	SOAR	5x75s	r	18.33+/-0.01 (AB)
7.14	60249.111	SOAR	3x150s	i	18.37+/-0.01 (AB)
7.14	60249.117	SOAR	3x200s	g	18.03+/-0.01 (AB)
7.15	60249.125	SOAR	2x120s	z	18.64+/-0.05 (AB)

Our images were taken under poor conditions and a bright moon. All the data in Sloan filters have been calibrated with respect to the PS1 catalog. Johnson filters have been measured using the Gaia catalog. All the data have been reduced by a single data processing pipeline STDPIPE (Karpov et al., 2022). Please contact us for more information and collaboration on this source.

- **A GRANDMA GCN was emitted : https://gcn.nasa.gov/circulars/34928**

- **No more studies about this SN finally classified as a young type II (Core Collapse Supernova)**

The follow-up campaign that we engaged in 2023

GRB 231115A (a short GRB - so possibly associated with a GW signal detected in M82!!!):
- **9 images provided (M. Freeberg, M. Serrau, E. Broens)**
- **We <u>did not</u> detect the GRB optical afterglow**

Subject GRB231115A: GRANDMA Observations
Date 2023-11-15T23:22:01Z (2 months ago)
From Cristina Andrade at UMN <andra104@umn.edu>
Via Web form

A. Iskandar (XAO), F. Wang (THU/BJP), J. Zhu (BJP), L. Wang, X. Zeng, C. Andrade (UMN), A. de Ugarte Postigo (CNRS/OCA), D. Akl (AUS), E. Broens (KNC), S. Antier (OCA-Artemis), I. Tosta e Melo (UniCT-DFA), P. Hello (IJCLAB), D. Turpin (CEA-Saclay/Irfu), T. Pradier (Unistra/IPHC), M. Coughlin (UMN), S. Karpov (FZU), J. Peloton (IJCLab) report on behalf of the GRANDMA collaboration.

We observed the field of GRB 231115A (Fermi GBM team, GCN 35035) covering the complete INTEGRAL error box (D'Avanzo et al. GCN 35036;Mereghetti et al. GCN 35037) within the GRANDMA collaboration. Imaging with the 0.4m SNOVA telescope did not find any candidate in r-band around 2023-11-15 17:37:53 (e.g 2h after the trigger time) down to an upper limit of 18.9 (5-sigma threshold) or 19.3 (3-sigma threshold) using PS1 catalog as photometric comparison. We also looked carefully at the location of AT 2023xvj (Kumar et al. GCN 35041).

The amateur contribution to GRANDMA, Kilonova Catcher (KNC), made no detection with a 30x180s image using a clear filter on 2023-11-15T20:00 UTC (TGRB + 3.28h). We determine a detection limit of 20 mag in r-band, using PS1 for calibration and color term correction. At 2023-11-15T18:53:25.219, we obtained R>18 from 5x180s exposure. The upper limit is given at 5-sigma averaged over all the images.

These upper limits are consistent with previous reports by MASTER (Lipunov et al. GCN 35046).

GRANDMA is a worldwide telescope network (grandma.ijclab.in2p3.fr) devoted to the observation of transients in the context of multi-messenger astrophysics (Antier et al. 2020 MNRAS 497, 5518). Kilonova-Catcher (KNC) is the citizen science program of GRANDMA (http://kilonovacatcher.in2p3.fr/ ☑).

- **A GRANDMA GCN was emitted : https://gcn.nasa.gov/circulars/35051**

- **Actually this was not a GRB but the first Giant flare from a Magnetar observed in M 82,** see Mereghetti et al. 2023
  https://arxiv.org/abs/2312.14645

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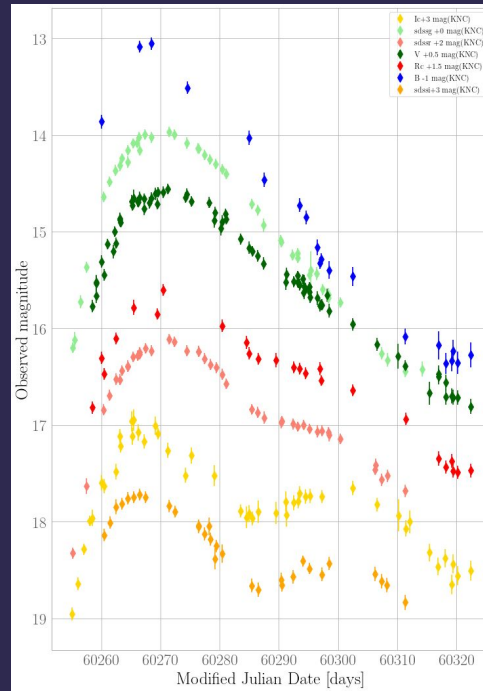# The follow-up campaign that we engaged in 2023

SN 2023wrk (a SN type Ia classified as a subclass SN 99aa-like):

- **461 images provided, it's just amazing (M. Freeberg, M. Serrau, E. Broens, D. Marchais, R. Ménard, F. Dubois, C. Galdies, D. ST-Gelais, A. Popowicz, M. Odeh, G. Parent)**
- **We detect the SN in all the images.**

SN type
Ia

Origin
Thermonuclear runaway in a C-O white dwarf exceeding the Chandrasekhar mass limit after matter accretion or through a DD merger channel

# The follow-up campaign that we engaged in 2023

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SN 2023wrk (a SN type Ia classified as a subclass SN 99aa-like):

- **472 images provided, it's just amazing (M. Freeberg, M. Serrau, E. Broens, D. Marchais, R. Ménard, F. Dubois, C. Galdies, D. ST-Gelais, A. Popowicz, M. Odeh, G. Parent)**
- **We detect the SN in all the images.**

SN type
Ia

Origin
Thermonuclear runaway in a C-O white dwarf exceeding the Chandrasekhar mass limit after matter accretion
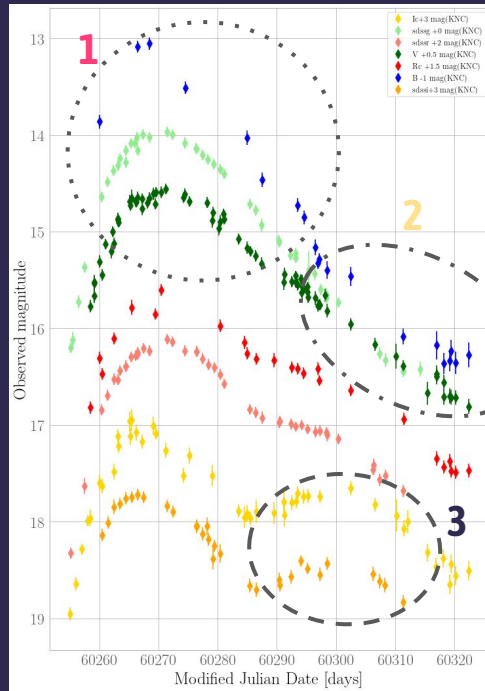
A typical SNIa light curve powered

1. by the radiating external envelope of the star and heated by the radioactive decay of freshly formed ^{56}Ni

2. by the radiating inner part of the ejecta heated by the radioactive decay of ^{56}Co

3. by the recombination process of newly formed and ionized ^{56}Fe into stable ^{56}Fe resulting in NIR and IR radiation

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2

Overview of the 2024 year scientific activities

The follow-up campaign that we engaged in 2024

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EP240331A
IC230427B

S240422ed

EP240618A
EP240625A

EP240702A

March — April — June — July — **2024**

Alert Name	Alert type	#images	filters	Publications
EP240331A	??	2	Rc	GCN 36010
IC240327B	HEN	21	L,B, V, R, g, r	GCN 36050
S240422ed	Gravitational waves	46	L, , Rc, V, g,r	GCN 36299
EP240618a	??	8	G, V, Rc, Ic, g, r	GCN 36712
EP240625a	??	5	G, B, V, Rc	GCN 36771
EP240702A	??	1	V	Not planned

KILONOVA CATCHER

3
What are we missing to be (much) better

Alert transmission to the KNC
community
for non GW alerts

Quick data (image) availability
(through STDweb?)

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Working environment
KNC website and server

Communication

Software development plans

1. Renovate the coding architecture during the Summer to include much more **automatization** everywhere

2. We should propose a more diverse set of MM transient alerts (EP, SVOM, KM3NeT, etc.) and we could even think about using KNC for your research besides GRANDMA BUT KNC data are GRANDMA (keep this in mind). Need

3. **Automatize** even more the data analysis of their images (all the building blocks are there…., we may think about connecting STDweb to KNC also) to produce quick light curve (I would need an intern in python code for doing this)

4. Refreshing the KNC web interface (bug fixes at least): but a big patch of the web interface is likely not feasible in the second semester of 2024

Any other idea?

Some people who have expressed interests in KNC project

KILONOVA CATCHER

I did not forget you, I need to find time to set up plans and actions

- **PA Duverne:** image analysis and tuning of the KNC image analysis pipeline (STDPipe)

- **JG Ducoin:** automatization of the KNC image analysis pipeline (Quicklook) + new follow-up proposal with KM3NeT alerts

- **N Guessoum:** Communication and networking

- **C Andrade:** Communication ?