



The Astronomical Panorama in 2020

J.-L. Atteia & S.-N. Zhang

the astronomical panorama in the epoch of SVOM



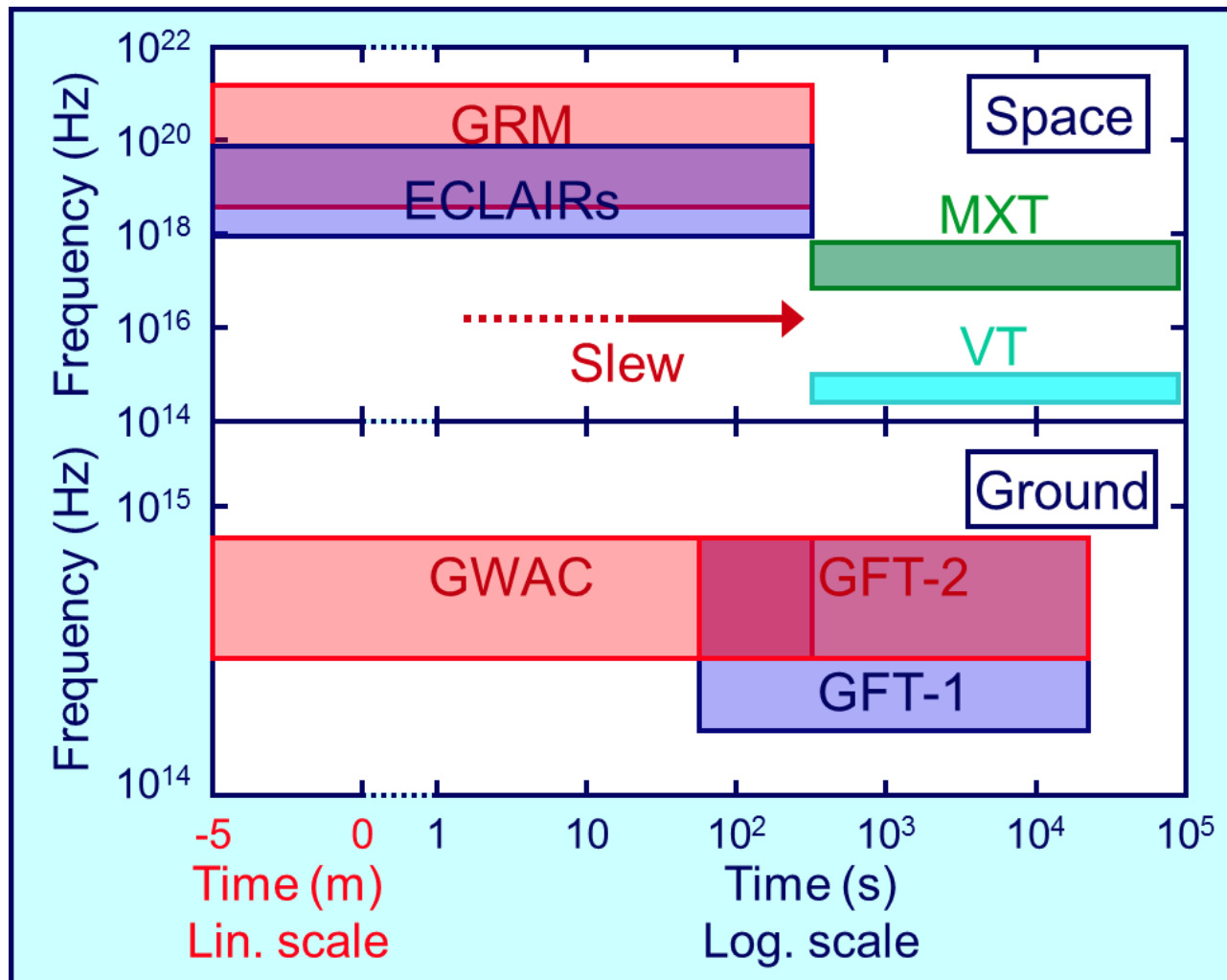
- Being part of the astronomical panorama of the next decade, SVOM will address some outstanding astronomical questions.
- We briefly discuss here the role of SVOM in connection with other major astronomical facilities.
 - This is our subjective view, based on the SVOM Mission Rationale.
 - This is not the outline of the *White Paper*
- We welcome your comments and suggestions for the *White Paper*.

Astronomical observations with

(N. Gehrels and all SVOM presentations, this afternoon)

- SVOM has been designed for GRBs!
 - Onboard instruments, ground segment, pointing strategy
 - Observing capabilities:
Monitoring the HE sky – Trigger/Repointing – Alerts – ToOs – Planned obs.
- The role of SVOM after 2021:
 - Monitor the hard X-ray sky for new galactic and extragalactic HE transients
 - Perform multi-wavelength follow-up of self-triggered HE transients
 - Alert other astronomical facilities of interesting sources
 - Perform multi-wavelength follow-up of remarkable sources on request (ToOs)
- The optical and X-ray sky will be well known when SVOM will fly, thanks to SDSS, LSST and eROSITA.

A MWL mission for TDA and multi-messenger astronomy



SVOM is a multi-wavelength **time domain astronomy** mission that will operate in a rich instrumental environment.

SVOM will operate in the era of **multi-messenger astronomy**.

The instrumental panorama

- Advanced GW detectors: **LIGO, VIRGO, KAGRA**,...
- Space telescopes: **Chandra, XMM, eROSITA, JWST, Euclid**
- Optical Time Domain Astronomy: **Pan-STARRS, ZTF, LSST**
- Large radio/submm observatories: **ALMA, precursors of SKA**
- Extremely Large Visible Telescopes: **E-ELT, TMT**
- VHE Cerenkov arrays: **CTA, HAWC**
- KM3 HE neutrino detectors: **ICECUBE, KM3Net**
- GRB instrumentation: **POLAR, Fermi?**

Outstanding astrophysical issues addressed with SVOM



- The Mission Rationale emphasizes several fields where SVOM will bring significant progress:
 - *A Universe of black holes*
 - *The sources of GWs*
 - *The epoch of reionization*
 - *The physics of relativistic jets*
 - *The population of GRB progenitors*
 - *Galactic monsters*
 - *Exotic transients*

A universe of black holes

(P. Antilogus, V. Beckmann, N. Leroy, P. O'Brien, N. Webb)

- SVOM will provide crucial information on transient black hole (BH) activity.
 - The history of stellar mass BH formation, SFR vs GRB FR up to high redshifts
 - Tidal Disruption Events (TDEs): SVOM will increase the statistics on TDEs, providing a better understanding of dormant massive BHs at the center of galaxies
 - Active Galactic Nuclei (AGNs): the optical to gamma-ray energy coverage of SVOM will permit a better understanding of the physics at work in AGNs, especially blazars. They can also be used to constrain Lorentz invariance.
 - Black holes and gravitational waves : see next slide
-
- The study of GRB FR requires measuring redshifts of the largest possible fraction of SVOM GRBs with **large optical telescopes**.
 - TDEs will benefit from follow-up with **large X-ray telescopes**.
 - Correlated observations with **radio and VHE instruments** on the ground, and **Fermi** (?) in space, will be needed to explore the physics of blazars.

The sources of GWs

(C. Lachaud, N. Leroy, J. Osborne)

- SVOM will benefit from the operation of advanced GW detectors to explore the zoo of transient GW sources. These studies can elucidate the origin of short GRBs, clarify which GRBs are coming from binary mergers and constrain the beaming angle of short GRBs.
- SVOM data may help GW detectors to identify low significance signals from binary mergers.

- These studies require simultaneous observations of SVOM with **advanced GW detectors** and the possibility to upload ToOs quickly.
- It will be very important to measure the redshift of short GRBs with **large optical telescopes** to predict the strength of their GW emission.

The epoch of reionization

(S. Basa, S. Boissier, E. Le Floc'h, P. O'Brien, P. Petitjean)

- GRBs provide unique glimpses into the epoch of reionization.
 - They constrain the contribution of massive stars to the reionization of the universe.
 - The most distant GRBs take place in small high redshift galaxies, which cannot be observed by other means.
 - The first stars (population III) are expected to be peculiar, SVOM may reveal if they produce GRBs.
-
- Optical spectra of GRBs beyond $z \approx 6$ provide a tomography of the host galaxies and of the intergalactic space. Early measurements with **large optical and X-ray telescopes** are required to get a good SNR. These studies require identifying high redshift GRBs quickly to measure their redshift. VT +MXT and the GFT will play a crucial role.
 - The largest optical and radio telescopes on the ground (**ALMA, E-ELT, TMT**) and in space (**JWST**) will be crucial to study the host galaxies of very distant GRBs at $z > 5$.

Physics of relativistic jets

(F. Daigne, D. Dornic, J. Rodriguez)

- The physics of accretion/ejection is a fundamental astrophysical problem. HE galactic transients, GRBs and AGNs offer complementary ways to capture the dynamic of this process. SVOM will address issues like the nature of GRB jets, the acceleration mechanism, the radiation processes, etc. with impacts on the origin of VHE cosmic-rays, and on the physics of relativistic jets.
 - The search for optical GRB afterglows with the LSST will strongly constrain the geometry of GRB jets, if we can decide the afterglow to an on-axis GRB or an orphan afterglow.
 - Closer to us, SVOM will monitor galactic transients simultaneously with VT and MXT (+ GFT), upon ToO or on self-trigger.
-
- Multi-wavelength observations during the accretion/ejection process (galactic sources, prompt GRB and early afterglow, AGNs) are crucial for this task. SVOM instruments will be complemented by **radio telescopes** and HE instruments like **Fermi** (?) and **VHE instruments**.
 - The polarimetry of the prompt emission will bring crucial insight into the magnetic field configuration of the jet (**POLAR**).
 - KM^3 neutrino detectors (**ICECUBE**, **KM3Net**) might bring surprises.

GRB progenitors

(F. Daigne, R. Mochkovitch, S. Vergani)

- Our understanding of GRB progenitors will make great progress with SVOM.
- The low energy threshold of SVOM will permit the detection of nearby XRFs, allowing investigating the connection between long GRBs and SNIbc.
- Fast observations with VT will be decisive to find the optical afterglows of short GRBs making possible the detection of kilonovae

Several other instruments will crucially contribute to these studies:

- **GW interferometers** will bring new constraints on the progenitors of short GRBs.
- **LSST** will constrain the beaming angle of GRB jets and the true GRB rate.
- **KM³ neutrino detectors** may constrain the rate of choked GRBs in the local universe.

Galactic monsters

(J. Rodriguez, A. Goldwurm)

- The low energy threshold of ECLAIRs will permit the detection of thousands of bursts and flares from galactic neutron stars (X-Ray bursters and magnetars), active black holes (microquasars), and white dwarves (novae), and their detailed follow-up with MXT and VT.
- These observations will permit powerful diagnostic of many important physical processes: accretion/ejection, nuclear burning on NS and WD, the origin of the activity of magnetars...

- Simultaneous follow-up with **radio, NIR, visible, X-ray and VHE telescopes** is mandatory for these studies

More transients...

(P. Antilogus, N. Gehrels, C. Lachaud, P. O'Brien)

- Orphan GRB afterglows
 - Fast Radio Bursts
 - they are more frequent than GRBs (≈ 2500 FRBs per sky per day), and for some of them repeating.
 - Little chance of observing an optical or X-ray counterpart with SVOM.
 - Other cosmological transients?
 - Selected microlensing events
-
- For many of them, SVOM will act as a follow-up machine, combining X-ray and optical sensitivity, fast response (several hours) and high availability

Some conclusions

- The highest benefit of SVOM will be obtained with collaboration with the largest astronomical facilities existing in the 2020 decade.
- This collaboration will go in both directions: large facilities observing SVOM HE transients, and SVOM observing remarkable transients discovered by other facilities, with its narrow field telescopes.
- We must use the *White Paper* and all other ways of communication to foster collaborations with these facilities.
- We welcome your advice about the content and organization of this chapter of the *White Paper*...