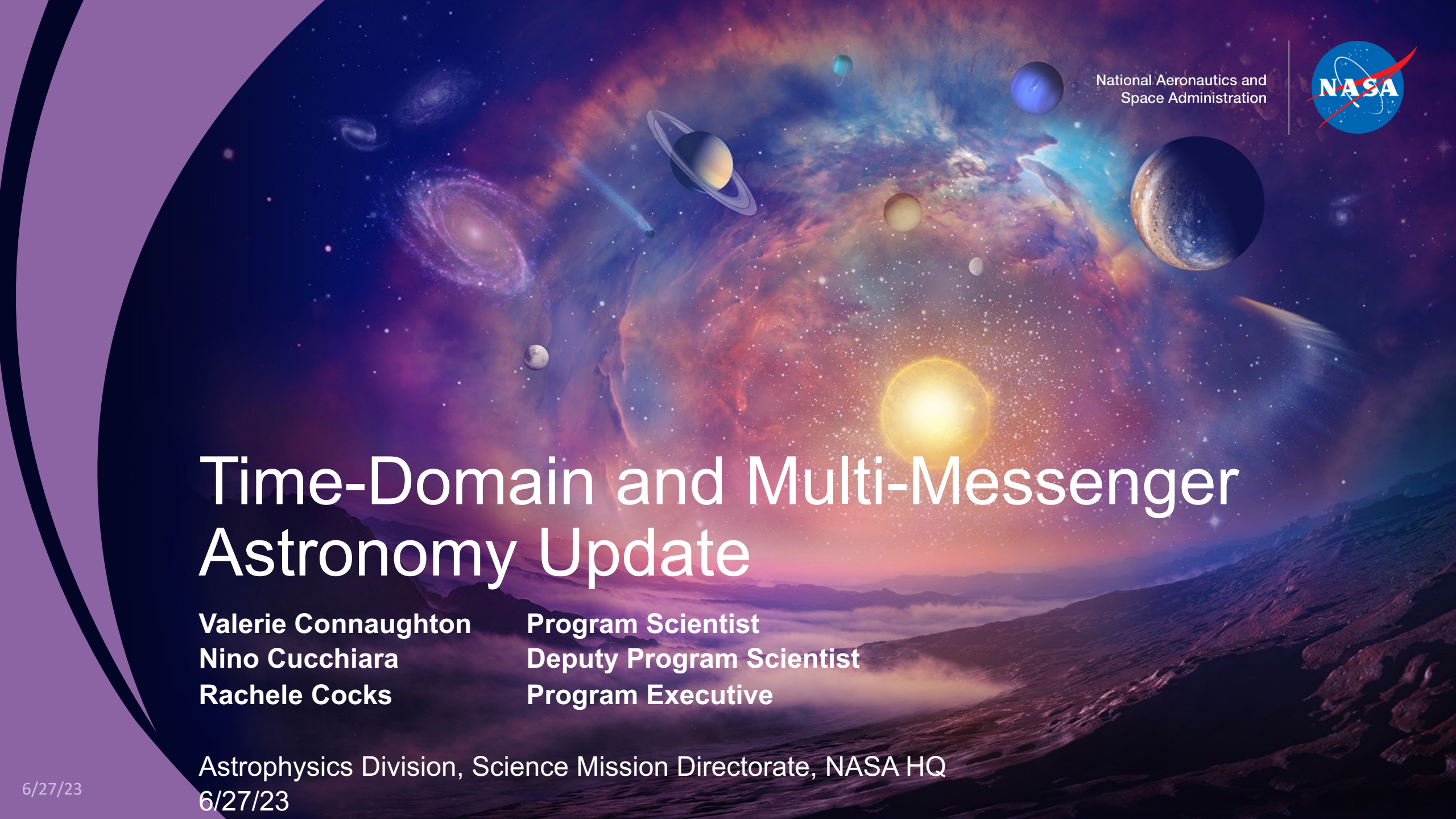


National Aeronautics and Space Administration

Time-Domain and Multi-Messenger Astronomy Update

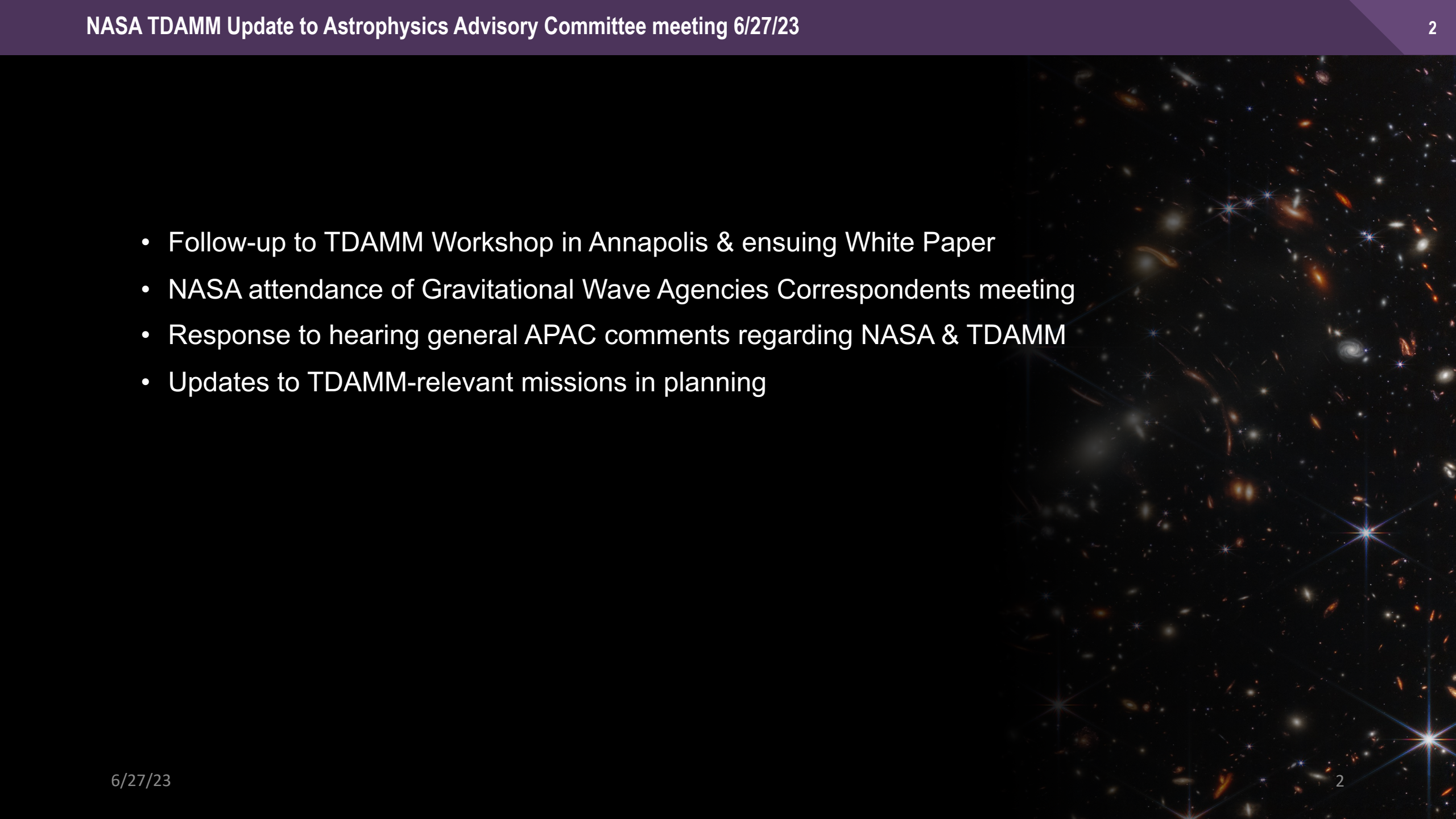
Valerie Connaughton **Program Scientist**
Nino Cucchiara **Deputy Program Scientist**
Rachele Cocks **Program Executive**

Astrophysics Division, Science Mission Directorate, NASA HQ

6/27/23

6/27/23

- Follow-up to TDAMM Workshop in Annapolis & ensuing White Paper
- NASA attendance of Gravitational Wave Agencies Correspondents meeting
- Response to hearing general APAC comments regarding NASA & TDAMM
- Updates to TDAMM-relevant missions in planning



The Dynamic Universe: Realizing the Potential of Time Domain and Multimessenger Astrophysics

- Special issue on TDAMM in Frontiers in Astronomy and Space Sciences (Editors: R. Sambruna and F. Civano)
- Inspired by the 2022 NASA Time Domain and Multi Messenger Astrophysics NASA Workshop and the subsequent summary paper written by the workshop Science Organizing Committee and delivered to NASA HQ in December 2022
- Workshop summary paper will be revised and published as a review in the Research Topic
- Invited TDAM workshop attendees and announced it to community through the PhysCOS newsblast
- Contributions to focus on the potential for the variable source to be a Multi-Messenger source, i.e., the likelihood of being detected in the future with Gravitational Wave detectors (e.g., LVK, LISA) and/or neutrinos. Papers focusing on mission concepts are NOT allowed
- 32 abstracts submitted so far
- Important Dates:
  - Abstract submission: July 9, 2023
  - Paper submission: Jan 15, 2024

Link to the call:

Upcoming TDAMM community workshop

- Vibrancy of session on Infrastructure at Annapolis workshop in 2022
- Emphasis on infrastructure in international splinter meeting involving 9 space agency representatives (plus in ensuing telecon in March 2023 with NSF and 2 more international agencies)
- Strong Astro 2020 recommendations for NSF (and NASA) in the areas of infrastructure
- Findings of NASA Gravitational-Wave ElectromagneticTask Force report of 2019
- Annapolis Work Shop White Paper

- "Windows on the Universe: Establishing the Infrastructure for a Vibrant Multi-messenger Ecosystem" Workshop October 16 – 18 organized by NOIRLAB in Tucson, AZ with NSF and NASA oversight.
- LOC & SOC active. Announcement & website live very soon!

NASA attendance at GWAC

- Gravitational-Wave Agencies Correspondents – NSF-led committee involving representatives from international facilities involved in Gravitational-Wave science
- https://www.nsf.gov/mps/phy/gwac.jsp
- To date NASA's participation has been LISA-centered
- I attended the telecon in March as TDAMM lead
- Main focus of APD interest from TDAMM perspective: keeping abreast of developments in ground-based GW experiments & activities
  - Timing and duration of Science Runs (LIGO / Virgo / Kagra kicked off O4 last month)
  - Any changes to configurations and/or schedules that could impact NASA counterpart observations
- One of Astro 2020 recommendations for NASA: future capabilities should be planned taking into account landscape of multi-messenger & international facilities
  - Seat at GWAC table facilitates this planning
  - Pilot of PhysCOS TDAMM study recommendations in connection with O4

Upcoming TDAMM missions

- Compton Spectrometer and Imager (COSI) Launch Readiness Date (LRD) August 2027
- NEO Surveyor – TDAMM aspect of Planetary IR mission LRD NET June 2028
- NASA Participation in Israeli Space Agency's ULTRASAT LRD June 2026
  - 14 US-based scientist selected through ROSES-22 D.19 to join Science Team 6/5
- Downselect of Explorers in 2024: Star-X and UVEX (Mid-EX) with a targeted launch of FY '29, MoonBeam and LEAP (MoO) targeted launch of FY '28
- Pioneers: StarBurst LRD 2026, PUEO 2024, TIGERISS 2026
- SmallSats & ISS: GlowBug launched to ISS 3/15/23, BurstCube early 2024, BlackCat LRD 2024.
- Roman – Julie McEnery update
  - TDAMM news in this presentation
- LISA – NASA contribution to ESA mission
- APRA: suborbitals & technology development
  - The Lobster-eye X-ray Telescope (LXT) sounding rocket mission (PI Galeazzi) selected APRA 22

Nancy Grace Roman Space Telescope as TDAMM mission

- Roman will conduct at least two significant time-domain astronomy surveys defined by Astro2010
  - Galactic Bulge – 15min cadence, ~2 sq.deg., timescales up to 5 years: stars & planets
  - High Latitude – ~5-day cadence, ~20 sq.deg., timescales up to 2 years: SNe, active galaxies, TDEs
- Roman has adjusted its science planning to elevate the level of support for time-domain astronomy in response to Astro2020 starting in FY24
- Roman's Project Infrastructure Teams associated with time-domain astronomy are planning on:
  - Enabling rapid image differencing
  - Providing prompt variable/transient alerts to brokers within ~24hrs of processing
  - Supporting light curves, photometry, moving object identification, catalog production
  - Developing tools to classify various transient phenomena
  - Developing tools to enable time series Roman photometry from external triggers
- More in Julie McEnery's Roman update

Regarding APD's TDAMM response & statements…

- Throughout Astro 2020 examples of TDAMM science display the breadth of science that comes under the TDAMM umbrella
- TDAMM science is broad but the recommendations for NASA are narrow
  - Space-based counterparts to potential multi-messenger phenomena
  - Maintenance and replacement of "workhorse" missions that have contributed so much to TDAMM science
    - Workhorses can be monitors (counterpart or trigger for observations) or follow-up telescopes.
  - Planning TDAMM workhorses within a changing international & interagency landscape
    - Astro 2020 mentioned need for sensitive gamma-ray & X-ray monitors & UV follow-up capability
- NASA is concentrating on the infrastructure aspect
  - Updated alert system for the Rubin era of 10M transients per night
  - More efficient use of existing resources – PhysCOS study existing mission responses & recommendations for efficiencies for both missions and investigators
  - Development of multi-mission software tools to enable TDAMM science
- Workhorse question to be answered within program of record and new missions within fiscal constraints. TDAMM White Paper & follow-up volume to lay out open science questions these workhorses need to consider most urgently.

Backup

Infrastructure – repeat of slide from March

- Operating missions: Ongoing study of the possibility optimizing the NASA fleet for TDAMM through centralized planning, proposal submission, Target-of-opportunity initiation, and science-driven coordination of observations
  - Pilot during LVK O4 to implement findings for fleet / observing community
- HQ studying future of Space Communications as TDRSS is replaced by commercial solution
  - Impact agency-wide - TDAMM is a science driver, particularly of Demand Access Service (DAS)
    - Damage to Guam ground station a challenge to TDRSS fleet
- HQ directed funding for 2 NASA center-based TDAMM projects:
  - Upgrade of General Coordinates Network (GCN) at GSFC
    - New GCN rolled out - April 2023!
  - Development of multi-mission design & analysis tools at MSFC

Community

- Physics of the Cosmos Program Analysis Group (PhysPAG):
  - New Science Interest Group (SIG) on TDAMM being spun up – HEAD splinter session 3/26/23 - cross-PAG interest
    - TDAMM SIG special session HEAD 2023 generated lively discussion
      - Ensuing cross-PAG SIG ToR for your perusal as part of this meeting
  - New Science Analysis Groups (SAGS) on 2 TDAMM-related issues:
    - The future of Gamma-Ray Transient Networks – kickoff January 2023: https://pcos.gsfc.nasa.gov/sags/gtnsag/gtn-sag.php
      - Report complete – comments in final stages of being addressed by leads
    - TDAMM Science Drivers for next-generation (post-TDRSS) Space Communications (presented here)
      - PhysPAG SpaceComm SAG kicked off following approval by APD – presentation to APC of ToR March