Astro2020 Impact on UV

Time-Domain (and Multi-messenger) Science

Brad Cenko - NASA GSFC - 11 Jan 2022

New Messengers and New Physics

Priority Area: New Windows on the Dynamic Universe

- *Multi-Messenger Astronomy*
  - Gravitational waves: Binary neutron star mergers (LIGO), merging SMBHs (LISA)
    - Where are heavy (r-process) elements formed?
    - How are relativistic jets structured and launched?
    - How do galaxies grow through major mergers?
  - High-energy neutrinos (IceCube): AGN, TDEs, ???
    - How / where are cosmic rays formed and how does particle acceleration work?
- Time-Domain Astronomy
  - Repeated imaging of large areas of sky to search for transient / variable sources
    - How do massive stars explode?
    - How do SMBHs accrete gas?
    - How does stellar variability impact planetary atmospheres?

TD and MM Follow-Up Program

Sustaining scientific balance and scale

- ELTs + LUVEX for thermal emission from faint/distant GW counterparts
- ngVLA for relativistic jets
- New “line” of MO/SMEX/MIDEX/Intl’l for TDA/MMA ($500-800M over decade)
  - “A program of competed missions and missions of opportunity to realize and sustain the suite of capabilities required to study transient phenomena and follow-up multi-messenger events.”
  - UV specifically highlighted
    - “The most important of these are wide-field gamma-ray and X-ray monitoring, and rapid and flexible imaging and spectroscopic follow-up in the X-ray, ultraviolet (UV), and far-infrared (far-IR). In addition, space platforms can be designed to access much of the sky at any given time, essential for the study of short-lived transients or rapidly variable sources. Space missions can also observe near continuously compared to ground-based telescopes.
  - Standing planning committee / advisory structure suggested
  - Implementation unclear (2021 MIDEX?)

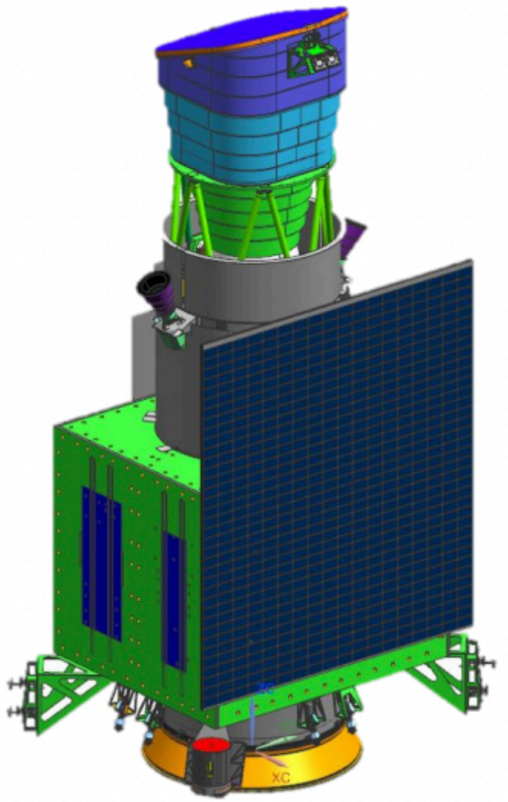
Desired Capabilities

- Large FOV ($\gtrsim$ 10 deg^2)
- Sensitivity and angular resolution ~ Rubin
- Multiple (broadband) filters
- Moderate resolution spectroscopy
- Rapid response (< hours)
- Launch:
  - Rubin: 2025
  - GW Runs: O4 - 2023; O5 - 2025; O6 - 2028

ULTRASAT (Q4 2024)

Israeli + DESY + NASA

Property	Value	Comments
Orbit	GEO	
Real-time download of data	Continuous	Except of 1% of ToOs
Transient alert after observation end	< 15 min	For both survey and ToO modes
Sky accessibility at any given moment	> 50%	
Observation start after ToO trigger	< 15 min	At any visible position
Total FoV	204 deg^2	Covered by 4 dies
Single die dimensions	7.14º x 7.14º	
Pixel scale	5.4''/pix	Focal length = 361mm
Operation waveband	230-290 nm	
Mean throughput in operation waveband	0.26	
Out of Band Rejection (> 300 nm)	1.4 x 10^{-5}	
Mean effective PSF	8.3''	In central 170 deg^2 of FoV For T = 20,000 K blackbody source.
Mean limiting magnitude (in 900s, 5σ)	22.5 ABmag	



Summary

- TD/MM will be a significant area of focus for NASA in 2020’s
- UV capabilities will be critical to achieve TD/MM science goals
- Implementation details TBD