

Initial Prospects for Astrophysics Science with a 4m-class UV-visible Observatory

COPAG SIG2 – Future of UV-visible Astrophysics from Space

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Preamble

- SIG established in December 2014
- Our discussions have focused on:
 - Compelling UV-visible astrophysics science for the next decade
 - Existing and developing technologies for this passband, workforce development
 - Mapping the science to the range of possible or available mission sizes
 - Evaluation of a UVOIR Flagship as a strategic move
- Understandably the immediate discussions have focused on the latter topic in the face of the Hertz charge
- Initial workshop to be held at GSFC June 25/26
- Details at <http://sig2.asu.edu>

STARS

- Ted Gull (GSFC) - How do molecules and dust form in the interacting winds of massive stars? - larger aperture OIR telescope w/ imaging spectroscopy, better 3-D modelling of wind-wind interactions
- Ian Roederer (Carnegie) - Detect and measure as many heavy elements as possible in stars whose atmospheres retain a fossil record of the evolution of the ISM – high resolution FUV spectroscopy over wide fields
- Myron Smith (STScI) – The dedicated measurement of stellar magnetospheres, winds, activity and environment of a variety of types over time; UV and visible spectroscopy; UV and visible spectropolarimetry

4m+
300-700nm
R~10,000
2" FoV

2m
190-300nm
R~60,000
10' FoV

2m
117-870nm
R~25,000
Polarimetry

STAR FORMATION AND NEARBY GALAXIES

- Paul Scowen (ASU) – A wide field UVO imaging survey of massive star forming complexes – to understand the formation mechanisms and survival rates of the star formation process – wide field ($>10'$) UVO imaging with diffraction limited ($0.04''$) resolution
- Paul Scowen (ASU) - how are chemical elements distributed and dispersed into the CGM and IGM? How does baryonic matter flow from the IGM into galaxies and then stars and planets? - high resolution multiband UVOIR imaging survey of the Magellanic Clouds; a narrowband survey of HII regions and the diffuse warm ISM; a FUV spectroscopic survey of 1300 early-type stars
- Martin Barstow (U. Leicester) - Conditions for Life in the Local Universe - how does cosmic feedback affect habitability – physics of hot atmospheres, changes in interplanetary environment? - need larger samples of targets, ultra-high FUV spectroscopy and widefield FUV imaging

2-4m
250-950nm
15' FoV

2-4m
200-1000nm
R~30,000
10' FoV

4m
100-300nm
R~100,000

INTERGALACTIC MEDIUM

- Todd Tripp (U. Mass) - QSO Absorption Lines in the FUV: An Untapped Gold Mine for Galaxy Evolution Studies - use of QSO absorption lines to probe the invisible baryons – challenges: the useful lines are in the UV, most QSOs are too faint - go deeper, in the EUV – high res. FUV spectroscopy
- Stephan McCandliss (JHU) - Project Lyman: Quantifying 11 Gyrs of Metagalactic Ionizing Background Evolution - How did the universe come to be reionized and how long did it take? - How did LyC and Ly α escape from galaxies? - Far-UV has the advantage of small number of Ly limit system corrections → need to measure the Evolution of the Galaxy UV luminosity function for $0 < z < 3$

2-4m
92-200nm
Same as COS

2m
95-400nm
R~5000
0.5 sq. deg.

INTERGALACTIC MEDIUM (2)

- Claudia Scarlata (U. Minnesota) - The Role of Dwarf Galaxies in Reionization – use of lensing magnification as the best and only way to study the faint galaxies that contribute to LyC budget – FUV widefield imaging and spectroscopy
- Chris Martin (Caltech) – Science from IGM/CGM Emission Mapping – can be used as a probe of baryonic structure formation – detect and characterize IGM emission; physical properties of the IGM; tracing baryonic structure formation using IGM emission – FUV MOS spectroscopy over modest fields

2m
100-630nm
R~5000
10' FoV

2m
100-400nm
R~5000
20' FoV

GALAXY EVOLUTION

- Brad Peterson (Ohio State) - UV Time Domain Studies of Active Galactic Nuclei - Intensive monitoring to get UV velocity-delay maps to establish flow of high-ionization gas - UV reverberation mapping of AGN BLRs – requires high cadence
- Matthew Hayes (U.Toulouse) - Extragalactic Lyman- α Experiments in the Nearby Universe - Using Lyman- α to probe the lowest mass galaxies, the cosmic web, dark clouds, Pop III stars - UV (150-360nm) survey telescope ($>0.1 \text{ deg}^2$): slitless spectroscopy ($R=100, 5000$)
- Paul Scowen (ASU) - Galaxy Assembly and SMBH/AGN Growth - How did galaxies evolve from the very first systems to the types we observe nearby? - objects at $z>7$ are very faint and very rare – need widefield imaging and diffraction limited optics - evolution of the faint-end slope of the dwarf galaxy luminosity function, tracing the reionization history using Ly- α emitters
- Sally Heap (GSFC) - A UVOIR Spectroscopic Sky Survey for Understanding Galaxy Evolution - to understand how galaxies evolved to form the Hubble sequence and to establish which processes were responsible - conduct a 0.2-1.7 micron spectroscopic survey of 10^6 galaxies at $z>0.8$

2m
110-300nm
 $R>600$

4m
122-350nm
 $R\sim 5000$
0.1 sq. deg.

2-4m
200-1000nm
 $R\sim 200$
15' FoV

2m
200-1700nm
 $R\sim 1000$
0.15 sq. deg.

OTHER SCIENCE

- Kevin France (U. Colorado) - From Protoplanetary Disks to Extrasolar Planets - to study inner regions of protoplanetary disks ($<10\text{AU}$) – planet formation timescales $\sim 10^6$ - 10^7 yrs; gas disk lifetimes and structure determine how planets form gas envelopes and determine final architecture of exoplanet systems – FUV/NUV MOS/Echelle spectroscopy
- Mike Wong (UCB/U. Michigan) - Solar System Science Objectives with the next UVO Space Observatory – to provide a local reference point for origin and evolution of stars and planetary systems – requires moving target tracking, ability to resolve time variable phenomena - UVO imaging and spectroscopy

4m
91-400nm
R~150,000
10' FoV

4m
UV-IR
R~2500
50" FoV

OTHER SCIENCE

- Ana Gomez de Castro (UC Madrid) - Seeking Behind the Anthropic Principle - metallic evolution of the IGM, physics and contents of galactic haloes, evolution of UV irradiated environments and emergence of life – need more spectroscopic lines of sight, narrow band UV imaging and spectroscopy, large collecting area, large photon-counting detectors, coatings, UV optics materials, UV survey of the Galactic plane, better molecular transitions database
- John Hutchings (CSA) - CASTOR – a widefield UVO survey telescope with 0.15” resolution - provides a wide field for high resolution surveys; supports DE/DM science; some PI programs envisioned; includes slitless spectroscopy - looking for partnerships, design exists, need to start Phase A studies, work on optical design - current design is off-axis TMA w/ imaging bands in UV, u and g

4m
90-320nm
R~1000
10' FoV

1-2m
150-550nm
R~7000
0.67 sq. deg.

Conclusions

- Early days for these discussions – expect clarification at the SIG2 workshop
- Clear that there is a strong initial portfolio for 4m-class astrophysics in the UV-visible
- Similarly strong portfolios exist from Explorer-class up through Probe- and Flagship-class missions sizes – what are the budgetary and political realities?
- The opportunities exist for real collaboration between the Exoplanet and Astrophysics communities - whether it is at the 4m-class or the 10m-class