BIG BANG TO BIOSIGNATURES: THE LUVOIR MISSION CONCEPT

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Science with the HST and JWST Telescopes 5  
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What is LUVOIR?

Large UV / Optical / Infrared Surveyor (LUVOIR)

A space telescope concept in tradition of Hubble

- Broad science capabilities
- Far-UV to Near-IR bandpass
- ~ 8 – 16 m aperture diameter
- Suite of imagers and spectrographs
- Serviceable and upgradable

“Space Observatory for the 21st Century”
Decades of science
Ability to answer questions we have not yet conceived
Imagine astronomy without Hubble ...
Imagine astronomy with LUVOIR ...

**Hypothetical planet “Nine”**
- Located at ~1000 AU
- Diameter of 40,000 km

**Hubble Space Telescope (HST)**
- Best optical resolution (2016)
  - 2.5m diameter (0.05’’)

**LUVOIR**
- 6m diameter
  - Resolution ~0.02’’

**LUVOIR**
- 18m diameter
  - Resolution ~0.007’’

Clear Identification of local differences

Detailed mapping of the surface morphologies and composition anisotropies
How we’re doing the study

NASA started four large mission concept studies in Jan 2016 to prepare for Astro2020 Decadal Survey

- LUVOIR
- Habitable Exoplanet Imaging Mission (HabEx)
- Origins Space Telescope (aka. Far-IR Surveyor)
- X-Ray Surveyor

Two LUVOIR mission architectures to be studied

- Aperture sizes chosen Nov 2016: 15-m and ~ 9-m

Study office and engineering team at GSFC
How we’re doing the study

Science and Technology Definition Team

- 24 voting members from community
- 8 non-voting reps. of international space agencies

Six Community Working Groups

- Exoplanets
- Cosmic Origins
- Solar System
- Simulations
- Communications
- Technology

Four Instrument Teams
The LUVOIR instruments

**Observational challenge**

Faint planets next to bright stars

**Solution**

**Optical / Near-IR Coronagraph**

Contrast < $10^{-10}$ to observe exoEarths
Low resolution spectroscopy ($R > 150$)
Bandpass: 0.2 μm to 2.4 μm
Tech development via WFIRST coronagraph

(Credit: D. Mawet)
The LUVOIR instruments

Observational challenge
No UV through Earth’s atmosphere

Solution
LUMOS
Far-UV to near-UV spectroscopy
Multi-object capability
Near-UV imaging
Major upgrade of HST STIS

HST STIS UV instrument
The LUVOIR instruments

Observational challenge
Imaging deep fields at high resolution

Solution
High-Definition Imager
2 x 3 arcmin field-of-view
Optical to near-IR bandpass
High precision astrometry mode
Major upgrade of HST WFC3

HST Wide Field Camera 3
The LUVOIR instruments

Observational challenge
Measuring warm molecules present in Earth’s atmosphere

Solution
Optical / Near-IR Spectrograph
Multiple resolutions up to $R \sim 10^5$
High photometric precision for transits
Possibly high precision RV to measure planet masses
Ground-based analogs in development

Credit: Natasha Batalha

ESPRESSO spectrograph for VLT (Credit: ESO)
POLLUX: a European contribution to the LUVOIR mission study

- POLLUX is a concept for a UV spectro-polarimeter with high resolution point-source capability ($R \sim 10^5$)
- Complimentary to the LUMOS instrument
- To be defined & designed by a consortium of 10 European institutions, with leadership/support from CNES
  - Instrument leads: Coralie Neiner & Jean-Claude Bouret
- The conceptual study conducted by CNES could serve as a support for a future ESA contribution
LUVOIR online simulation tools in development

http://asd.gsfc.nasa.gov/luvoir/tools/
Technological challenges

Deployment of large segmented telescope

To be demonstrated by JWST

LUVOIR deployment
Technological challenges

Need heavy lift launch vehicle with large fairing
Suitable vehicles (SLS and commercial) in development

Compatibility of UV and coronagraphy
New lab work shows UV reflective mirrors are just fine for coronagraphy

Ultra-high contrast observations with a segmented telescope
Coronagraphs can be designed for segmented telescopes. Working hard to demonstrate needed system stability

Difference between LUVOIR and HabEx?

Both LUVOIR and HabEx have two primary science goals

- Habitable exoplanets & biosignatures
- Broad range of general astrophysics

The two architectures will be driven by difference in focus

- For LUVOIR, both goals are on equal footing. LUVOIR will be a general purpose “great observatory”, a successor to HST and JWST in the ~ 8 – 16 m class
- HabEx will be optimized for exoplanet imaging, but also enable a range of general astrophysics. It is a more focused mission in the ~ 4 – 8 m class

Similar exoplanet goals, differing in quantitative levels of ambition

- HabEx will *explore* the nearest stars to “search for” signs of habitability & biosignatures via direct detection of reflected light
- LUVOIR will *survey* more stars to “constrain the frequency” of habitability & biosignatures and produce a statistically meaningful sample of exoEarths

The two studies will provide a continuum of options for a range of futures
Get involved with LUVOIR

http://asd.gsfc.nasa.gov/luvoir/

4th meeting Apr 17 – 18, 2017 at JPL

Observers welcome at all LUVOIR meetings & telecons

Interim Report: Dec 2017
Final Report: Jan 2019