# CASTOR: A Proposed Wide-Field, UV-Blue Imaging Space Telescope

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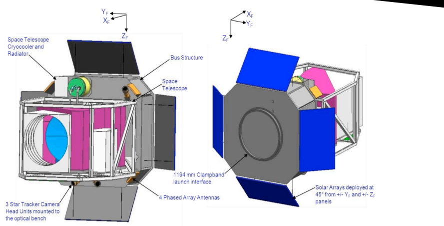


Figure 1. External ***spacecraft layout*** for CASTOR.

Text

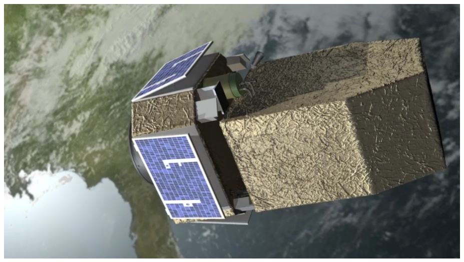

Figure 2. Visualization of CASTOR in orbit, illustrating its ***compact and low-mass design***.

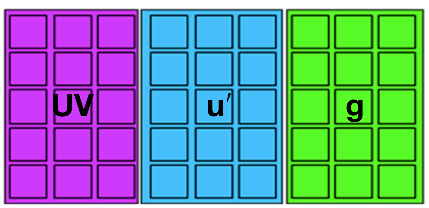


Figure 4. ***Focal plane array*** (FPA) layout for CASTOR, which consists of 45, 4k x 4k detectors. Each band is covered by 3 x 5 FPAs. A candidate detector assessment study is underway since 2013.

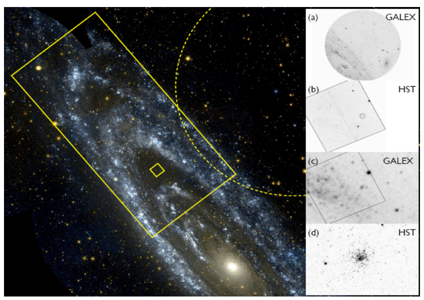


Figure 6. CASTOR field of view, relative to HST and GALEX. The underlying image is a GALEX UV mosaic of M31 (inset a). A single GALEX image is the dashed circle. The large rectangle shows the CASTOR ***field of view***, which measures 1.16° × 0.58°. The smaller polygon shows the HST field, which is ~1/200th that of CASTOR (inset b). Inset c shows the HST field at GALEX resolution. Inset (d) shows a magnified view from HST indicated by the small circle from inset (b).

## Summary

The Cosmological Advanced Survey Telescope for Optical and UV Research (CASTOR) is a proposed CSA mission that would provide a unique capability for panoramic, high-resolution imaging at UV/optical (150–550 nm) wavelengths. In addition to providing UV access, CASTOR would surpass any ground-based optical telescope in terms of angular resolution, and provide ultra-deep imaging in three broad filters that supplement longer-wavelength data from upcoming dark energy missions (Euclid and WFIRST). Combining one of the largest focal plane ever flown in space with an innovative optical design that delivers HST-quality images over a field two orders of magnitude larger than HST, CASTOR would be capable of imaging, during a 1.8-year legacy survey, an area of 2000 deg$^2$ to a (u′-band) point-source depth ~1.5 mags fainter than will be possible with LSST even after a decade of operations.

## Key Features and Capabilities

- A 1m-diameter, unobscured Three Mirror Anastigmat telescope provides ***Hubble-like image quality of FWHM ≈ 0.15″ over a 1.16° x 0.58° field*** of view.
- A huge ***725 Megapixel camera*** with wavelength coverage from 150-550 nm, allowing access to wavelengths not visible or easily observable from the ground.
- High observing efficiency would allow a ***survey area of several thousand deg$^2$*** in less than two years.
- A ***u′-band sensitivity of 27.1 or 27.6 AB mag*** for possible Euclid-Wide or WFIRST-HLS optimized surveys (see Figures 5 and 7). High angular resolution leads to improved depth for unresolved sources: i.e., CASTOR would have ***point source sensitivity comparable to a 40m ground-based telescope*** in good (0.6″) seeing.
- CASTOR has been designed to fulfill a ***top space astronomy priority*** identified in the *2010 Long Range Plan for Canadian Astronomy*. International partners are welcome.

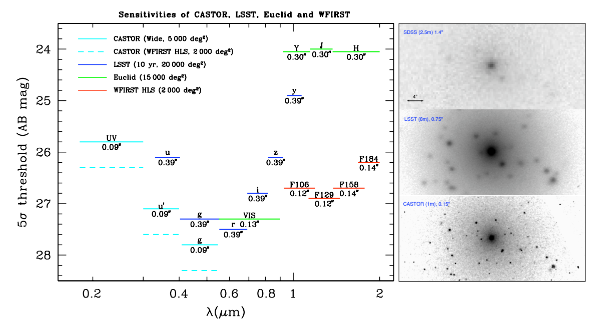


Figure 7. (Left) ***Depth of various wide-field imaging surveys*** as a function of wavelength, adapted from a figure by Spergel et al. (2013). Results are shown for CASTOR, LSST, Euclid (Wide) and WFIRST (HLS). For CASTOR, we show two possible surveys: (1) a deep (u′ = 26.1) 5000 deg$^2$ northern hemisphere survey in the Euclid-Wide survey region; and (2) a 0.5 mag deeper survey covering the 2000 deg$^2$ WFIRST-HLS footprint. The labels under each filter indicate the image quality (EE50 radius) for each survey. (Right) Comparison of g-band images for a typical low-mass galaxy in the Virgo cluster. From top to bottom, these panels show an actual image from the SDSS, and typical images expected from LSST and CASTOR. Despite its modest aperture, CASTOR can provide deeper and far sharper images than is possible with even large ground-based telescopes.

Table 1. Detector Performance

| | |
|---|---|
| Photometric accuracy | < 1% |
| Random noise | <2.5 e/600 sec |
| NUV band sensitivity | 10 min |
| NUV band red leak | 16 |
| 10 micron pixel pitch | 0.1″ (dithered to 0.05″) |
| Dark current | <0.01 e/p/s (end of life) |
| Low power dissipation | <20 mW/cm$^2$ on focal plane |
| Sub-windowed fine guiding | 10 Hz |

Table 2. Data Volume

| | |
|---|---|
| Gigapixels per exposure | 0.725 |
| Exposures/image | 4 |
| Time per exposure | 10 min |
| Bits per pixel | 16 |
| Bits per Image | 46.4 |
| Exposure time per image | 40 min |
| Data generation rate | 2.4 MB/sec |
| Operation duty cycle (target) | 80% |
| Orbit period | 100 min |
| Data per orbit | 12 GB |
| Data per day | 172.8 GB |

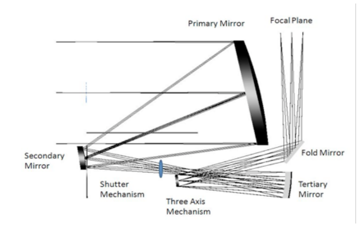


Figure 3. CASTOR's ***optical design*** features an off-axis primary mirror and a wide field of view with excellent quality. A shutter is located at an intermediate image plane, and a three-axis fine-steering mechanism sits at a pupil. This can take the form of either a plane mirror for imaging or a grating for slit-less spectroscopy.

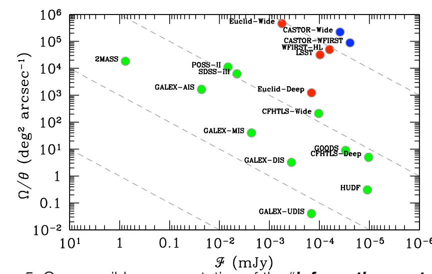


Figure 5. One possible representation of the "***information content***" of wide-field imaging surveys in the UV, optical and IR spectral regions. The abscissa gives the depth, F, of each survey in mJy while the ordinate shows the ratio Ω/θ, where Ω is the survey area in deg$^2$ and θ is the FWHM in arcseconds. Some notable past surveys are shown in green, while major upcoming surveys at red-optical or IR wavelengths are shown in red. Two possible CASTOR surveys are shown in blue (see Figure 7). Using this metric, either the CASTOR-Wide or CASTOR-WFIRST survey would have an information content equal to or greater than any other UV/optical/IR survey.

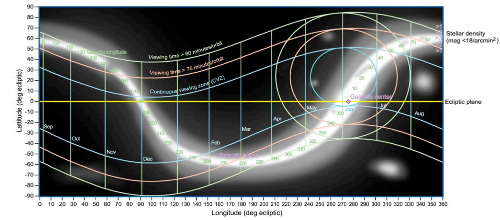


Figure 8. With the preferred ***polar terminator orbit***, CASTOR's observations would be concentrated in the anti-sun direction, as with ground-based astronomy. Solar panels are mounted on the sun side, angled to permit use at off-anti-sun angles to 40 deg. The continuous viewing zone is close to the anti-Sun direction for much of the year.