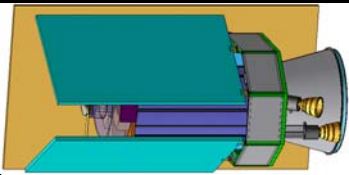




# Dark Universe Observatory (DUO)



DUO is a candidate for the US Small Explorer (SMEX) program with strong contribution from MPE; Phase A is already finished. Scientific goal is the precise measure of cosmological parameters through the 3d-distribution of a large sample of (X-ray detected) clusters of galaxies.

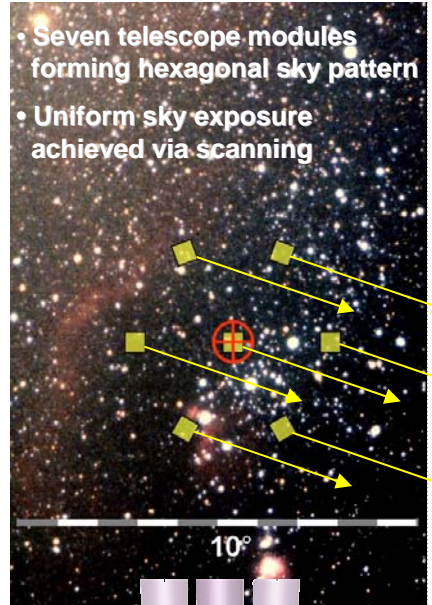
## Standard Cosmology (WMAP *et al.*):

- Flat, accelerating universe
- Early, rapid expansion (inflation)
- 73% Dark Energy, 23% Dark Matter, 4% gas, stars

## Dark Energy:

- is smoothly distributed – needs whole Universe to study it
- Conspires with Dark Matter to make Universe ‘flat’
- ‘Deceleration parameter’ is an acceleration, because Dark Energy dominates the universe
- Equation of state parameter: pressure vs. density  $P = w\rho$   
If  $w = -1$ , DE = Einstein’s ‘Cosmological constant’  
If  $w$  is more negative, Universe will rip apart (the ‘Big Rip’)

- Seven telescope modules forming hexagonal sky pattern
- Uniform sky exposure achieved via scanning



## Mission:

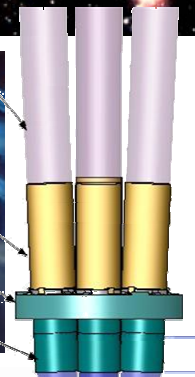
- DUO will perform an X-ray sky survey for clusters of galaxies
- X-ray data distinguishes clusters of galaxies from Active Galactic Nuclei or stars because clusters are spatially extended
- Optical identifications and redshifts will come from the Sloan Digital Sky Survey (Wide Field: 8,000 clusters) and DUO follow-up program (Deep Survey: 1,800 clusters)

## Instrument Performance:

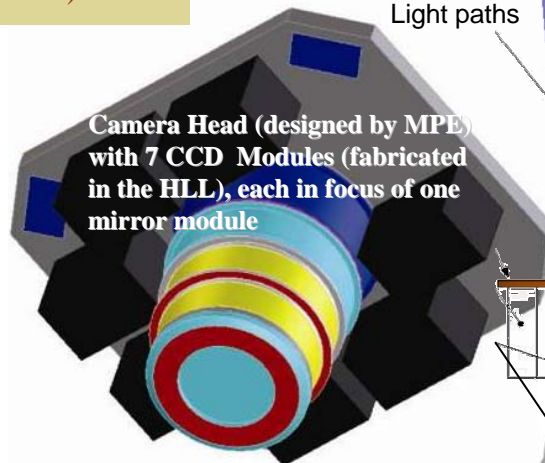
Camera and telescope will be tested and calibrated in the PANTER X-ray facility



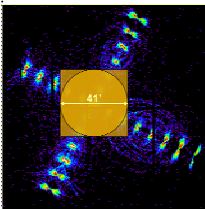
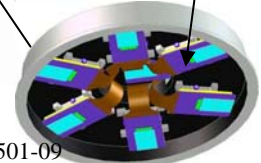
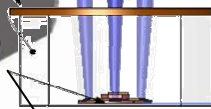
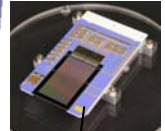
Zeiss mirrors are near duplicates of ABRIXAS



Light paths



Camera Head (designed by MPE) with 7 CCD Modules (fabricated in the HLL), each in focus of one mirror module



## References:

- Griffith et al. 2004, “The Dark Universe Observatory”, SPIE 5488-13
- Friedrich et al. 2004, “The Dark Universe Observatory (DUO): telescope concept”, SPIE 5488-44
- Meidinger et al. 2004, “CCD-detector development for the DUO and ROSITA Mission”, 2004, SPIE 5501-09
- Pfeffermann et al. 2004, “Shielding of cosmic ray induced background in CCD detectors for X-ray astronomy”, SPIE 5501-39

The DUO team