Chandra Synergies Panel Discussion: NuSTAR, Euclid and WFIRST

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Chandra Science for the Next Decade
Cambridge

NuSTAR

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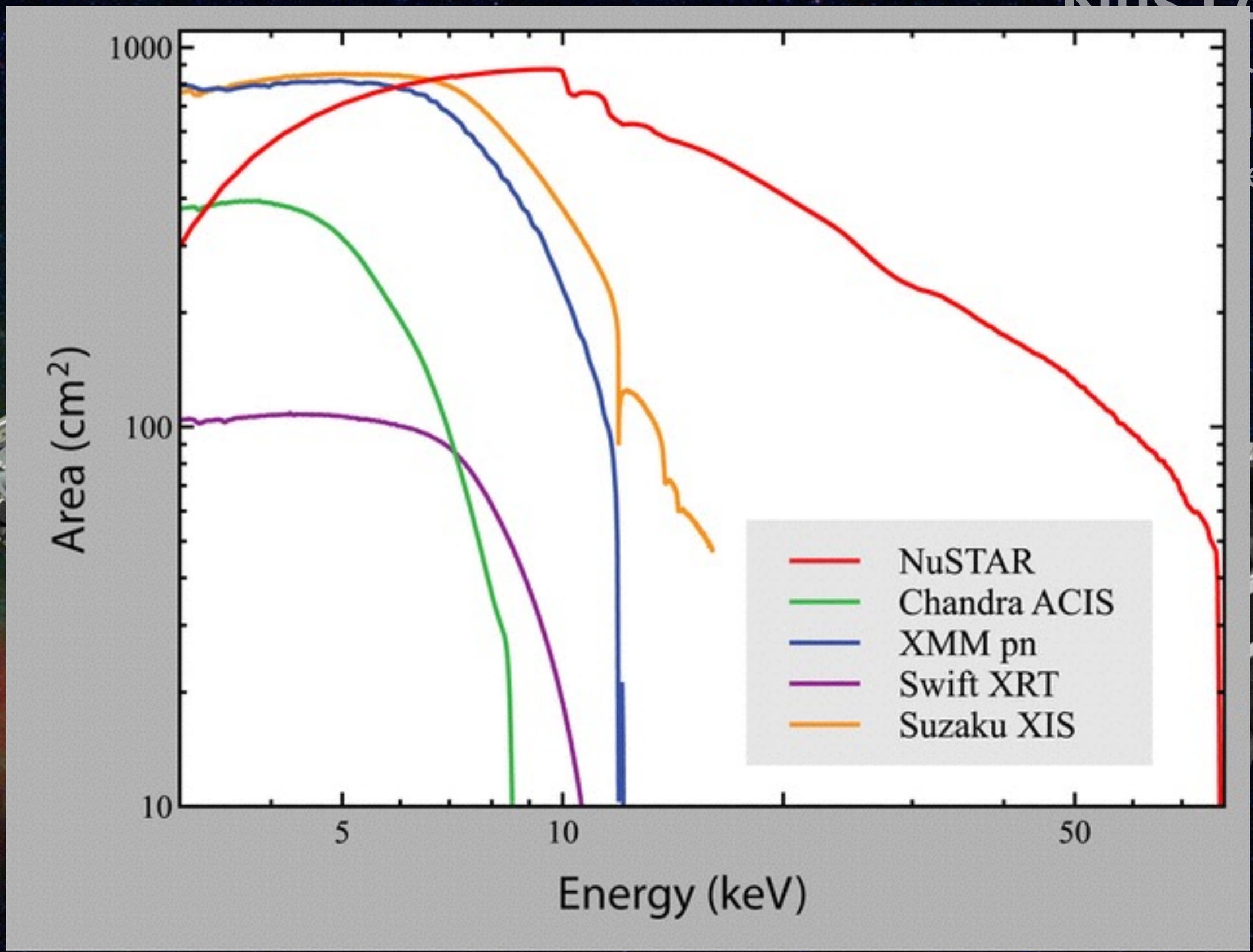
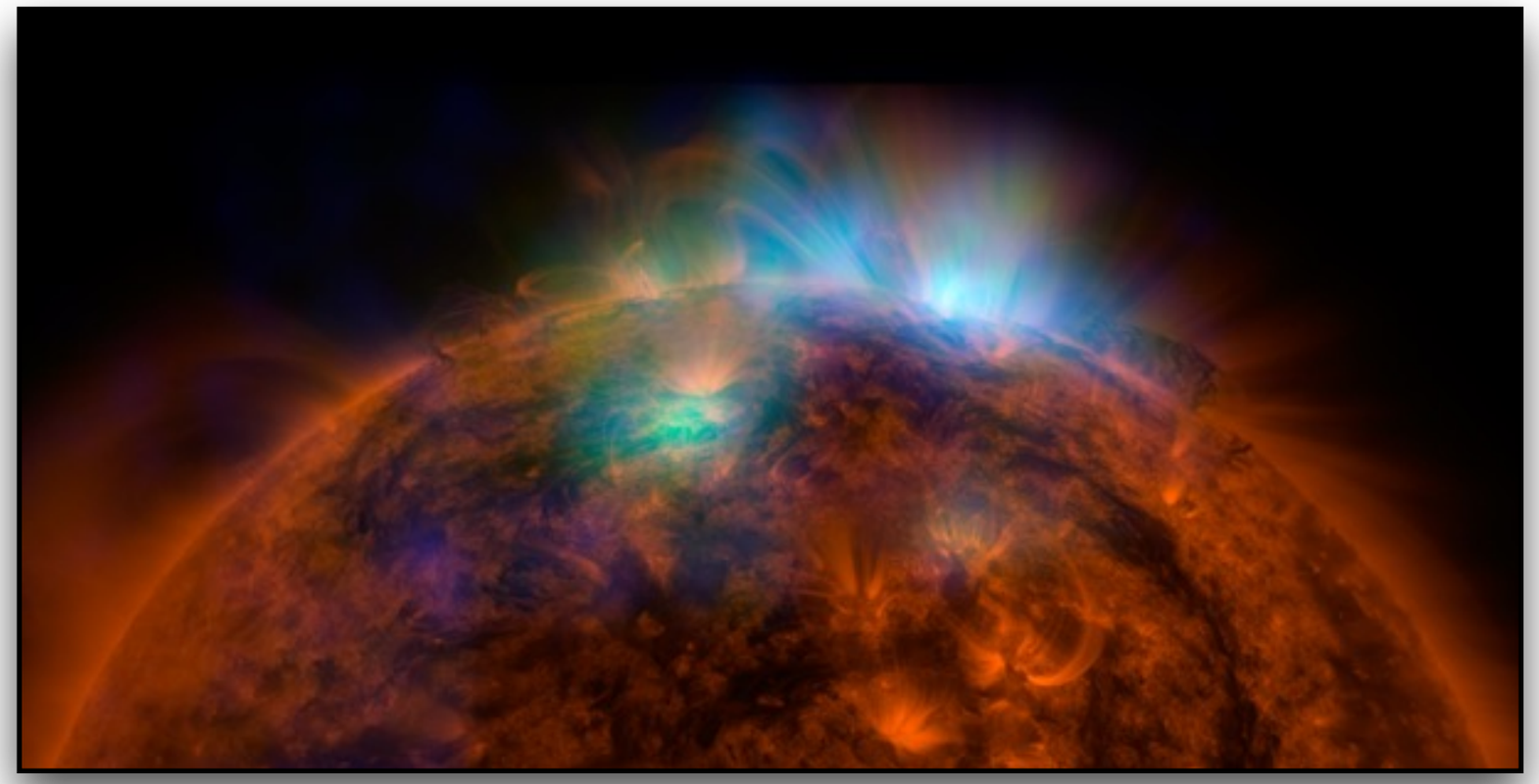


Chandra - NuSTAR Joint Observations

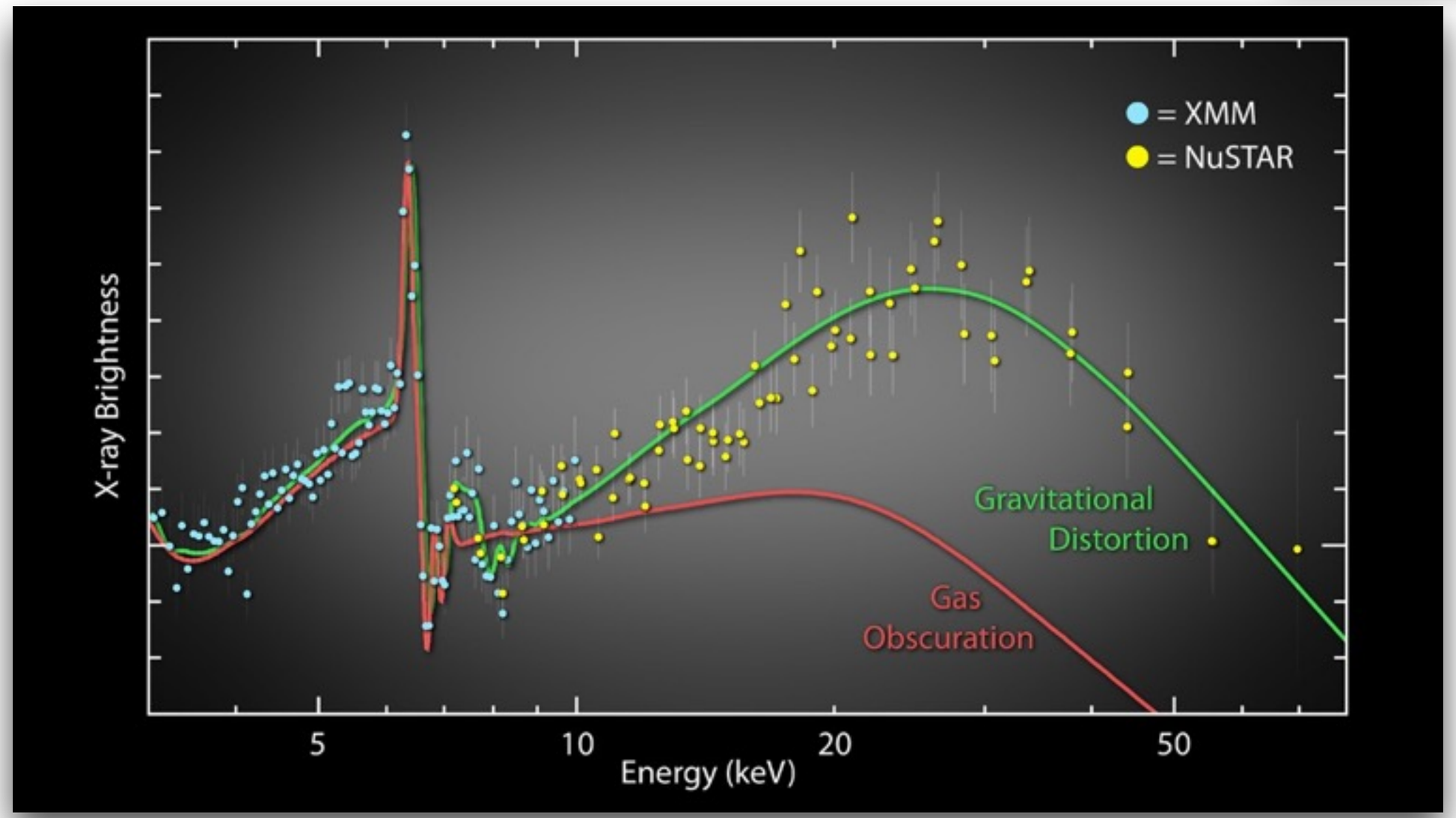
- strong case for scientific synergies given the complimentary in energy range
  - most oversubscribed Chandra joint program in last cycle; NuSTAR allocated 500 ks for last two cycles, and ended up giving extra time
- note coordination is easy given NuSTAR's flexible pointing constraints
- data rights



Chandra - NuSTAR Joint Observations

Examples:

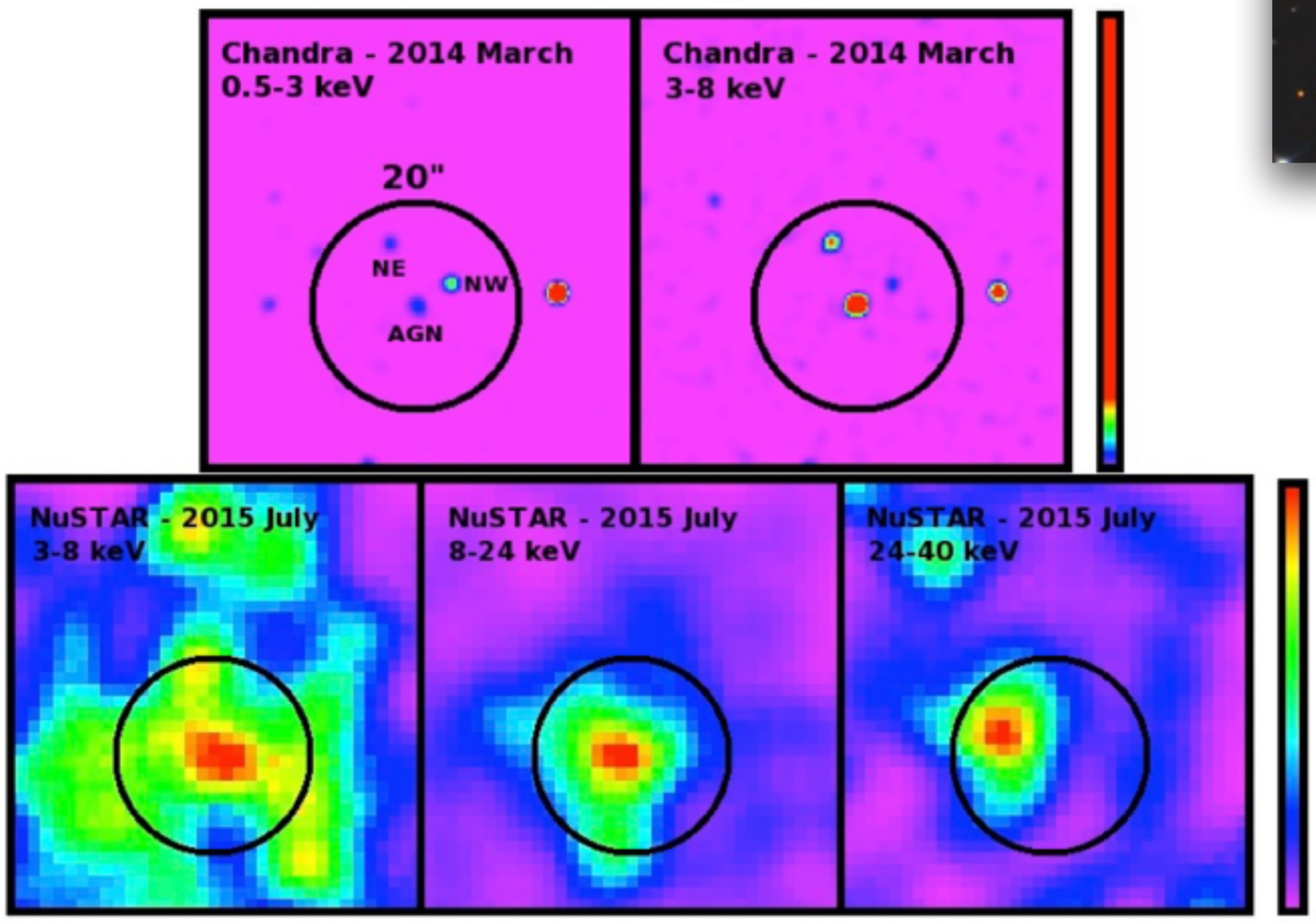
- NGC 3783 (Seyfert 1) with Chandra/HETG + NuSTAR to measure the spin of the supermassive black hole (P.I. L. Brenneman)



Chandra - NuSTAR Joint Observations

Examples:

- studying nearby AGN — taking advantage of the spatial resolution of Chandra with higher energy coverage of NuSTAR



Annuar et al., ApJ, submitted

Chandra - NuSTAR Joint Observations

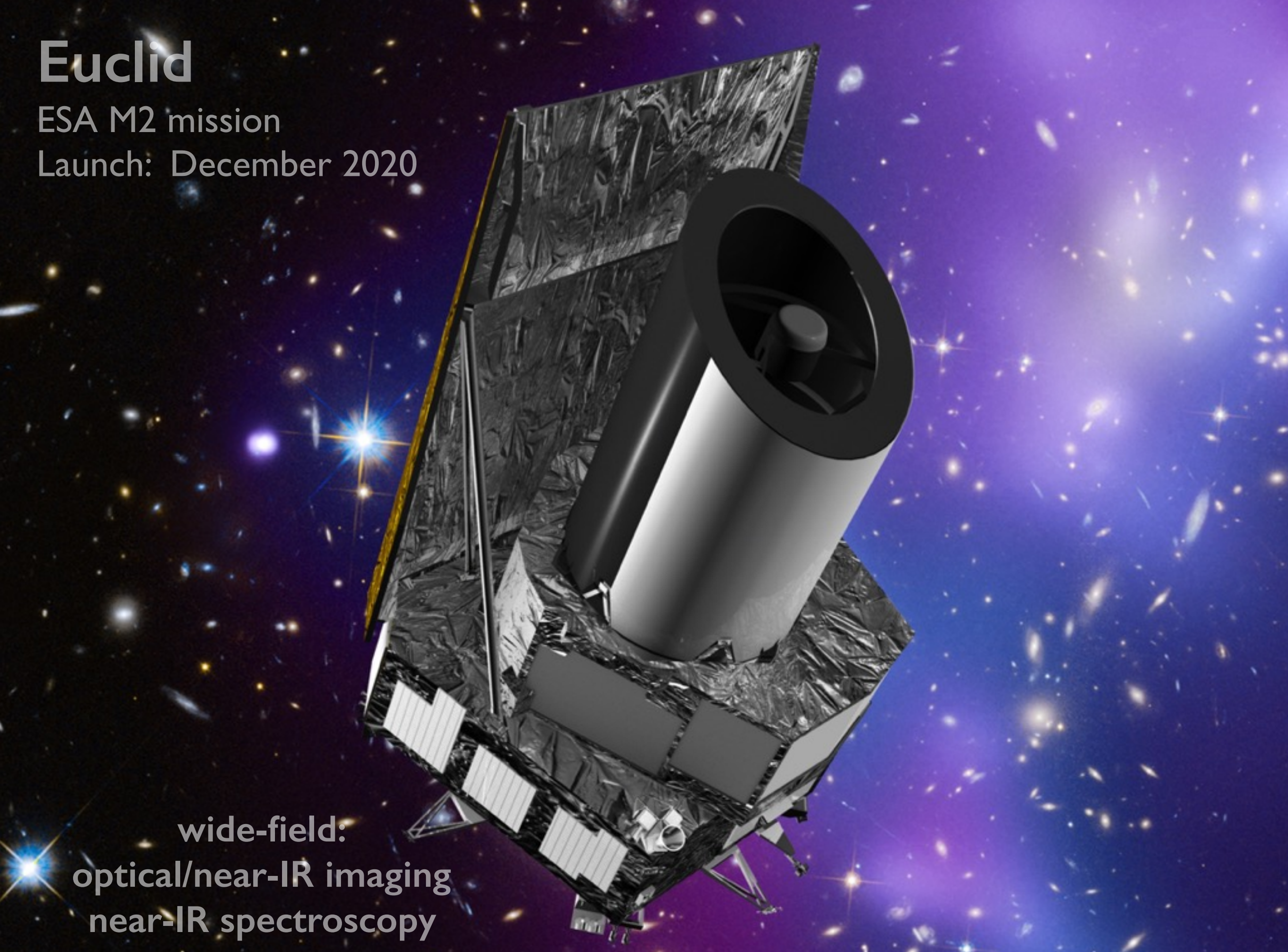
Examples:

- NGC 3783 (Seyfert 1) with Chandra/HETG + NuSTAR to measure the spin of the supermassive black hole (P.I. L. Brenneman)
- 3C 111 (FRII radio galaxy): jet variability and broad-band spectrum (P.I. Eric Perlman)
- nearby strongly interacting supernova to map temperature and spectral evolution, thereby learning about explosion physics and swept-up mass (P.I. Raffaella Margutti)
- Orion nebula to learn about energetic coronal flares in pre-main sequence stars (P.I. Hans Moritz Guenther)
- ToO program to study winds, jets, and state transitions in Galactic black hole binary transient (P.I. Joey Neilsen)
- ESO 121-G6 + NGC 1792: towards a complete census of Compton-thick AGN in the local Universe (P.I. Ady Annuar)
- ToO program to study magnetic fields and accretion geometry in Galactic high magnetic field accreting pulsar (P.I. Mark Reynolds)
- HESS J1731-381 magnetar (P.I. Jules Halpern)
- M31 (P.I. Ann Hornschemeier)
- identifying NuSTAR sources/transients (P.I. John Tomsick)
- obscured dual AGN (P.I. Shobita Satyapal)

Euclid

ESA M2 mission

Launch: December 2020

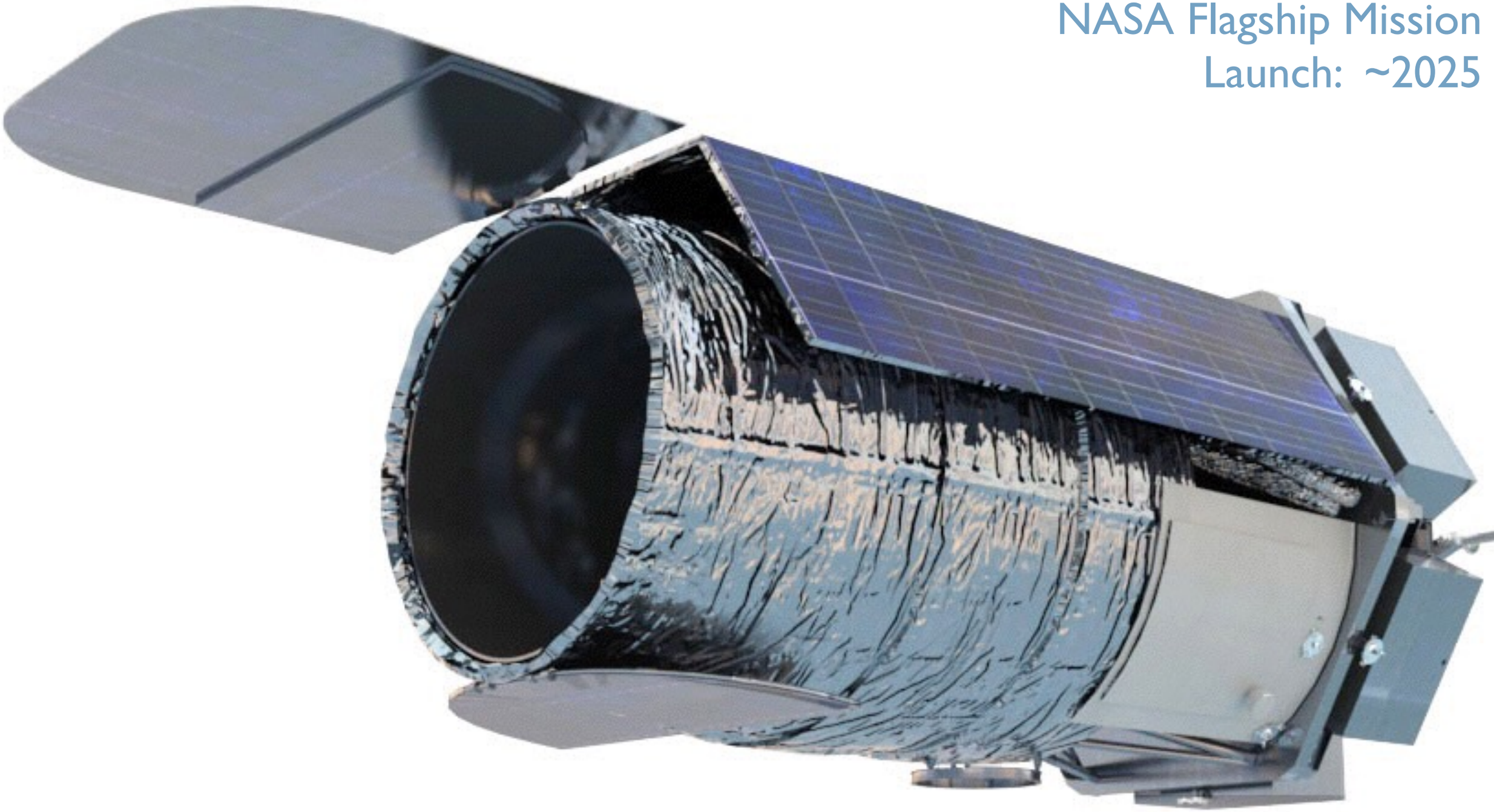


wide-field:
optical/near-IR imaging
near-IR spectroscopy

WFIRST

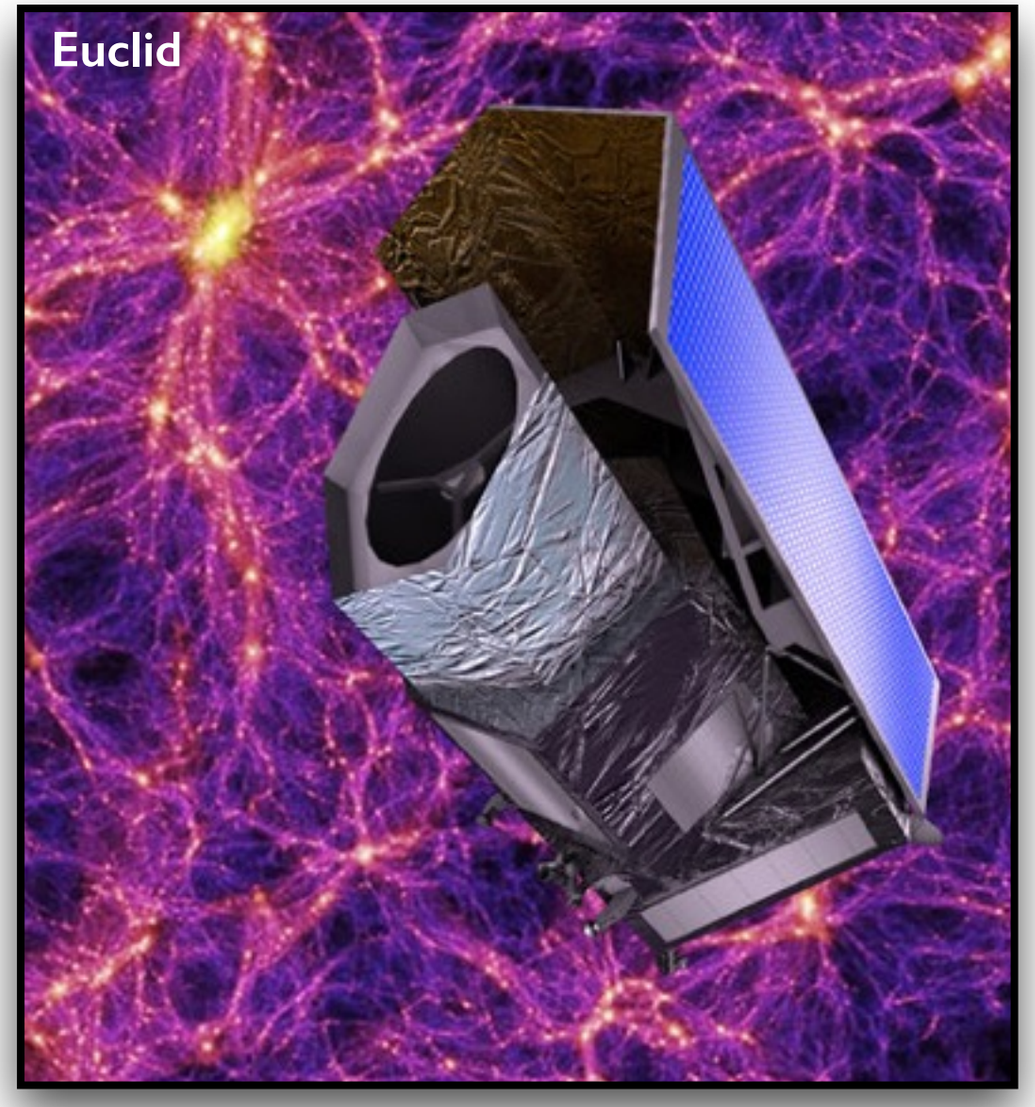
NASA Flagship Mission

Launch: ~2025



wide-field:
near-IR imaging
near-IR spectroscopy
+ coronagraph (& starshade?)

Euclid compared to WFIRST

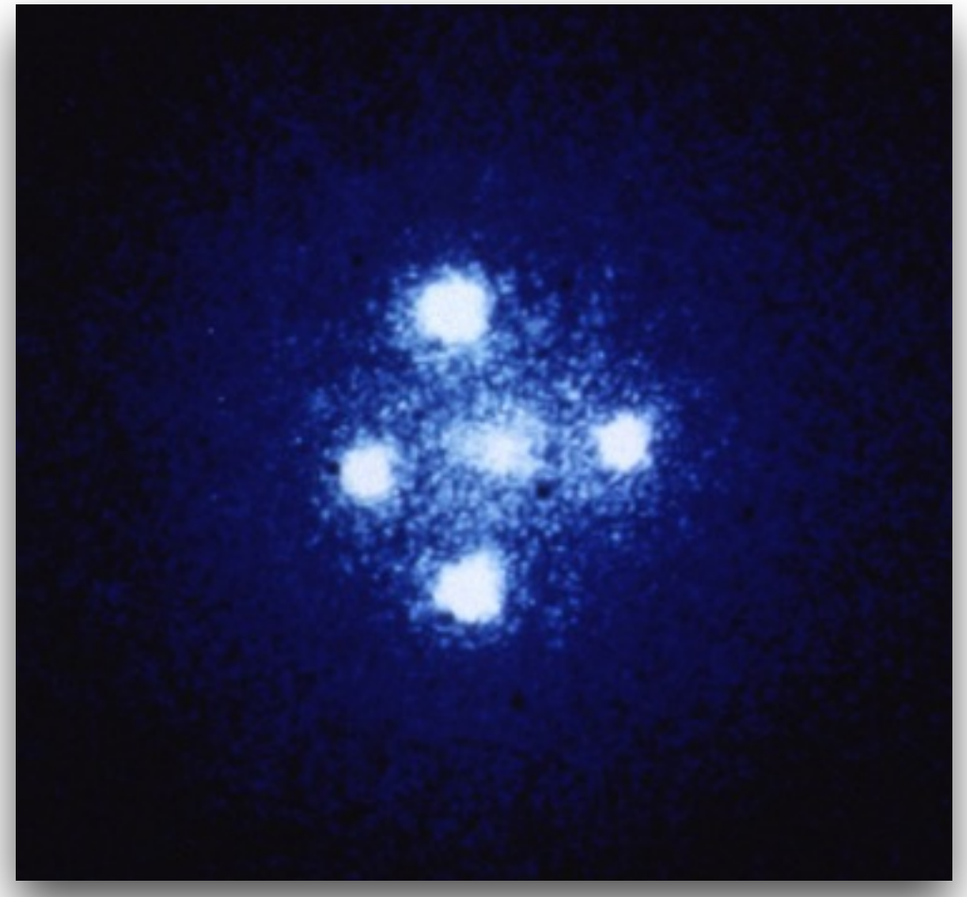


1.2 m aperture
0.55 sq.deg. FoV
cosmology
main survey: 15,000 deg^2 to 24 mag (near-IR)

2.4 m aperture
0.28 sq.deg. FoV
cosmology + exoplanets + GO program
main survey: 2400 deg^2 to 27 mag (near-IR)

Chandra - Euclid/WFIRST Joint Observations

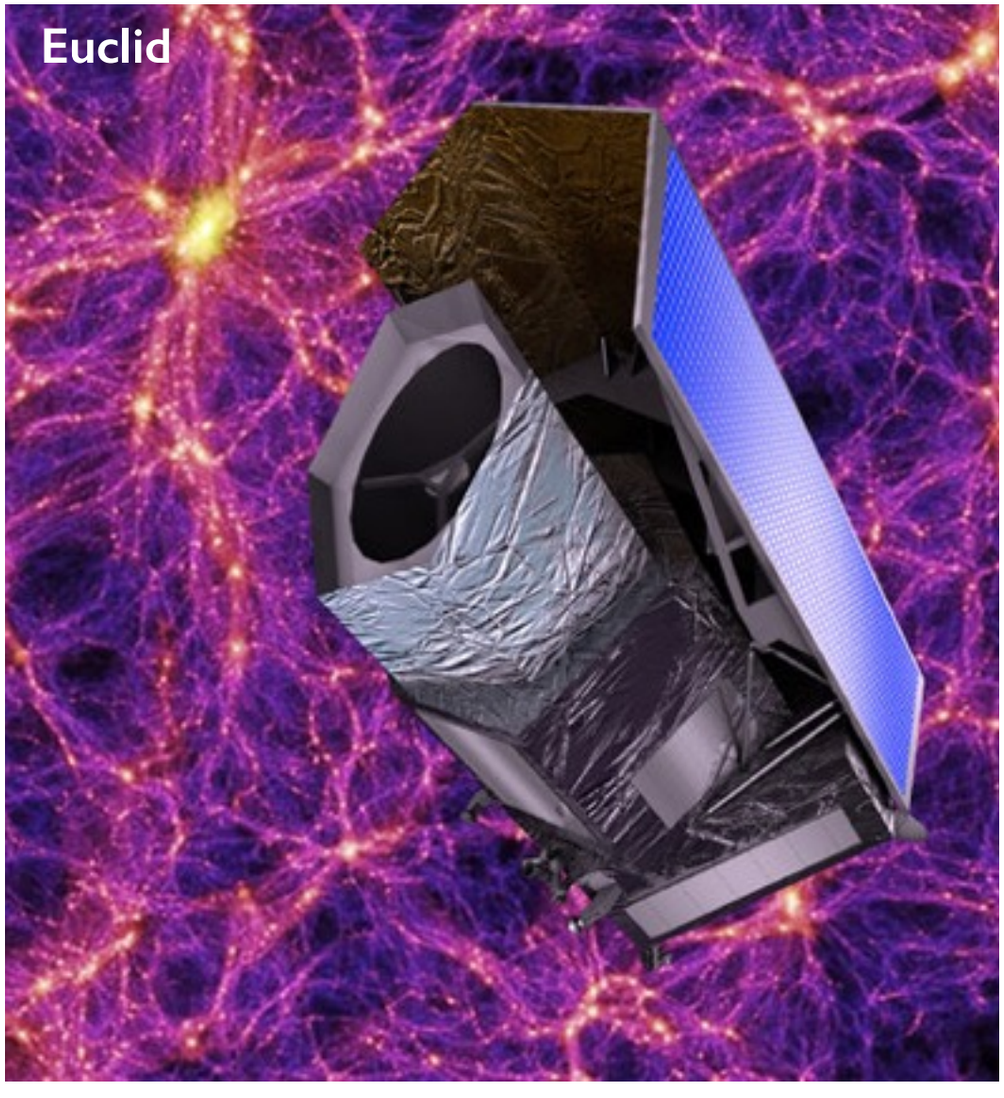
- synergies probably mostly for follow-up / preparatory observations (e.g., in the deep calibration fields), not coordination
- these missions are expected to find >1000 quasars at z>7, and ~20 at z>10 (mainly in the wide surveys)
- many gravitational lenses expected as well



Backup Slides

WFIRST-AFTA / Euclid comparison

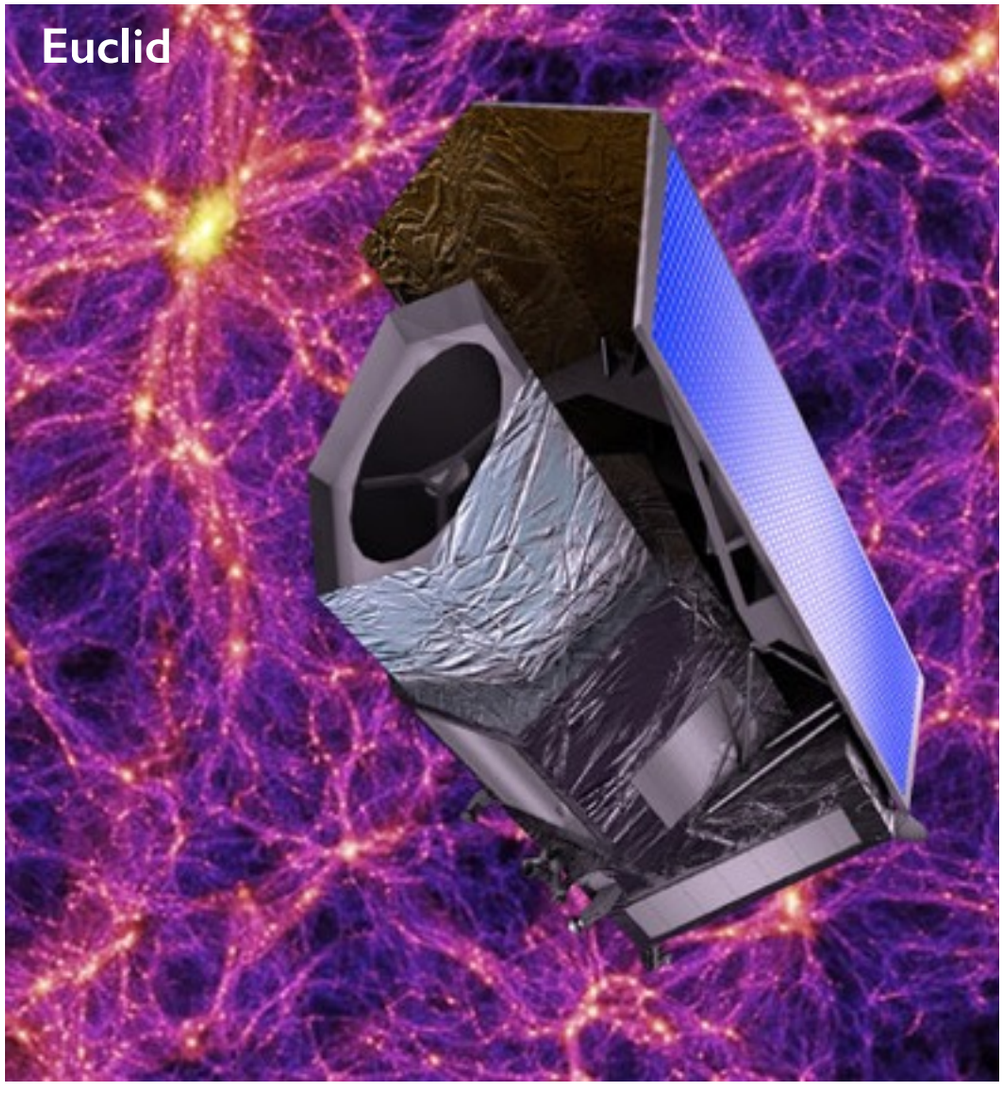
2.4 m TMA ("AFTA")
18 H4RG detectors
0.7 - 2.0 micron bandpass
0.28 sq. deg FoV
4 filter imaging + grism spectroscopy
6 yr. baseline mission



1.2 m TMA
36 4kx4k CCDs + 16 H2RG detectors
0.55 - 2.0 micron bandpass
0.55 sq. deg FoV
4 filter imaging + grism spectroscopy
6 yr. baseline mission

WFIRST-AFTA / Euclid comparison

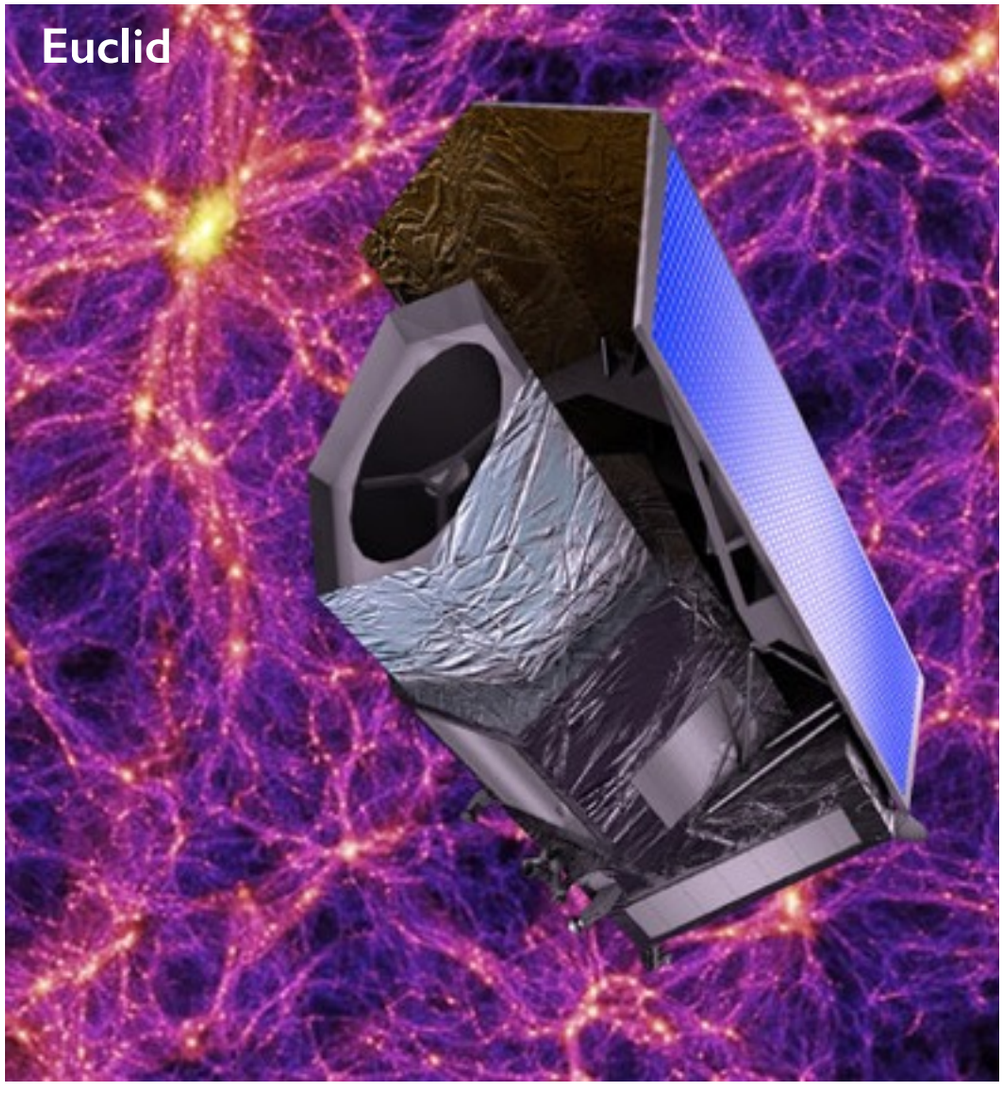
0.11” / pix
wide survey: 2400 sq. deg., ~27 mag (near-IR)
R~600 grism + R~100 IFU
grism survey depth: 3e-17 erg/cm2/s (3.5σ)



0.10” / pix (optical); 0.30” / pix (near-IR)
wide survey: 15,000 sq. deg., ~24 mag (near-IR)
R~250 grism
grism survey depth: 3e-16 erg/cm2/s (3.5σ)

WFIRST-AFTA / Euclid comparison

cosmology
infrared survey science
microlensing exoplanet survey
(coronography survey?)
guest observer (GO) program: 25% of time



cosmology
optical + infrared survey science
(no microlensing survey or GO program)

WISE (Wide-Field Infrared Survey Explorer)

NASA Mid-sized Explorer (MidEx)

42 cm mirror; polar orbit

Launch date: 2009 Dec 14

Initial survey: 2010 Jan 14 - 2011 Feb 1

Survey resumed: 2013 Dec 23

All-sky survey:

3.4, 4.6, 12, 22 um (W1-W4)

~750 M sources catalogued

Spitzer Space Telescope

NASA Infrared Flagship

Launch date: 2003 August 25

85 cm mirror; Earth-trailing orbit

Pointed observations at 3.6 to 160 um