Concluding remarks

Exoplanets, asteroids, neutron stars

Comparison of telescopes for small fields

pixel²/area

Table 1

	eff. area	⟨FoV⟩	pixel size	PM "time" for EPs
unit	m^2	arcmin	milli-arcsec	$mas^2/m^2/100$
HST/WFC3	4	2.7	40	4.00
HST/ACS	4	3.5	50	6.25
Gaia	0.7	60	59	49.73
JWST/NIRCAM	25	2.2	70	1.96
Euclid/VIS	**1.0**	**45**	**100**	100.00
Rubin/LSST	35	210	200	11.43
Xuntian	4	63	80	16.00
Roman/WFI	4.5	32	110	26.89
JASMINE	0.13	33	400	12307.69
Gaia-NIR	1.575	90	88.5	49.73
Theia	**0.5**	**30**	**64**	81.92
HWO/UVIS	**32**	**2.5**	**8.6**	**0.02**
HWO/NIR	**32**	**2.5**	**17.3**	**0.09**

HWO is clear winner!

Exoplanets, asteroids, neutron stars

Chas Beichman

HWO should be able to reach 0.3 *μ*as/yr
despite only ~15 Gaia ref stars in 2.5 arcmin FoV

Theia only 2 *μ*as/yr with ~260 Gaia ref stars in 30 arcmin FoV

Positional drift from Gaia (2020±5) to HWO and/or Theta (2045±5)
—> requires Gaia-NIR

Large-field science

Nature of dark matter

- internal kinematics of dwarf spheroidals — Vitral, Read, Watkins
- shape of MW halo w hypervelocity stars — Gnedin
- subhalos (MW blind searches; strong lensing by clusters) — Read, Nierenberg
- ultra-light DM — Kim

Milky Way astrophysics — Katz

Star clusters

- cores of globular clusters — Watkins
- expansion of open clusters — Pfalzner

Stellar-mass black holes

- globular clusters
- in binaries — Poshak, Lu
- free-floating

Gravitational waves

- individual sources
- stochastic — Garcia-Bellido, Crosta, Chen

"a handful of accelerations teaches us as much as 1000 PMs!" Read

Particle physics

- parity violation — Caravano

Chakrabarti, Darling

Cosmology

- H_0 & much more with astrometic accelerations

Comparison of telescopes for large fields

pixel²/area | pixel²/area/FoV²

Table 1

	eff. area	⟨FoV⟩	pixel size	PM "time" for EPs	PM "time" wide fields
unit	m^2	arcmin	milli-arcsec	$mas^2/m^2/100$	$mas^2/(arcmin^2\ m^2)$
HST/WFC3	4	2.7	40	4.00	54.87
HST/ACS	4	3.5	50	6.25	51.02
Gaia	0.7	60	59	49.73	1.38
JWST/NIRCAM	25	2.2	70	1.96	40.50
Euclid/VIS	**1.0**	**45**	**100**	100.00	**4.94**
Rubin/LSST	35	210	200	11.43	0.03
Xuntian	4	63	80	16.00	0.40
Roman/WFI	4.5	32	110	26.89	2.63
JASMINE	0.13	33	400	12307.69	1130.18
Gaia-NIR	1.575	90	88.5	49.73	0.61
Theia	**0.5**	**30**	**64**	81.92	**9.10**
HWO/UVIS	**32**	**2.5**	**8.6**	**0.02**	**0.37**
HWO/NIR	**32**	**2.5**	**17.3**	**0.09**	**1.50**

LSST is best, then HWO & Xuntian, then Gaia-NIR, then Gaia, then Roman

Large-field science

Euclid/VIS ~ 2✕ more efficient than Theia!

could observe 3 dSphs + 3 globular clusters in 2500 hours
= **6% of time after end of Wide survey**

HWO (with mosaicing) ~ 25✕ more efficient than Theia!
so what if we do a 12x12 mosaic?

full Theia science can be done in:
- **1.8 years of HWO (0.45 years of HWO with 2x wider FoV)**

Goals of workshop

What scientific breakthroughs with very high precision astrometry?

many!

What telescopes & instruments to achieve these scientific results?

many! e.g. HWO w Gaia-NIR

Strategic questions:

- focus on a single telescope OR go for many? Gaia-NIR + HWO
- combine all science OR split exoplanets around nearby stars from rest?
  HWO can do both
- federate scientists from ≠ continents or work separately?
  federate!

Strategies

ESA: Gaia-NIR — complementary ~ synchronous — NASA: HWO — Beichman

ESA: Gaia-NIR — tesselation (instead of scanning) to permit long pointed observations — Vitral, Lattanzi

but cannot do EPs around nearby stars!

Thanks to:

Scientific Organizing Committee

for recommending such great scientists-speakers

Local Organizing Committee

- Emily DIOMAT (IAP)
- Christophe GOBET (IAP)
- Céline LAVET (Grenoble)
- Ketia MUSAU (IAP)
- Nadia NDIBU (IAP)
- Marie-Hélène SZTEFEK (Grenoble)

+ Jean MOUETTE for workshop photo

Fabien MALBET for co-organizing with me in great harmony