

SKA & SKA Japan



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Kumamoto University
2014/10/31

1、Square Kilometre Array

Square Kilometre Array

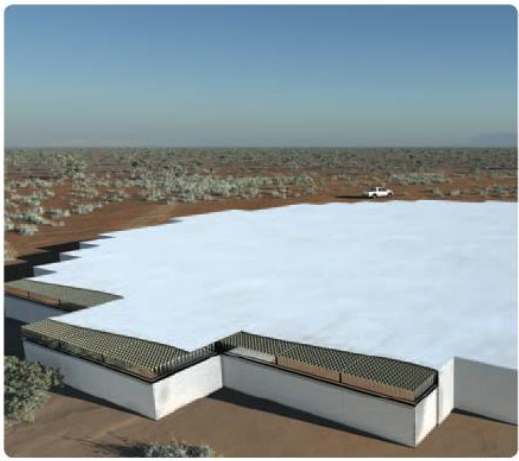
next generation cm-m radio telescope

- high sensitivity, wideband, large FoV, high resolution
- 50-350MHz (SKA-low), 0.35-10GHz (SKA-mid)
- baseline: 3000km
- site: Australia (SKA-low), South Africa (SKA-mid)
- member: Australia, Canada, China, Germany, India
Italy, Netherland, New Zealand, South Africa
Sweden, UK
(Portugal, Spain)

→ number of sources: $\times 100$

sensitivity: JVLA $\times 40$

survey speed: JVLA $\times 10^4$



Dense
Aperture Arrays

Dishes

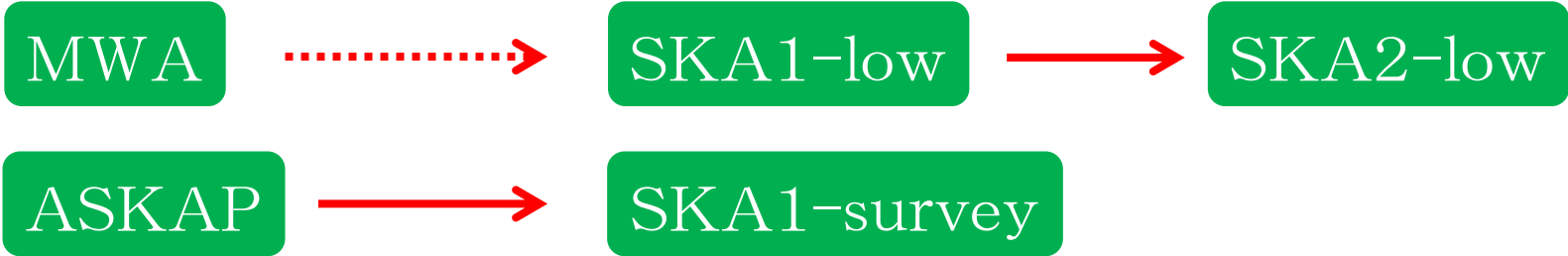
Sparse
Aperture Arrays

SKA Central Region



precursors

Australia



South Africa



timeline

SKA phase 1

- 2018- construction
- 2020- early science
- Sparse Aperture Array
+ Dish
- EoR, pulsar, cosmology



SKA phase 2

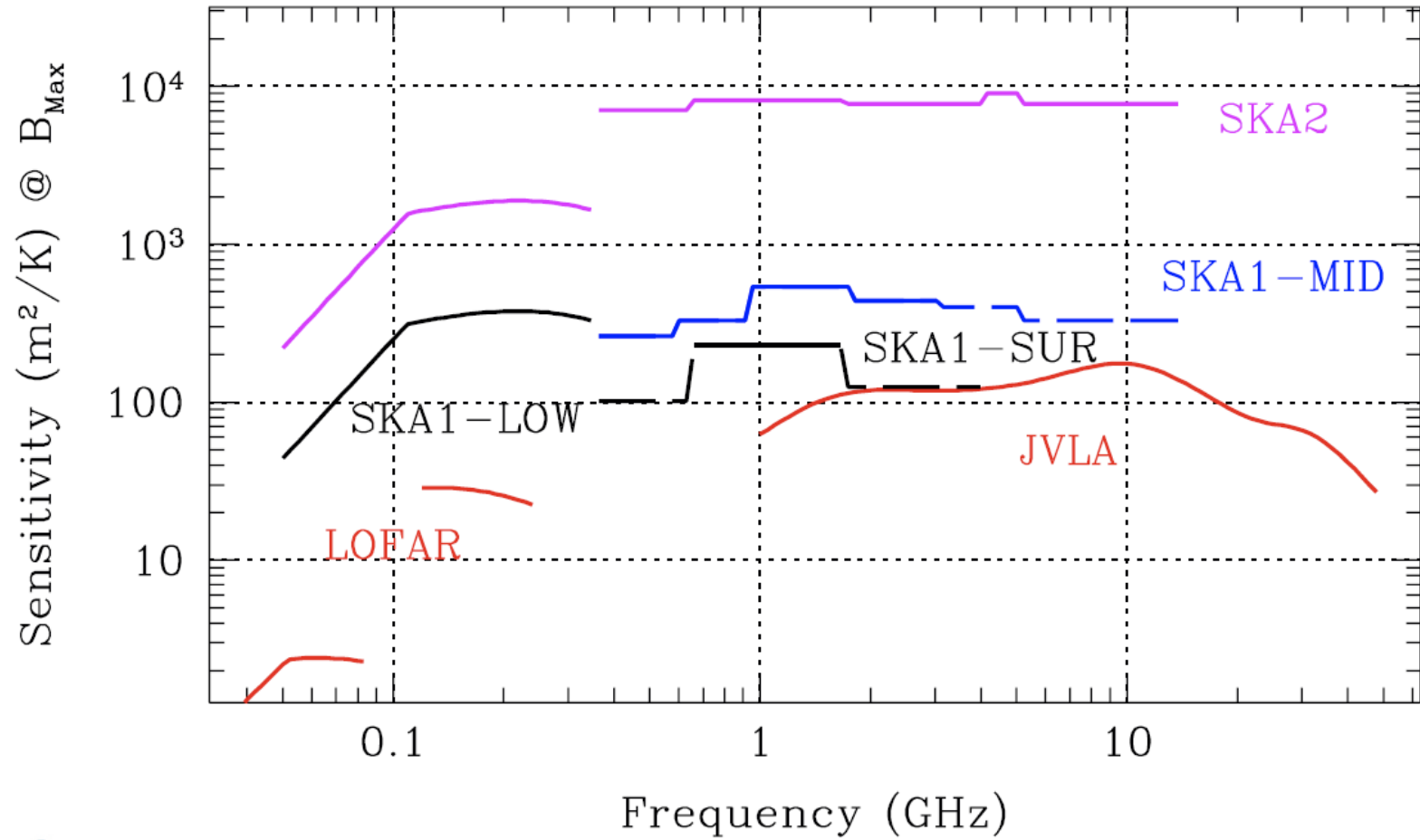
- 2023- construction?
- 202?- observation
- AIPを取り入れる



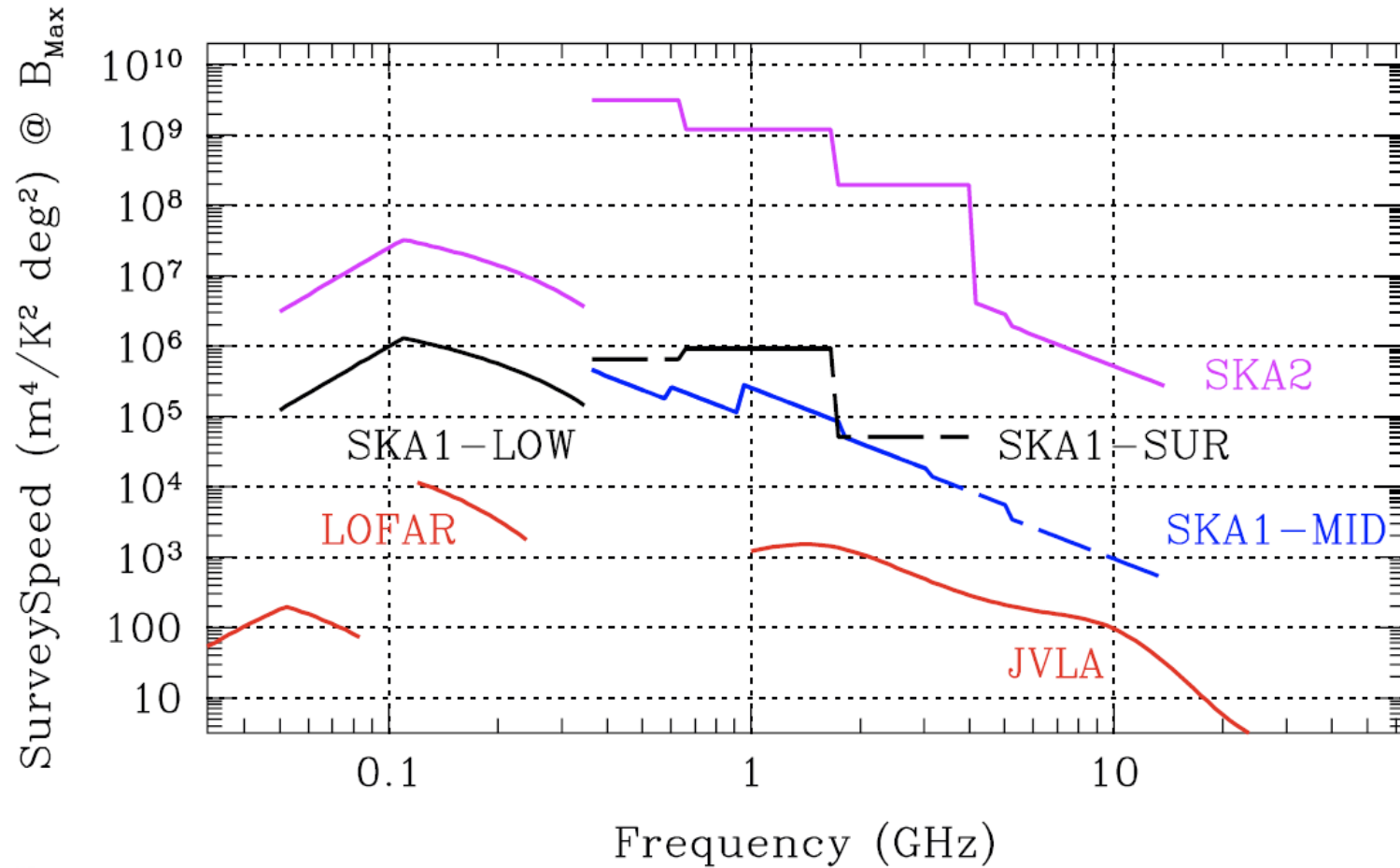
Advanced Instrumentation Program

- Dense Aperture Array
- Ultra-Wideband Single-Pixel Feed

sensitivity



survey speed



SKA Key Science

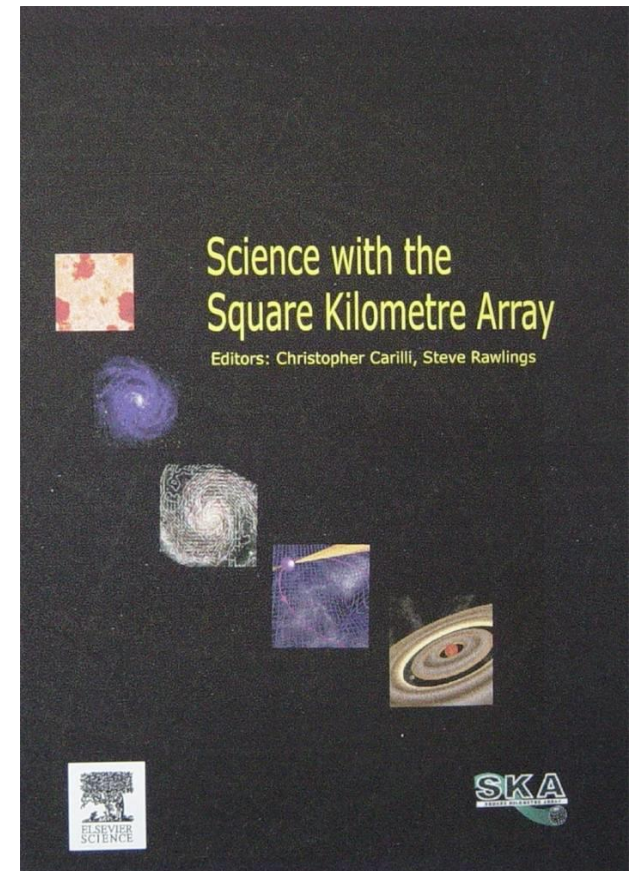
Key Science

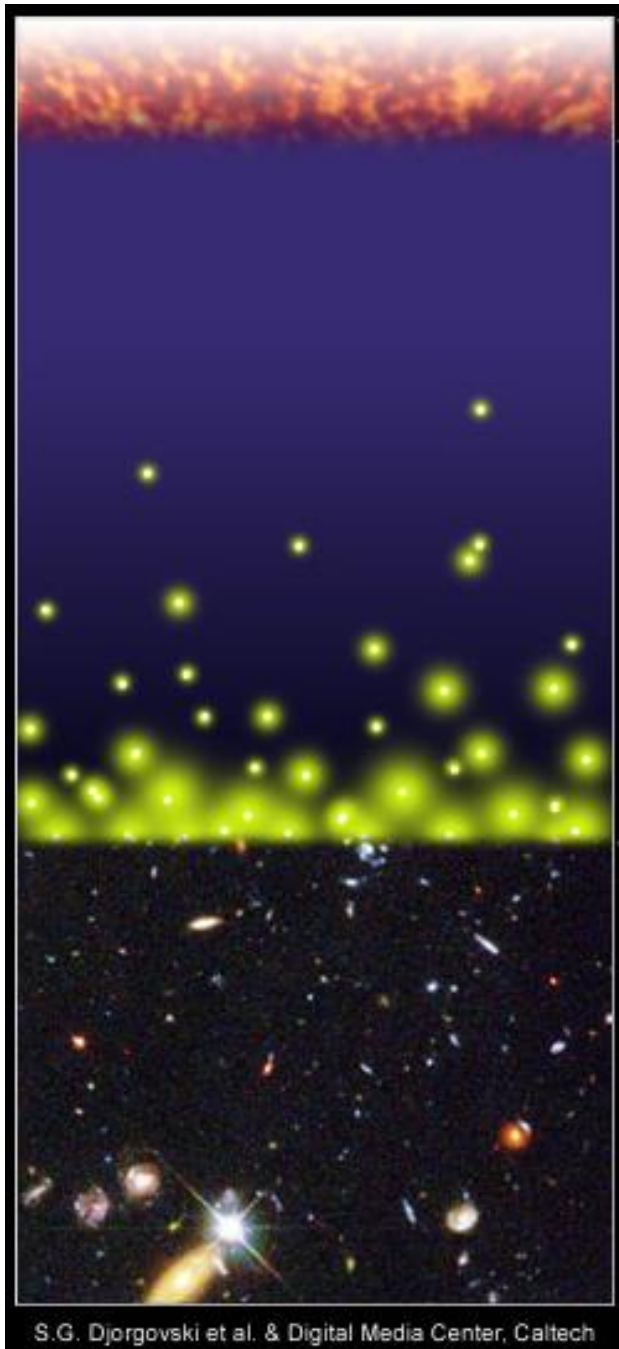
- Dark Age and Epoch of Reionization
- Gravity Tests with Pulsars
- Cosmology
- HI Survey
- Continuum Survey
- Transients
- Cradle of Life

Science with the Square Kilometre Array
(2004, eds. Carilli & Rawlings, *New Astron. Rev.*, 48)



Now Updating





S.G. Djorgovski et al. & Digital Media Center, Caltech

inflation \rightarrow density fluctuations
 $z=1100$ recombination

dark age

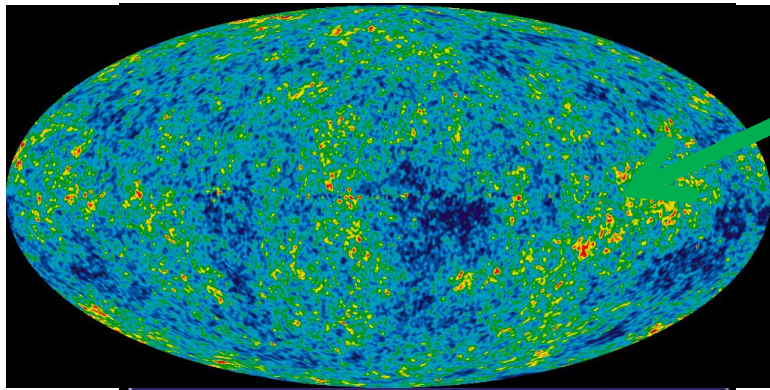
$z \sim 30$ cosmic dawn
first object formation

$z \sim 10$ reionization

$z \sim 6$ completion of reionization

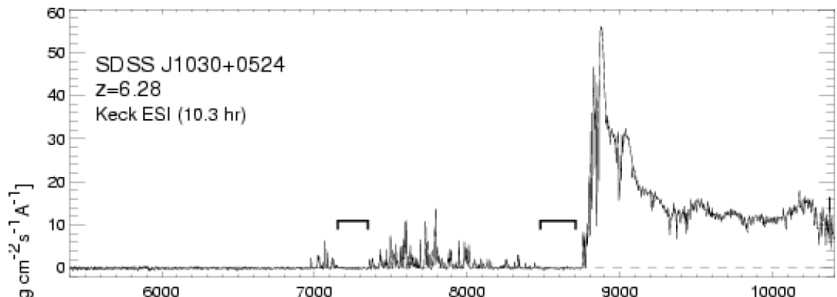
galaxy evolution

$z \sim 1$
large-scale structure
dark energy



inflation → density fluctuations
 $z=1100$ recombination

dark age

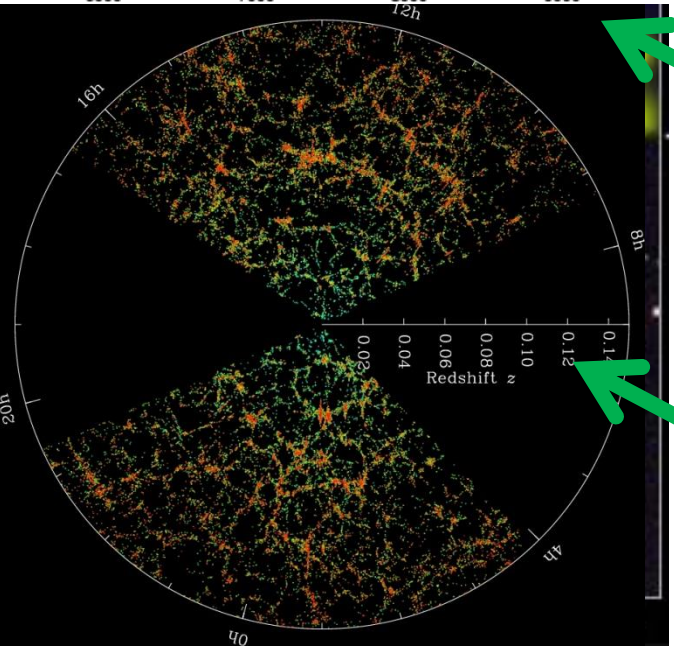


$z \sim 30$ cosmic dawn
 first object formation

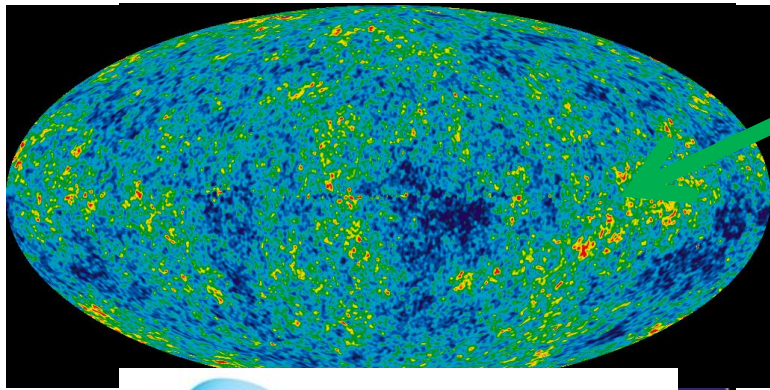
$z \sim 10$ reionization

$z \sim 6$ completion of reionization

galaxy evolution



$z \sim 1$
 large-scale structure
 dark energy



inflation \rightarrow density fluctuations
 $z=1100$ recombination

dark age

$z \sim 30$ cosmic dawn
first object formation

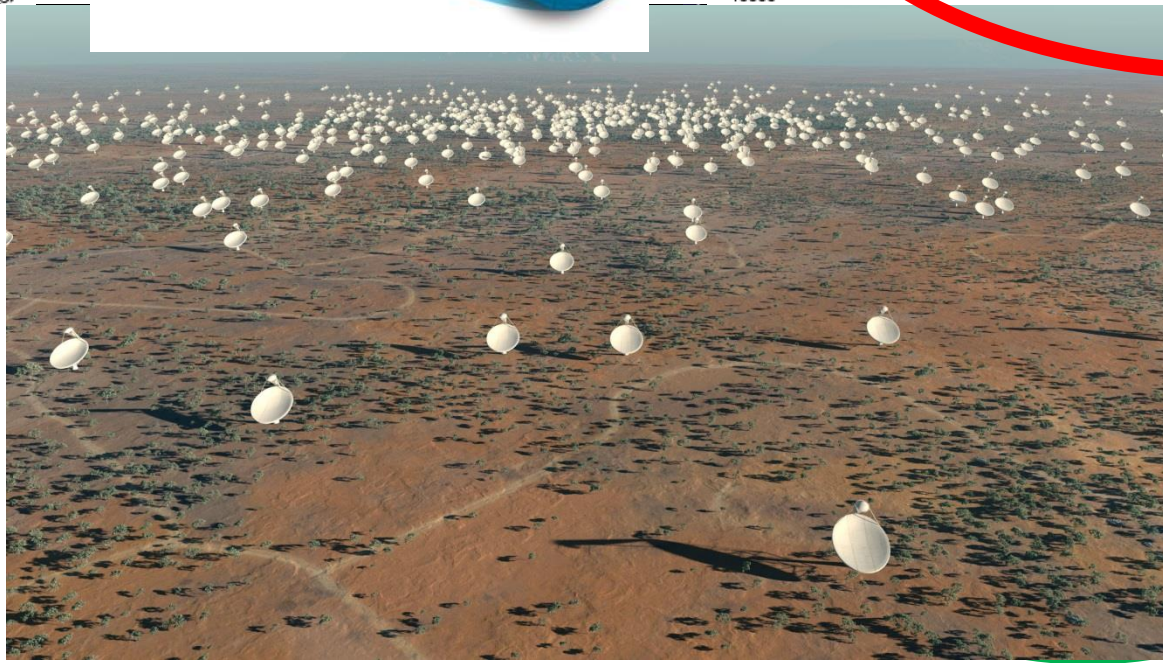
$z \sim 10$ reionization



completion of reionization

evolution

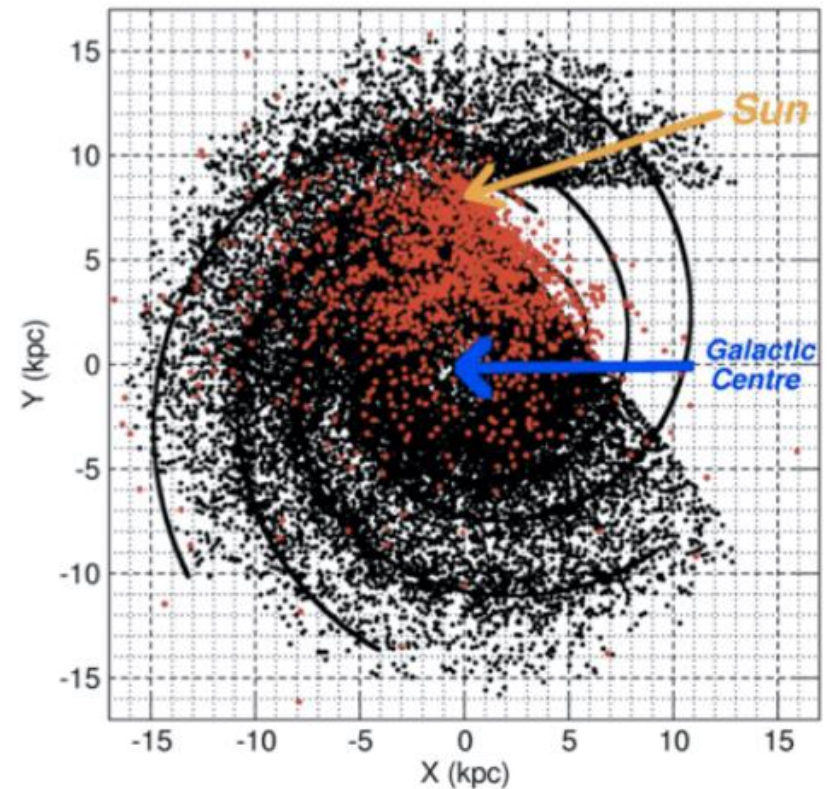
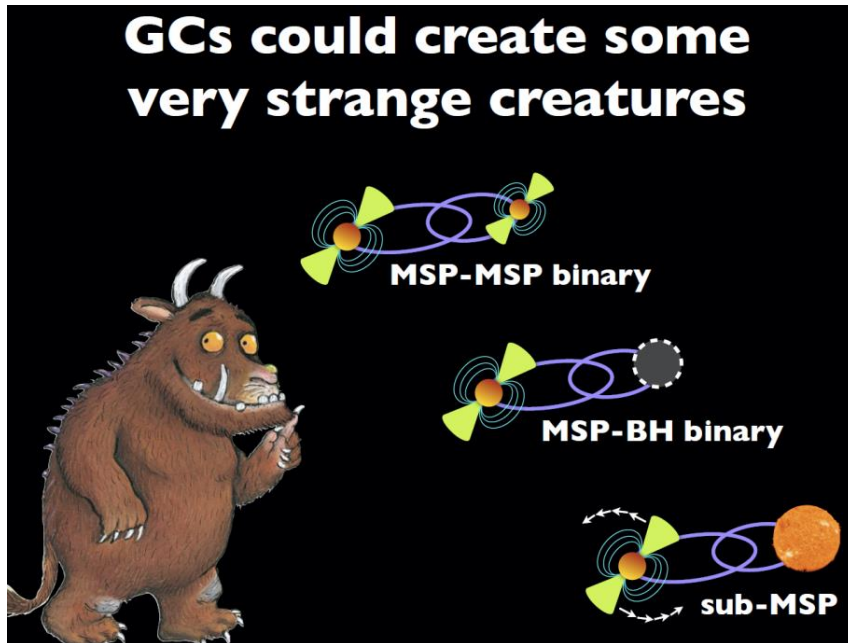
large scale structure
cosmology



SKA pulsar survey

SKA1 all-sky survey

- 30,000 normal pulsars
- 3,000 millisecond pulsars
- 100 relativistic binaries
- first pulsar at Galactic Center
- first pulsar in extragalaxy



gravitational wave

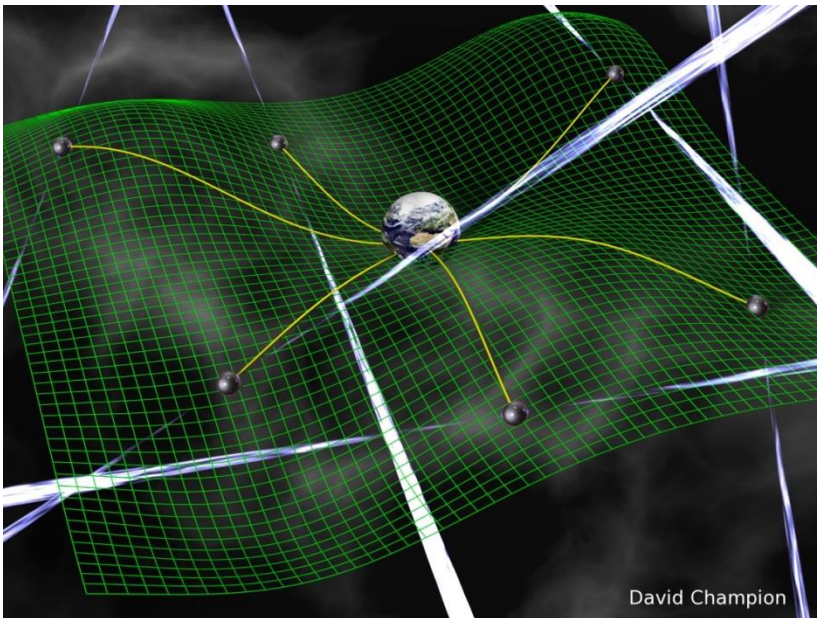
gravitational wave

→ distance change

frequency $\sim (1 \text{ yr})^{-1}$

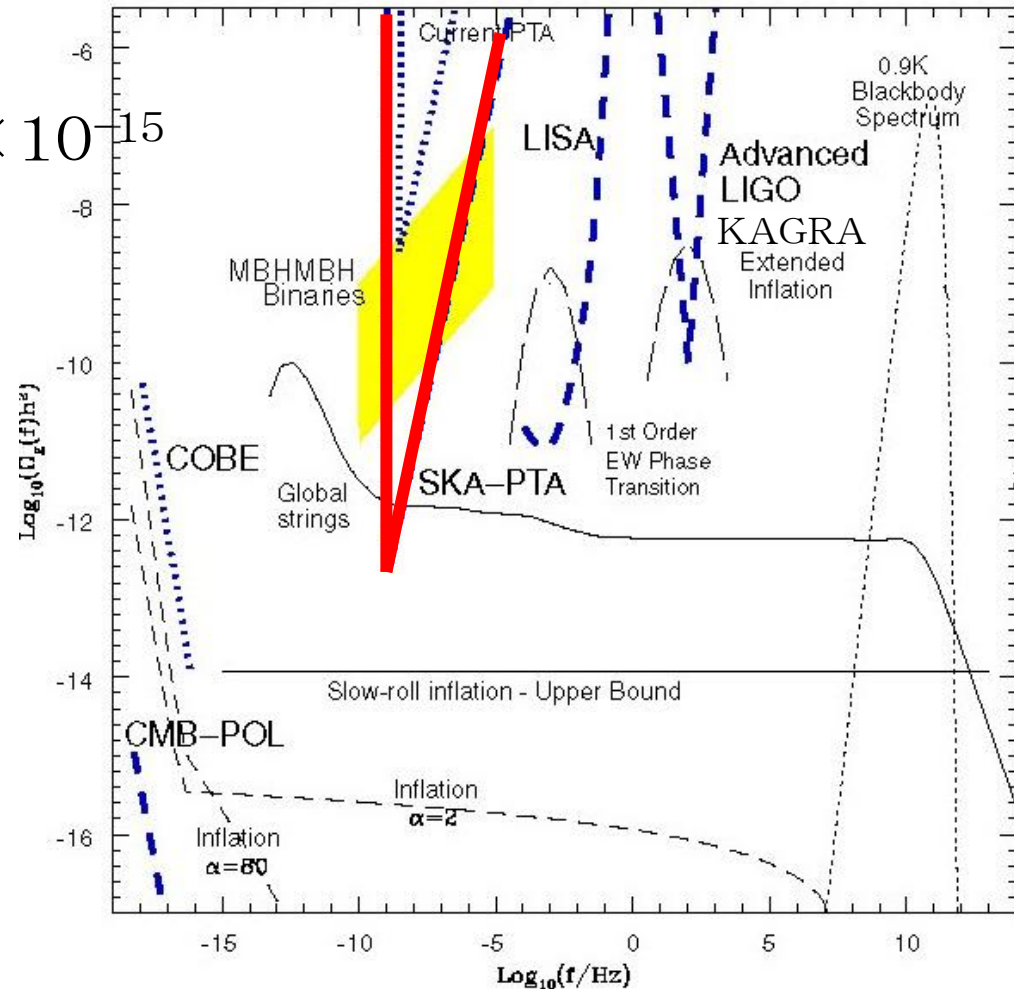
→ SMBH binary

sensitivity: $10 \text{ ns}/1 \text{ yr} \sim 3 \times 10^{-15}$



multi-wavelength GW astronomy

- CMB
- pulsar timing array
- space telescope
- ground telescope



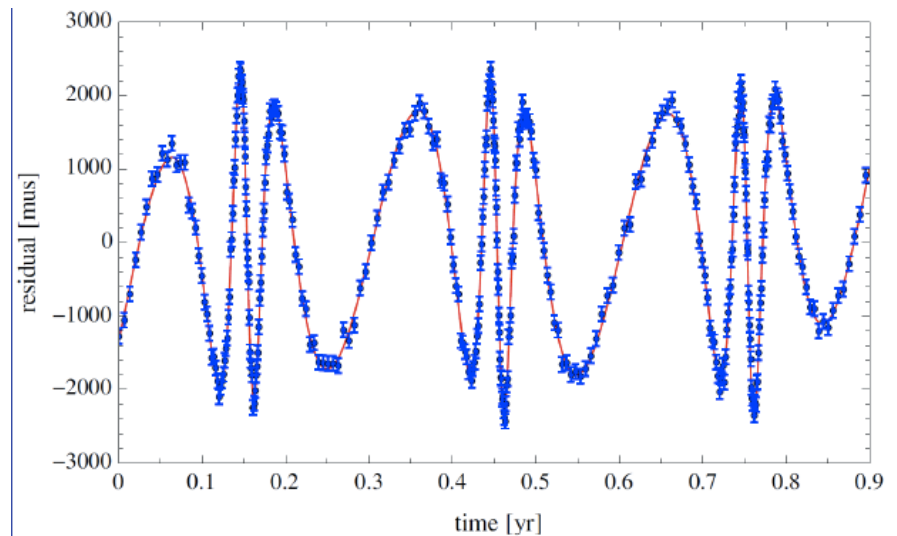
gravity test

- no-hair theorem
- cosmic censorship conjecture

pulsar at Galactic Center (1mpc)

→ measure mass, spin, quadrupole

→ test general relativity, constrain modified gravity



international status

- withdraw of Germany in 2015 (?)
- UK commitment: £ 100M (15% to construction)
- access principles (a model)
 - key science project: 50% (mostly member countries)
 - proposal: 50%
- re-baselining (2014–15)
 - cost estimation → €1B
 - cost cap: €650M
 - science prioritization

2、SKA Japan

SKA Japan



2008–, ~130 researchers

- Chair: Sugiyama (Nagoya)
- Vice Chair: Nakanishi (Kagoshima), Ichiki (Nagoya)
- Science Working Group: Takahashi (Kumamoto)
- Engineering Working Group: Nakanishi (Kagoshima)



SKA Japan Science & Engineering

Science Working Group

- high-z universe: Hirashita (ASIAA)
 - galaxy evolution: Takeuchi (Nagoya)
 - cosmology: Takahashi (Kumamoto)
 - EoR: Ichiki (Nagoya)
- pulsar: Kameya (NAOJ)
- magnetism: Akahori (Kagoshima)
- astrometry: Imai (Kagoshima)
- ISM: Handa (Kagoshima)
- transient: Aoki (Waseda)

Engineering Working Group

- correlator: Nakanishi (Kagoshima)
- wideband feed: Ujihara (NICT)
- software: Kurayama (Teikyo)
 - Faraday tomography, pulsar timing

SKA-Japan activity

- SKA-Japan Science Book (more than 200 pages!)
EoR, cosmology, galaxy evolution, magnetism
astrometry, pulsar, transient
2015.1 publish
2015.3.3-5 SKA-Japan Workshop 2015

- support from NAOJ
 - hire associate prof @ Kagoshima
send to SKA HQ
 - hire posdoc for EoR @ Nagoya
 - send students abroad @ Kumamoto

