Looking into the future of the radio reference frame with SKA

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Outline

- What is SKA?
- Combining SKA with VLBI arrays
- SKA-VLBI astrometric survey
Square Kilometre Array (SKA)

Two telescopes

Australia

0.05-0.35 GHz

2 m dipoles

+ headquarters (UK)

South Africa

0.35-14 GHz

15 m dishes

(possibly reaching 24 GHz ?)
SKA science

« Study the history of the Universe from its formation until now by using its main constituent, hydrogen »

SKA science summarized in two big volumes of 1000 pages each, …for a total weight of 9 kg
Key science drivers

- How were the first black holes and stars formed?
- How were the first galaxies formed? How do they evolve?
- What is the origin of cosmic magnetism?
- Was Einstein right about gravity?
- Are we alone?

… and the exploration of the unknown
SKA construction

- Design phase is ending (critical design reviews)

- Phase 1: 2021-2025+
  - 130,000 dipoles
  - 200 dishes
  - Construction cost cap: 674 M€

- Phase 2: 2025+
  - 1 million dipoles across Western Australia
  - 2000 dishes across 3500 km in Southern Africa
SKA Organisation

**Members**
- Australia
- Canada
- China
- France
- Germany
- India
- Italy
- New Zealand
- South Africa
- Spain
- Sweden
- The Netherlands
- United Kingdom

Treaty for setting up SKA Observatory signed on 12 March 2019 (inter-governmental organisation)

**Signatories of Treaty**
- Australia
- China
- Italy
- Portugal
- South Africa
- The Netherlands
- United Kingdom
Incorporating SKA as an element of a VLBI array will provide ultra-high sensitivity:

→ 100 μJy in 1 min to a 30 m dish.

SKA-VLBI feasibility is assessed as part of the JUMPING JIVE project.
African VLBI Network (AVN)

About 20 “retired” telecommunication antennas with large diameter (~ 30 m) identified over the African continent

→ Large potential to create an African VLBI network (AVN)
Independent sub-arrays: different purposes, up to 16

Simultaneous/commensal observing modes: Imaging/Non-Imaging

Independent multi-beam capability within each sub-array
Global astrometry science case

- Goal: observe 50,000 extragalactic sources selected from the Gaia celestial reference frame

- Should the sources be selected randomly or based on detection in deep radio surveys (e.g. ~10% of the 1.8 million NVSS sources seen in Gaia CRF2)?

- 250 targets measured per day, with 3 to 5 1-min long scans on every target → 200 days of observation

- Is this realistic?
Commensal observing?

- Gaia has one source per square degree
- Up to 52 beams over about 1° can be formed for any SKA sub-array

The idea would be to observe any Gaia CRF source that falls within the field of other SKA programs.
Thank you for your attention