The Square Kilometre Array and the Cradle of Life

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From planet formation to the distribution of life with the SKA

[Hoare et al. (2015), SKA and the Cradle of Life, in "Advancing Astrophysics with the Square Kilometre Array (AASKA14)": 115]
SKA books downloadable at www.skatelescope.org/books/

1. Explain planet formation.

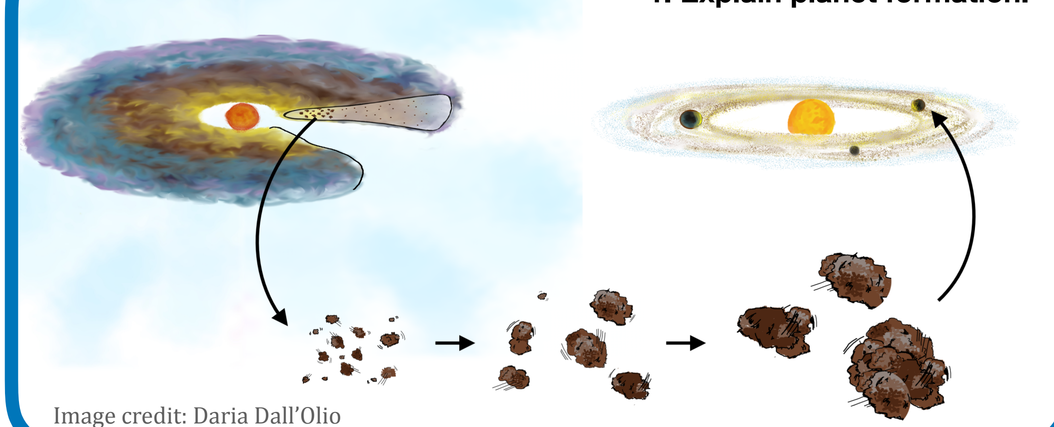
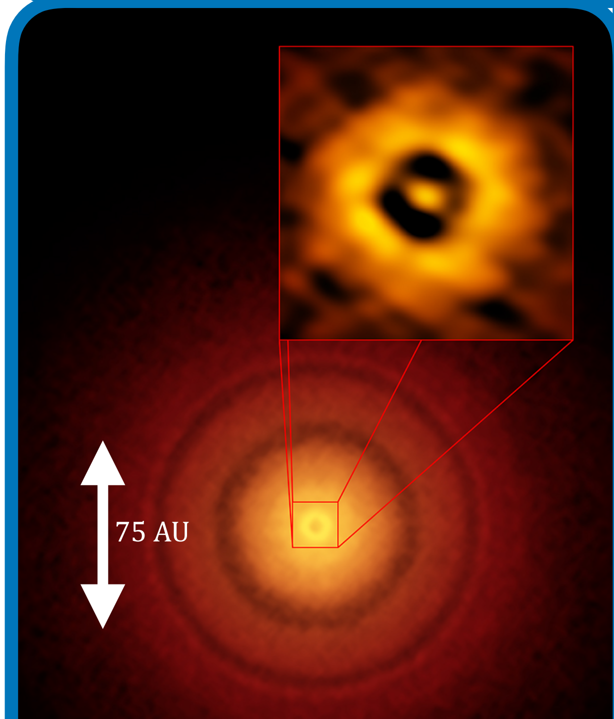
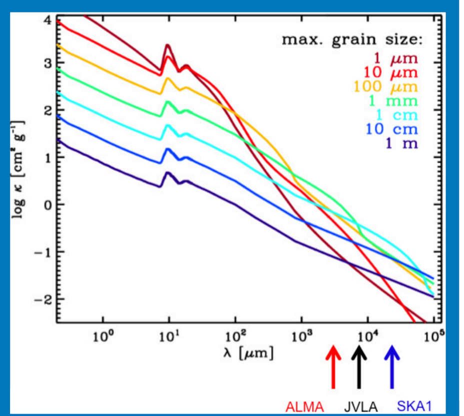


Image credit: Daria Dall'Olio



TW Hydrae protoplanetary disk observed with ALMA. Image credit: S. Andrews (Harvard-Smithsonian CfA), ALMA (ESO/NAOJ/NRAO)

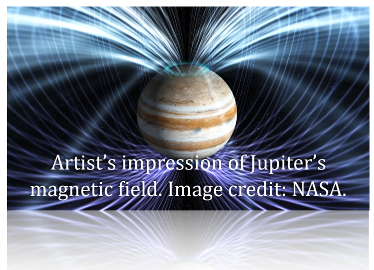
Coagulation of μm-sized dust particles in circumstellar disks is the first step in planet formation. Crossing the 'cm barrier' is theoretically challenging. Wavelength coverage and resolution of SKA is needed to observe cm-size grains at solar system scales and at low vertical scale-heights.
[See Testi et al. (2015), in AASKA14]



Opacities of various grain size distributions.
Figure from Hoare et al. (2015).

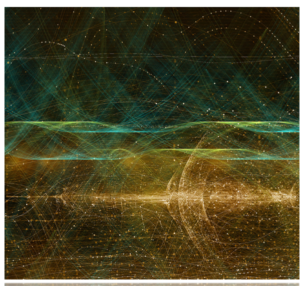
2. Detect and characterize large molecules in planet-forming regions.
Organic compounds relevant in cosmochechemistry and biology (e.g., sugar-like species, peptide-like bonds) are found in primordial meteorites and in analogs of the young Solar system[a]. Spectra of chemically rich sources at (sub)millimeter wavelengths suffer from extreme spectral line blending[b]. The same molecules have signatures at longer wavelengths. Advantages of the cm wavelengths are[c]: (1) spectra will be less crowded, (2) dust emission is optically thin.
[a] e.g., Altwegg et al. (2017), Ligterink et al. (2017); [b] e.g., Caux et al. (2011), Jørgensen et al. (2016); [c] Testi et al. (2015, in AASKA14).
Image credit: ESO/L. Calçada

3. Detect existence and study properties of exoplanet magnetic fields.
The magnetic field of a planet probes its interior and its habitability, because (1) it can protect the atmosphere and surface from high-energy particles, and (2) it may limit atmospheric escape. SKA1-low will be sufficiently sensitive to detect magnetospheric radio emissions revealing magnetic fields of gas giant planets, analogs of Jupiter, and potentially even signatures of exo-moons through their modulation of the auroral emission of the host planet. Intended sample: 250 stars and hundreds of exoplanets within 10 pc of Earth.
[See Zarka et al. (2015), in AASKA14]



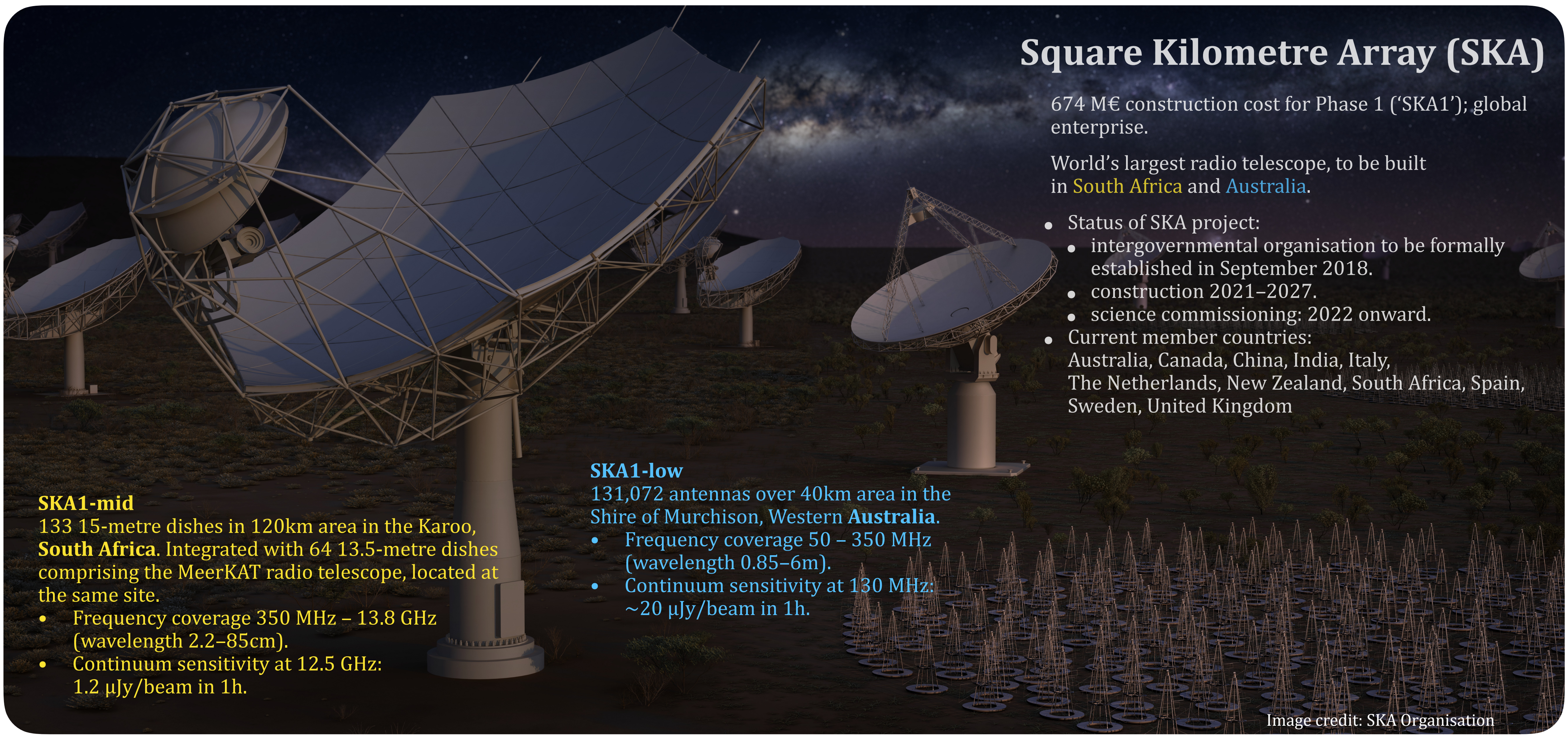
Artist's impression of Jupiter's magnetic field. Image credit: NASA.

4. Search for ExtraTerrestrial Intelligence (SETI).
SKA1 will be capable of detecting emission sources analogous to high-power terrestrial transmitters such as airport radars. For a source at 10 pc distance, a detection could be made in 15 minutes. With longer integrations, unbiased surveys of all (>10,000) stars within 60 pc are feasible.
[See Siemion et al. (2015), in AASKA14]



The SKA Cradle of Life science working group (SWG) is one of the eleven working groups advising the SKA Organisation on design, commissioning and future operations, with a focus on the above science topics. Sign-up is open to scientists from any country. Speak to **Matthijs**, or contact one of the current SWG chairs, **Izaskun Jimenez-Serra** or **Doug Johnstone**.
Note: SWG ≠ key science project (KSP). Proposals for KSPs: ~late 2022. KSPs will use ~50%–70% of time in first years of operations.

Square Kilometre Array (SKA)



674 M€ construction cost for Phase 1 ('SKA1'); global enterprise.

World's largest radio telescope, to be built in South Africa and Australia.

- Status of SKA project:
  - intergovernmental organisation to be formally established in September 2018.
  - construction 2021–2027.
  - science commissioning: 2022 onward.
- Current member countries:
  Australia, Canada, China, India, Italy, The Netherlands, New Zealand, South Africa, Spain, Sweden, United Kingdom

SKA1-mid
133 15-metre dishes in 120km area in the Karoo, **South Africa**. Integrated with 64 13.5-metre dishes comprising the MeerKAT radio telescope, located at the same site.
- Frequency coverage 350 MHz – 13.8 GHz (wavelength 2.2–85cm).
- Continuum sensitivity at 12.5 GHz: 1.2 μJy/beam in 1h.

SKA1-low
131,072 antennas over 40km area in the Shire of Murchison, Western **Australia**.
- Frequency coverage 50 – 350 MHz (wavelength 0.85–6m).
- Continuum sensitivity at 130 MHz: ~20 μJy/beam in 1h.

Image credit: SKA Organisation