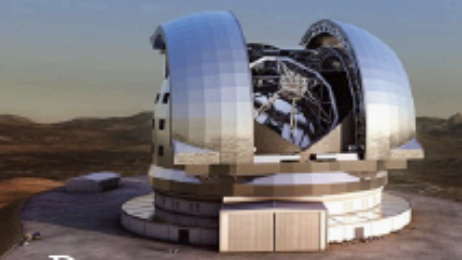


# Mapping the Universe with the Square Kilometre Array

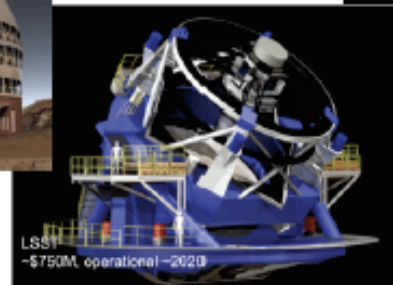
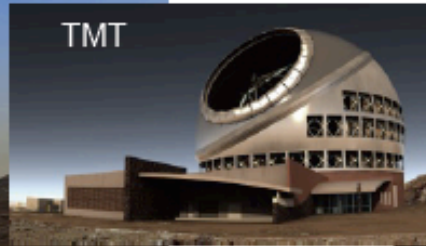
Isabella Prandoni  
INAF - IRA

# Great Observatories for >2020

E-ELT optical/IR



Programme approved

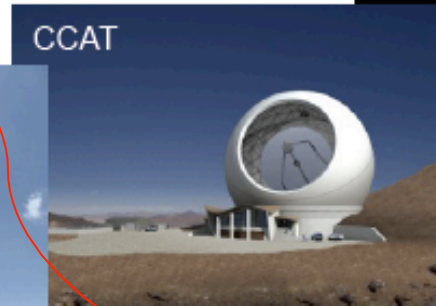


James Webb Space Telescope



due for launch in 2018

*From optical to radio*



ALMA: mm/submm  
Chajnantor Plateau  
@ 17,000 ft  
Early science now



16/06/16  
Inaugurated on 13<sup>th</sup> March 2013



# The SKA in a nutshell

## SKA: Major radio facility of the 21<sup>st</sup> Century

### Main parameters:

- **km<sup>2</sup> collecting area** → 100x sensitivity
- **Large FoVs** → 100x survey speed
- **3000+ km max baseline** → mas angular resolution
- **large frequency range [50 MHz – 24+ GHz]**

### Multi-messenger science:

- Fundamental Physics: Gravity, DE, cosmic magnetism
- Astrophysics: Cosmic dawn & first gals, gal. assembly and evol., proto-planetary disks, biomolecules, etc.
- The Unknown: transients, SETI, ...



# SKA Key Science



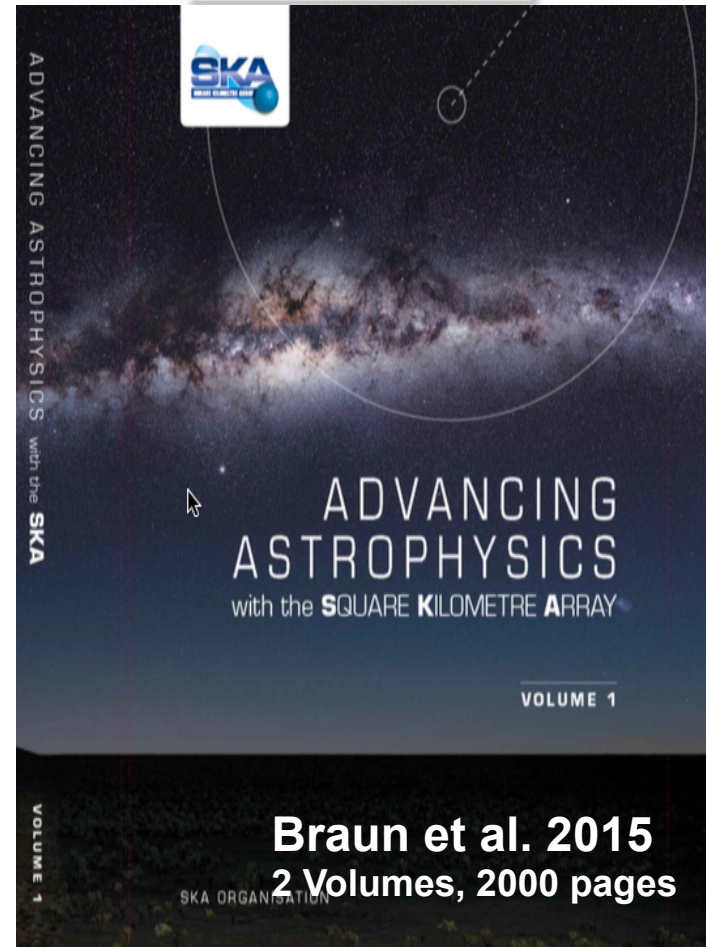
## SKA Science Book – Updated in 2015!

- Strong-field Tests of Gravity with Pulsars and Black Holes  
**Phase 1 headline science**
- Galaxy Evolution, Cosmology, & Dark Energy  
**Phase 1 “H I through cosmic time” headline science**
- Emerging from the Dark Ages and the Epoch of Reionization  
**Phase 1 “H I through cosmic time” headline science**
- The Cradle of Life & Astrobiology
- The Origin and Evolution of Cosmic Magnetism

With design philosophy of *Exploration of the Unknown*

16/06/16

I. Prandoni



# SKA Key Science

## SKA Science Book – Updated in 2015!

- Strong-field Tests of Gravity with Pulsars  
Black Holes

### Phase 1 headline science

- Galaxy Evolution, Cosmology, & Dark Energy

### Phase 1 “H I through cosmic time” headline science

- Emerging from the Dark Ages and the Epoch of Reionization

### Phase 1 “H I through cosmic time” headline science

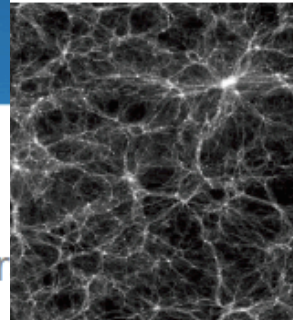
- The Cradle of Life & Astrobiology
- The Origin and Evolution of Cosmic Magnetism

With design philosophy of *Exploration of the Unknown*

5/16/14

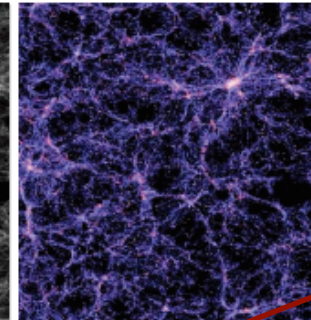
I. Prandoni

Millennium Simulation  
(Springel et al. 05)  
Dark matter



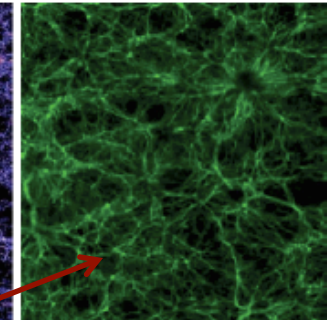
DM haloes, merger trees

Semi-analytics  
(De Lucia et al. 06/07)  
Visible matter

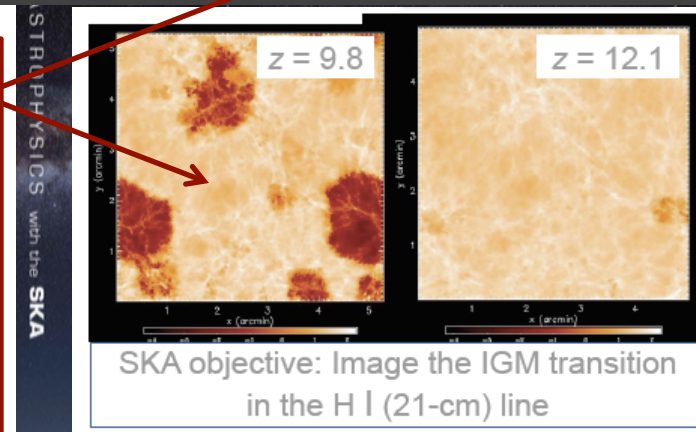


SFR, cold gas mass

Post-processing  
(Obreschkow et al. 08)  
Neutral atomic hydrogen



HI from cold gas mass



SKA objective: Image the IGM transition  
in the H I (21-cm) line

VOLUME 1

VOLUME 1

Braun et al. 2015  
2 Volumes, 2000 pages

SKA ORGANIZATION

# SKA Key Science



All-sky RM/pol. surveys provide information on magnetic fields ( $B_{||}$  and  $B_{\perp}$ ) for all environments

## SKA Science Book – Updated in 2015!

- Strong-field Tests of Gravity with Pulsars  
Black Holes

### Phase 1 headline science

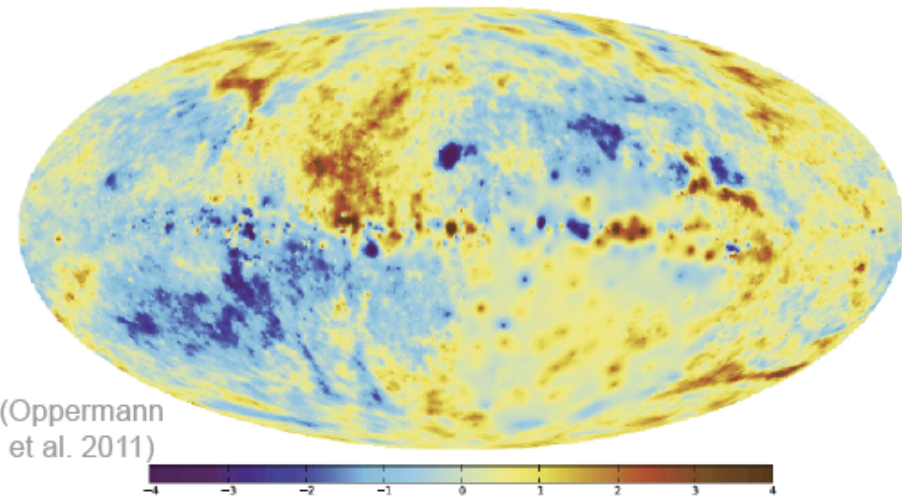
- Galaxy Evolution, Cosmology, & Dark Matter  
Phase 1 “H I through cosmic time” headline science

- Emerging from the Dark Ages and the Reionization

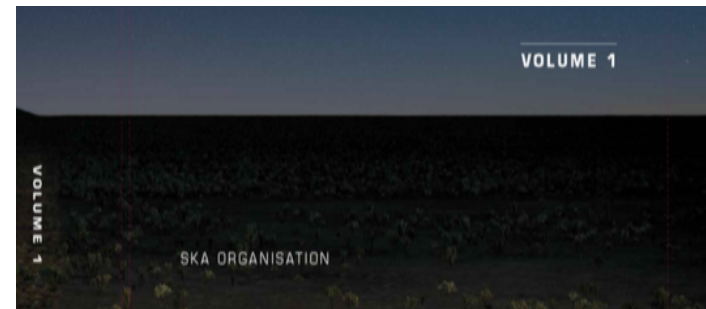
### Phase 1 “H I through cosmic time” headline science

- The Cradle of Life & Astrobiology
- The Origin and Evolution of Cosmic Magnetism

With design philosophy of *Exploration of the Unknown*



(Oppermann et al. 2011)



# The SKA in Phases

## SKA will be implemented in phases:

- SKA<sub>1</sub> subset (~10% area) of SKA<sub>2</sub>

**SKA1-low** (sparse AA): Freq. Range: 50 - 350 MHz

Australia ~80 km baselines

**SKA1-mid** (dish+SPF): Freq. Range: 0.35 – 14(24) GHz

South Africa (3 Bands)

~150 km baselines

- SKA<sub>2</sub> : full SKA sensitivity/baseline/frequency capability
- between 50 MHz and 24 GHz

- **SKA-related science already started with**
  - **pathfinders** (*JVLA, e-MERLIN, Apertif, ATCA-CABB, LOFAR*)
  - **precursors** (*MeerKAT, ASKAP, MWA*)



# The Roadmap to SKA

- **SKA Key Project definition has started in 2015 and will end in 2018**

Re-baselining (2015) introduced concept of *'notional'* Science KPs (5 years of operations)

Science Goal	SWG	Objective
1	CD/EoR	EoR - I. Imaging
2	CD/EoR	EoR - II. Power spectrum
4	Pulsars	Reveal pulsar population
5	Pulsars	High precision timing
13	HI	Resolved HI out to $z \sim 0.8$
14	HI	ISM in the nearby Universe.
15	HI	ISM in our Galaxy
18	Transients	Fast Radio Bursts
22	Cradle of Life	Map dust grain growth
27	Magnetism	All-Sky magnetic fields
32	Cosmology	Gravity on super-horizon scales.
33	Cosmology	Non-Gaussianity and the matter dipole
37+38	Continuum	Star formation history of Universe

**Same dataset: HI, continuum, polarization**

**Exploitation of synergies & commensality important part of SKA KP definition:**

- Survey strategy/Fields
- **Scientific synergies:**
  - Galev: HI+continuum
  - ...



# The Roadmap to SKA

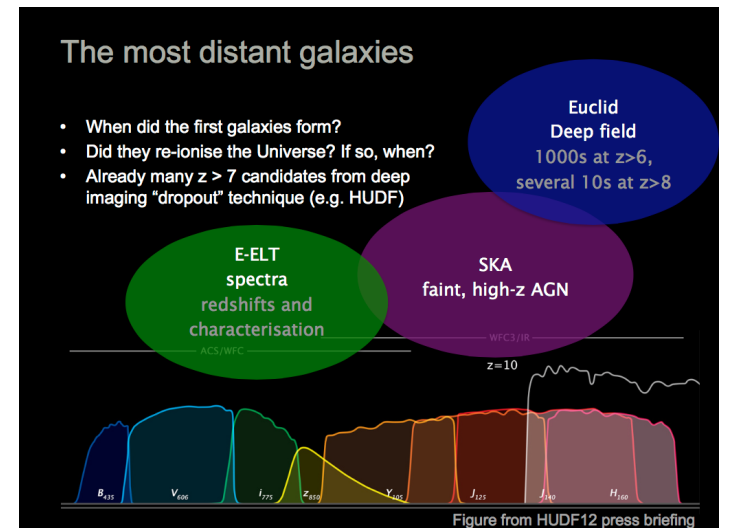
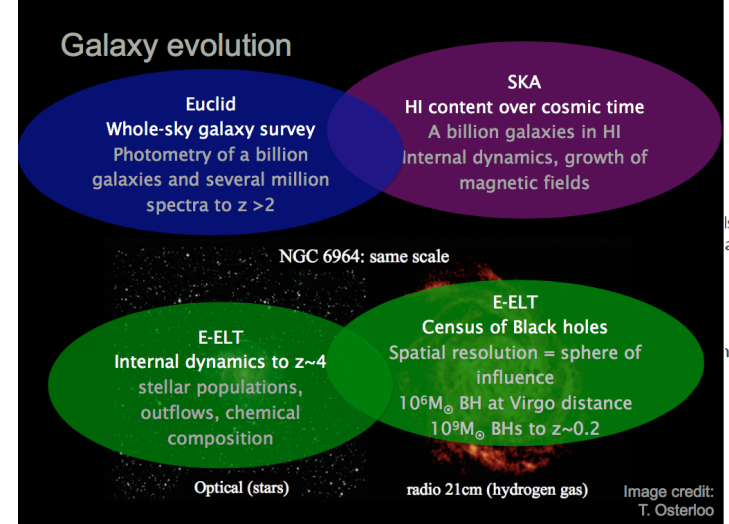
**Exploitation of synergies & commensality important part of SKA KP definition → multi-band approach:**

- Survey strategy
- Fields
- **scientific synergies**

*Toward an Italian roadmap:*

- More Coordination + fundings (*PRIN SKA+CTA*)
- Explore ways to get involved in precursors
- Synergies with other projects/facilities (especially those led by Italy)
- Exploit Italy-based/led facilities (e.g. WEAVE/LBT for LOFAR)

*I. Hook @ SKA-Euclid Synergies, Oxford, 2013*



**Grazie!**