

Netherlands Institute for Radio Astronomy

# Aperture arrays The future of radio astronomy...

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ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

#### Aperture arrays



- Large field-of-view
- Multi-directional
- Flexible
- SKA technology



#### EMBRACE: AA-mid technical demonstrator

- 400-1500MHz
- area: 100m<sup>2</sup>
- temperature: 100K
- TWO analogue beams
- ~200 digital beams (195.3kHz wide
- ~40MHz bandwidth
- single polarization

#### Nançay station (France)

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WSRT station (Netherlands)



#### EMBRACE results: WSRT





#### On-off strategy





#### EMBRACE results: Nançay



#### Limits for EMBRACE



imaging dynamic range

- polarization
- bandwidth

Need for science capable instrument

- (post-)processing
- big gap towards SKA





#### African European Radio Astronomy Aperture Array (say: AERA-cubed)

Aperture array radio telescope in Africa



Science capable

#### **Basic specs**



- 2000m<sup>2</sup> (A/T ~ 40 m<sup>2</sup>/K)
- multiple stations
- full Stokes
- 2 FoV, 64 digital beams
- ■~80 deg<sup>2</sup> per FoV
- ■T<sub>sys</sub> ~50K
- bandwidth <500MHz</p>
- frequency range TBD:300 1500 MHz



#### Configuration



- ~dozen stations
- ~15m diameter
- compact core
- Iongest baseline between 300-1000m



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- Cosmology (intensity mapping, BAO): galaxies going through growing pains
- Search for pulsars: the best clocks in the Universe
- Surveys of the whole sky: deepen our understanding of the static Universe
- Transient detection machine: new discoveries in the dynamic Universe (e.g. Lorimer bursts)

#### **Baryonic Acoustic Oscillations**



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#### **Baryonic Acoustic Oscillations**



Abdalla & Rawlings 2010



#### Galactic polarization





#### Transient machine





### Neutral hydrogen

Cosmic flow

- Nearby small structures
- Associated absorption



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 $10^{8}$ 

#### Local HI







#### Tobias Westmeier, CSIRO Australia Telescope National Facility

Based on the Leiden/Argentine/Bonn Survey (Kalberla et al. 2005, A&A 440, 775) and the Milky Way model of P. Kalberla (Kalberla et al. 2007, A&A, in press).



#### More science goals



#### Search for pulsars and timing experiments

Continuum surveys

Recombination lines



#### Technical goals



Double polarization tiles

- Imaging capability over wide field-of-view (piggy-back on LOFAR developments)
- Calibration and processing
- Fully digital beam-forming

...



#### AERA3 participants

#### Interests from:

- ASTRON
- South Africa: UCT, UWC, Rhodes, ...

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- Observatoire de Paris
- Spain & Portugal

 First assessment of science interest workshop on AERA3 science
Cape Town, 22-2-2014

